A new proposed guidance system for beverage consumption in the United States[1–3]

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ABSTRACT

The Beverage Guidance Panel was assembled to provide guidance on the relative health and nutritional benefits and risks of various beverage categories. The beverage panel was initiated by the first author. The Panel's purpose is to attempt to systematically review the literature on beverages and health and provide guidance to the consumer. An additional purpose of the Panel is to develop a deeper dialog among the scientific community on overall beverage consumption patterns in the United Sates and on the great potential to change this pattern as a way to improve health. Over the past several decades, levels of overweight and obesity have increased across all population groups in the United States. Concurrently, an increased daily intake of 150–300 kcal (for different age-sex groups) has occurred, with approximately 50% of the increased calories coming from the consumption of calorically sweetened beverages. The panel ranked beverages from the lowest to the highest value based on caloric and nutrient contents and related health benefits and risks. Drinking water was ranked as the preferred beverage to fulfill daily water needs and was followed in decreasing value by tea and coffee, low-fat (1.5% or 1%) and skim (nonfat) milk and soy beverages, noncalorically sweetened beverages, beverages with some nutritional benefits (fruit and vegetable juices, whole milk, alcohol, and sports drinks), and calorically sweetened, nutrient-poor beverages. The Panel recommends that the consumption of beverages with no or few calories should take precedence over the consumption of beverages with more calories. *Am J Clin Nutr* 2006;83:529–42.

KEY WORDS Water, tea, coffee, milk, fruit juice, alcohol, calorically sweetened beverages, beverage guidance system

INTRODUCTION

The development of the Beverage Guidance System was motivated by the large increase in unhealthy weight patterns in the United States over the past 20 y and the 5–15% increase in dietary energy intake during that same period. Although the focus of the US Dietary Guidelines for Americans has been on food, energy intake from beverages currently represents 21% of the total energy intake for Americans aged >2 y (1). This quantity of calories from fluids, which is predominantly from calorically sweetened beverages, adds to the energy intake from current foodstuffs in our diet and is a contributing factor to the energy excess needed to produce obesity (2–4). Depending on the reference point, the average calorie intake for all Americans aged >2 y has increased by ≈150–300 kcal/d for different age-sex groups (5, 6). Data also show that ≈50% of this increase is contributed by the consumption of calorically sweetened beverages. Between 1977 and 2001, the proportion of energy obtained from calorically sweetened soft drinks and fruit drinks, which—as defined later—are different from fruit juices, has increased 3-fold, from 2.8% to 7.0% (50–144 kcal/d), with a concurrent reduction in milk intake (1). Portion sizes of calorically sweetened beverages for all ages increased from 13.6 fl oz (402 mL) to 21.0 fl oz (621 mL) between 1977 and 1996—a proportionately larger increase than the increase in the number of servings (1). At the same time that portion sizes have increased, Americans have also increased the number of servings of calorically sweetened beverages from 1.96 in 1977 to 2.39 in 1996. Servings are measured for beverages according to US Department of Agriculture (USDA) standards. Our proposed guidance thus focuses on obtaining as much of the daily fluid needs as possible from beverages that have lower amounts of energy and an improved nutrient profile.

The Beverage Guidance Panel was assembled to provide guidance on the relative health and nutritional benefits and risks of various beverage categories. A healthy diet does not rely on fluids to provide energy or nutrient needs. Therefore, potable water could be used to fulfill almost all the fluid needs of healthy individuals. However, to allow for variety and individual preferences, healthful diets may include several other types of beverages. In fact, the other motivation for this Beverage Guidance System was to help consumers select a variety of beverages.

There is evidence that beverages have weak satiety properties and elicit poor dietary compensation. Studies of appetitive sensations (eg, hunger, fullness, and prospective consumption) support the view that fluids are less satiating than are solid foods (7–9). Dietary compensation (the adjustment in energy intake made by individuals in subsequent meals in response to earlier food intake) has been studied with solid, semisolid, and fluid foods. For fluids, Mattes (10) reported a complete lack of compensation, which suggests that fluid calories are not readily

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"registered" for appetite regulation. Another study found that ingestion of 450 kcal of calorically sweetened fruit drink produced a significant increase in body weight that was not found when the same amount was consumed in solid form by the same individuals (11). The mechanisms for this weaker compensatory response to fluids are not known.

The Panel on Water and Electrolytes of the Institute of Medicine (IOM) has recognized that fluid requirements vary widely among individuals and populations (12). Therefore, no estimated average requirement (EAR) has been set for water, and an adequate intake (AI) was defined instead. The AI, derived from the usual intake of total fluids in the general population, was set at 125 fl oz (3.7 L)/d for men and 91 fl oz (2.7 L)/d for women. About 80% of those daily needs is contributed by beverages, including water, and the rest by solid foods (12). Conversely, the contribution of fluids to meeting the Recommended Dietary Allowance (RDA) for essential nutrients is minimal, except for milk and fruit juices. This balance between energy and nutrient content is a critical factor to define the role of beverages in a healthy diet. In this proposed guidance system, we have ranked beverages with water at the bottom (level 1), to be consumed frequently, and calorically sweetened beverages at the top (level 6), which should be consumed sparingly.

The focus of the proposed guidance system is on caloric and noncaloric sweeteners and other substances that affect the energy density (kcal/100 mL) and nutrient density of each beverage. It is recognized that the concept of "energy density" for solid and liquid foods may not be equivalent, particularly when focusing on hunger and satiety responses; however, the concept is used by some scholars for solid foods, soups, and beverages (13–17), whereas others do not use this concept in their measurement (18). In this article, we use a simple operational definition that is based on caloric content per unit volume. Relative to most foods, beverages have a low energy density [<350 kcal/12 fl oz (355 mL)] because water is the item that reduces energy density the most (19–22). Thus, relative energy density within each beverage category was compared with other beverage categories.

Our recommendations are aimed at the population older than 6 y. Below that age, there are many additional factors, such as development of taste preferences and early imprinting of food choices, that may affect beverage choice and intake.

TERMS AND DEFINITIONS

We defined beverages as all fluids consumed by humans, including water. However, we excluded liquid meal replacement products aimed at weight management as well as soups. In assessing each beverage category, we considered the following factors:

1) Energy and nutrient density. Energy density was defined as kcal/100 mL. Nutrient density was defined as the nutrient content (in nutrient-specific units) per 8 fl oz (237 mL) and per 100 mL (3.4 fl oz).
2) Contribution to total energy intake and body weight.
3) Contribution to the daily intake of essential nutrients.
4) Evidence for beneficial health effects.
5) Evidence for adverse health effects.

The Panel used 8 fl oz (237 mL) as the reference unit. Eight ounces is the official FDA (Food and Drug Administration) portion size used for food labels; however, the actual portion size served and consumed is larger. For instance, for soft drinks this was 19.9 fl oz for the average American aged ≥2 y in 1994–1996 (23). The USDA food-composition table uses 8 fl oz (237 mL). We also recommend that calorically sweetened beverages move back to the 8-oz beverage size. A set of definitions for all the key concepts used in discussing beverages in this review is provided in **Table 1**.

THE BEVERAGE GUIDANCE SYSTEM

This Beverage Guidance System ranks beverages in 6 levels, from the least preferred by the Panel (Level 6—beverages that should be consumed in limited quantities) to the most preferred by the Panel (Level 1—those that should be consumed as the major beverage, ie, water).

It is not possible to define a set amount of water for each person because the water needs depend partially on overall diet and the water contained in the foods. An example from the IOM report on water and electrolytes (12) of a healthy menu that fulfills all nutrient requirements, including fiber, for a healthy man is shown in **Table 2**. In this example, beverages provide 76% of the total fluid needs; the remainder comes from solid foods. This table can be viewed in terms of total fluid intake. This person's diet requires 96.3 fl oz (2849 mL) of beverage intake. Of these beverages, the main contributor is tea (33%), followed by potable water (25%), coffee (21%), milk (15%), and orange juice (6%). A key message in this example is that all beverages combined contribute only 14% of the total caloric intake.

On the basis of the rationale outlined above, different combinations of beverages can be used to fulfill the fluid needs of a healthy person. Potable water has the advantage that it is virtually devoid of adverse effects when consumed within the allowable intake.

Level 1: water

Water consumption is necessary for metabolism and for normal physiologic functions and may provide essential minerals such as calcium, magnesium, and fluoride. For a detailed review of the maintenance of water balance, see the IOM report on water and electrolytes (12). Despite the importance of water for human life, and because of our incomplete understanding of everyday water turnover, in recent years scientists have begun studies of human water requirements, of hydration, and of the relation between hydration status and human health (24–26).

Acute dehydration results in impaired cognition, moodiness, poor thermoregulation, reduced cardiovascular function, and impaired physical work capacity. These expenses can be charged to an overhead or trust account (12). The effects of dehydration on cognitive function have been studied in several randomized controlled clinical trials, in which dehydration was achieved by fluid restriction, heat exposure, exercise, or combinations thereof (27). In healthy young adults, dehydration to 2.8% body weight loss by heat exposure or exercise significantly decreased alertness, concentration, tracking performance, and short-term memory and increased tiredness, headaches, and reaction time (28). In the only study performed in older subjects (healthy 50–82-y-olds), dehydration by overnight fluid restriction was related to slower psychomotor processing speed, poorer attention, and diminished memory (29).

TABLE 1
Glossary of definitions of the key concepts and beverages

Metabolic water	Water formed during the metabolism of food.
Potable water	Whether supplied from ground water or underground aquifers, water suitable for human consumption, free of pathogens and major pollutants, containing <50 mg nitrates/L (European standard), and not having toxic amounts of any mineral.
Added caloric sweeteners	All the composite sugars added to a food, including sucrose, high-fructose corn syrup, honey, molasses, and other syrups.
Naturally occurring sugars	Sugars occurring in food and not added in processing, preparation, or at the table.
Calorically sweetened beverages	Any beverage to which a caloric sweetener has been added, including carbonated or noncarbonated soft drinks, fruit punch, fruit drinks, lemonade, sweetened powder drinks, or any other nonartificially sweetened beverages. Excluded from this definition are sugars naturally present in fluids and that are not added in processing, in preparation, or at the table.
Soft drinks	Nonalcoholic carbonated or noncarbonated beverages containing caloric sweeteners and flavorings.
Fruit drinks	Calorically sweetened beverages with a small percentage of a fruit juice or juice flavoring containing carbonated water and flavoring.
Fruit and vegetable juices	Beverages that are composed exclusively of an aqueous liquid or liquids extracted from one or more fruits or vegetables with no added caloric sweeteners.
Noncalorically sweetened beverages	Soft drinks (diet sodas) or fruit drinks sweetened with Food and Drug Administration–approved noncaloric sweeteners. Noncaloric sweeteners do not provide calories, but they do provide the sweet taste. Noncaloric sweeteners currently include aspartame (Equal[1] or NutraSweet[1]), acesulfame K (Sunett[2]), saccharin or benzosulfamide (Sweet'n Low[3]), and sucralose (Splenda[4]). All are many times sweeter than sugar per gram.
Energy density	Kilocalories per 8 fl oz (237 mL) of beverage.
Nutrient density	Amount of each nutrient in 8 fl oz (237 mL) of beverage. The health benefits and risks to be considered include noncommunicable diseases such as obesity, type 2 diabetes, heart disease, various cancers, dental caries, and bone health.

[1] Merisant, Chicago, IL.
[2] Nutrinova Inc, Somerset, NJ.
[3] Cumberland Packing Corp, Brooklyn, NY.
[4] McNeil Nutritionals (Johnson & Johnson), Washington, PA.

The adverse effects of acute dehydration on physical work capacity and exercise performance are well established (30), especially when dehydration exceeds 1–2% of body weight (31, 32).

Chronic dehydration increases the risk of bladder cancer (12). However, some of the effects are not well established, because few studies have focused on chronic disease outcomes. Between 2001 and 2004, 11 of 13 studies showed a significant association

TABLE 2
Daily water intake from a diet providing 2200 kcal energy and adequate intake of all essential nutrients[1]

Meal	Food or beverage consumed	Energy	Water
		kcal	*mL*
Breakfast	Total food	299	83
	Milk, 1% (8 fl oz)	102	237
	Orange juice (6 fl oz)	82	177
	Coffee (12 fl oz)	13	355
	Total for meal	496	852
Snack	Total food	105	88
	Water (12 fl oz)	0	355
	Total for snack	105	443
Lunch	Total food	534	190
	Iced tea, brewed, decaffeinated (16 fl oz)	5	473
	Total for meal	539	663
Snack	Total food	314	7
	Milk, 1% (8 fl oz)	102	237
	Water (12 fl oz)	0	355
	Total for snack	416	599
Dinner	Total food	649	523
	Iced tea, brewed, decaffeinated (16 fl oz)	5	473
	Coffee, decaffeinated (8 fl oz)	9	237
	Total for meal	663	1233
Total	Energy and water from foods	1,901	891
	Energy and water from beverages	318	2899
	Total energy and total water (all sources)	2,219	3790

[1] Data are from the Institute of Medicine Panel on Dietary Reference Intakes for Electrolytes and Water, 2004 (12). 1 oz = 29.574 mL.

between improved hydration status and reduced kidney stone occurrence (33, 34).

Excess water intake can occur; however, this is rare in healthy persons with properly functioning kidneys because the kidneys can produce a large volume of urine in a relatively short period of time to correct the disturbance. Only in exceptional circumstances does hyperhydration occur (ie, 1 out of 1000 ultraendurance competitors), resulting in the dilution of body fluids and a low serum sodium concentration (ie, $<$136 mEq Na^+/L) (35). Drinking water may contain different concentrations of Ca^{++} and Mg^{++}, which contribute to meeting the recommended dietary intakes of these minerals (36). Calcium and magnesium from bottled water are well absorbed and utilized (37–39). The fluoride content of bottled water is usually much lower than fluoridated tap water, but on occasion it may exceed advisable concentrations (40).

Level 2: tea and coffee

Tea

Black, green, and oolong tea are the 3 main categories of tea consumed in the world. Tea provides a variety of flavonoids and antioxidants as well as a few micronutrients, in particular fluoride (41). Although there is solid evidence that tea protects against chemically induced cancers in experimental animals, it remains unclear whether tea consumption lowers cancer risk in humans (42). Tea also provides some amino acids, primarily theanine. Recently, theanine was shown to enhance innate immunity—the body's ability to resist infections—by stimulating γ-δ T cells (43), and this effect has been replicated with regular (5–6 cups/d, or 1185–1422 mL/d) tea consumption in humans (43–45). Tea consumption may also increase bone density (46), reduce tooth decay and cavities (47), and reduce kidney stones (48, 49).

Numerous epidemiologic studies have examined the association between tea consumption and the risk of cardiovascular diseases. A meta-analysis that combined the data from 10 prospective cohort studies and 7 case-control studies concluded that an increase in tea consumption of 3 large cups/d (24 fl oz, or 710 mL) is associated with an 11% decrease in the risk of myocardial infarction (50). However, the results among prospective cohort studies are inconsistent. A 6-y study of Dutch men and women found that those who drank $\geq$3 cups/d ($\approx$13 fl oz) had a significantly lower risk of myocardial infarction than did nondrinkers (51). A 7-y study of US women found that the risk of vascular events was significantly lower in a small number of women who drank $\geq$4 cups black tea/d (52). Finally, a 15-y study of US men found no association between tea consumption and cardiovascular disease risk, but tea consumption in this population was relatively low, averaging 1 cup/d (53). Overall, the current data suggest that consumption of $\geq$3 cups black tea/d may modestly decrease the risk of myocardial infarction. Although green tea consumption may confer a similar benefit (54), there is currently not enough data to draw firm conclusions.

Recent evidence suggests that tea consumption improves endothelium-dependent vasodilation, which could explain, at least in part, a reduction in cardiovascular disease risk (55). Two clinical studies found that the daily consumption of 4–5 cups (30–40 fl oz) black tea for 4 wk significantly improved endothelium-dependent vasodilation in patients with coronary artery disease (55) and in patients with mildly elevated serum cholesterol concentrations (56) compared with the equivalent amount of caffeine or hot water. In agreement with these studies, a recent double-blind crossover study found that acute consumption of black tea improved coronary vessel function, as assessed by coronary flow velocity reserve (57). The beneficial effects of tea consumption on endothelium-dependent vasodilation may be explained by activation of endothelial nitric oxide synthase (eNOS) by tea flavonoids, via an estrogen receptor α-dependent pathway (58). Despite these intriguing results, the potential health benefits of flavonoids in tea and their antioxidant compared with nonantioxidant mechanisms of action remain to be fully explored (59).

Coffee

Several prospective cohort studies have observed significant inverse associations between regular coffee consumption and the risk of type 2 diabetes (60–63). In a US cohort, a modest inverse association between decaffeinated coffee consumption and the risk of type 2 diabetes also was observed, which suggests that compounds other than caffeine may contribute to risk reduction (61). High intakes of coffee have been associated with significant reductions in colorectal cancer risk in numerous case-control studies, but prospective cohort studies have not generally observed such significant associations (64, 65). Coffee and caffeine consumption have been consistently associated with significant reductions in the risk of Parkinson disease in men (66) but not in women (67), which may be due to the modifying effects of estrogen. In 2 large prospective cohort studies, coffee consumption was inversely associated with the risk of Parkinson disease in women who had never used estrogen postmenopausally, but inverse associations were not observed in women who used estrogen postmenopausally (67, 68). In the Nurses' Health Study, daily consumption of $\geq$6 cups of coffee was associated with a significant increase in Parkinson disease risk among postmenopausal estrogen users (68). Two prospective cohort studies in the United States found significant inverse associations between coffee consumption and the risk of suicide (69, 70). However, a J-shaped relation between coffee consumption and the risk of suicide was observed in Finland, where daily consumption of $\geq$8 cups of coffee was associated with a significant increase in the risk of suicide compared with more moderate consumption (71).

Most large prospective cohort studies have not found high intakes of coffee or caffeine to be associated with a significantly increased risk of coronary heart disease or myocardial infarction (72–74). In contrast, coffee consumption has been associated with increases in several cardiovascular disease risk factors. The consumption of boiled unfiltered coffee has been found to increase plasma total and LDL-cholesterol concentrations, whereas the consumption of filtered coffee does not appear to have adverse effects on lipid profiles (75). The diterpenes cafestol and kahweol have been identified as cholesterol-raising factors in roasted coffee beans (76). Diterpenes are extracted by hot water when coffee is brewed, and they are trapped by paper filters. Consequently, filtered coffee contains very little cafestol and kahweol, whereas boiled coffee and espresso may contain significant amounts (77). Controlled clinical trials have found that high intakes of filtered and unfiltered coffee increase plasma homocysteine concentration—an independent risk factor for cardiovascular diseases (78, 79). In randomized controlled trials, caffeinated coffee consumption has been found to result in modest but significant increases in systolic (2.0–2.4 mm Hg) and

diastolic (0.7–1.2 mm Hg) blood pressure (75, 80). Although coffee consumption was associated with small increases in systolic and diastolic blood pressure in one prospective cohort study, the risk of developing hypertension after an average of 33 y was not affected (81).

Caffeine intake

There are greater amounts of caffeine in coffee than in tea (**Table 3**). Although caffeine is a mild diuretic, human studies indicate that caffeine consumption of up to ≈500 mg/d does not cause dehydration or chronic water imbalance (82, 83). A caffeinated beverage's fluid content compensates for an acute diuretic effect. At this time, the preponderance of evidence in healthy adults suggests that a moderate caffeine intake up to 400 mg/d is not associated with an increased risk of heart disease, hypertension, osteoporosis, or high cholesterol (84). Some people are more sensitive to caffeine's effects than are others and may feel effects at lower doses. Pregnancy and aging may affect one's sensitivity to caffeine. Pregnant women are often advised to limit caffeine consumption because caffeine intakes >300 mg/d have been associated with an increased risk of miscarriage and low birth weight (85–87). It is unclear whether caffeine has adverse effects in children, but concerns regarding its effects on the developing nervous system have led to recommendations that daily caffeine intake by children should be limited to 2.5 mg/kg body weight (84).

Interestingly, a variety of investigations report an "inverted U" relation when a physiologic or psychological response is plotted versus caffeine intake. That is, the magnitude of caffeine's effect is smaller at low and high intakes but greater at intermediate intakes. Such a relation has been reported for exercise performance time (88, 89), reaction time (90), vigilance (91), information processing (92), and mood state (93) but may not exist for all physiologic and psychological responses. Furthermore, this graphic relation may shift left or right, with caffeine habituation or naiveté.

Added calories

Addition of milk, cream, or caloric sweeteners to coffee and tea increases the energy density of these beverages and would lower their value in this guidance system. This might be particularly important for gourmet coffee users who consume a lot of high-energy coffee drinks. For instance, Shields et al (94) found in one very small sample of college women that gourmet coffee drinkers consumed 206 more calories per day than did nongourmet coffee drinkers. The high caloric content of some gourmet coffee drinks is shown in Table 3. Sweetened tea provides smaller amounts of energy than does gourmet coffee, as noted in Table 3.

Level 3: low fat (1.5% or 1%) and skim (nonfat) milk and soy beverages

For children, milk is the current key source of vitamin D and calcium and is an excellent source of high-quality protein. Low fat and skim milks, including low-fat yogurt drinks, can contribute to a healthy diet but are not essential. Fortified soymilk is a good alternative for individuals who prefer not to consume cow milk, although consumers should be aware that soymilk cannot be legally fortified with vitamin D and provides ≈75% of the calcium bioavailable from milk (95). Yogurt drinks have a lower lactose content than does milk and may be preferred by individuals with reduced lactose tolerance. In general, low-fat dairy beverages and fortified soymilk provide an important source of protein, calcium, and other essential micronutrients.

Many beneficial, and some detrimental, health effects have been attributed to the consumption of cow milk. The role of milk intake on weight control has been explored in many studies. Teegarden and Zemel (96) found that a higher consumption of milk appeared to induce weight loss, but their study had a small sample size and a high dropout rate. In larger randomized trials, those subjects assigned to a higher intake of low-fat milk experienced a greater weight gain that was either statistically significant (97) or not statistically significant (98). In a longitudinal study of many thousand adolescents, low-fat milk consumption was positively associated with a gain in body mass index; this was accounted for by a higher energy intake among those who consumed more milk (99). The 2005 *Dietary Guidelines for Americans* Committee performed a detailed review of this topic and concluded that there was not sufficient evidence that milk consumption reduced, or prevented, weight gain (100). Subsequent published research has found that milk did not prevent weight gain, including one 48-wk clinical trial funded by the National Dairy Council (101, 102).

A second issue relates to bone health. The Dietary Guidelines Committee also evaluated 7 randomized trials and 32 observational studies that explored the relation between milk intake and bone health. All 7 randomized trials and 25 of the observational studies showed a positive relation between milk consumption and bone mineral density in one or more skeletal sites (103). However, the benefits of higher calcium intake on bone mineral density are not maintained if the high intake is reduced. In one trial with children, milk intake, but not calcium supplementation, had a continuing effect on bone mineral density 3.5 y after termination of the intervention (104). The duration of the randomized studies was too brief to validly assess fracture incidence. Large prospective studies in adults have consistently shown no significant relation between milk intake and risk of fractures.

Milk is an important source of calcium and is the key source for vitamin D due to fortification, particularly for persons aged 6–18 y, for whom calcium requirements are higher. Milk products are also important contributors to the intake of essential nutrients in the diet of children and adolescents. Data from the National Health and Nutrition Examination Survey (NHANES) and Continuing Survey of Food Intakes by Individuals (CSFII) indicate that as consumption of milk products increases, so does the intake of calcium, magnesium, potassium, zinc, iron, vitamin A, riboflavin, and folate (105). Conversely, eliminating milk products from the USDA dietary pattern would substantially reduce intakes of those essential nutrients (100). Nevertheless, although it would require a careful selection of foods, milk products could be replaced with soy-based products and items from other food groups, particularly fruit and vegetables—some of which are also good sources of calcium. The essential micronutrients in milk products could also be replaced by daily multivitamin-mineral and calcium supplements. Fortification of milk with vitamin D has reduced the occurrence of rickets in children, but other sources of supplemental vitamin D can be used.

Some studies have reported a beneficial effect of milk consumption in reducing the risk of the metabolic syndrome, a

TABLE 3
Beverage nutrient composition table[1]

	Calories	Total fat	SFA	Sugars	Caffeine	Sodium	Potassium	Vitamin A	Vitamin C	Calcium	Vitamin D	Folate
	kcal	*g*[1]	*g*	*g*	*mg*	*mg*	*mg*	*IU*	*mg*	*mg*	*IU*	*μg*
Level 1: water, bottled water[2]												
Level 2: tea and coffee (unsweetened)												
Tea	0	0	0	0	0	1	0	0	0	0	0	0
Brewed black tea[2]	0	0	0	0	47	7	88	0	0	0	0	3
Decaffeinated black tea, brewed[2]	0	0	0	0	2.4	0	88	0	0	0	0	3
Brewed green tea[2]	0	0	0	0	30	0	0	0	0	0	0	0
Decaffeinated green tea, brewed[2]	0	0	0	0	3	0	0	0	0	0	0	0
Lipton original (unsweetend)[3]	0	0	0	0	35	0	0	0	0	0	0	0
Herbal tea[2]	0	0	0	0	0	0	0	0	0	0	0	0
Coffee[2]												
Coffee, brewed	2	0	0	0	95	5	116	0	0	4.7	0	4.7
Coffee, brewed, espresso	1	0	0	0	64	0	34.5	0	0	1	0	0
Decaffeinated coffee, brewed	0	0	0	0	2.4	0	128	0	0	4.7	0	0
Level 3: low-fat and skim milk and soy beverages[2]												
Reduced fat (1.5% and 1%) and skim milk												
Milk (1% fat, vitamin A–fortified)	102	2	1.5	12.7	0	103	366	478	0	290	127	12.2
Milk (skim, vitamin A–fortified)	83	0.2	0.3	12.5	0	103	448	499	0	352	98	14.8
Soy beverages[4]												
Silk soy milk, plain	100	4	0.5	6	0	85	300	500	0	300	120	24
Silk soy milk, vanilla	100	3.5	0.5	7	0	130	300	500	0	300	120	24
Silk live "mango"	230	4	0.5	35	0	120	350	1250	15	350	100	100
Silk soy milk, chocolate	140	3.5	0.5	19	0	100	350	500	0	300	120	24
Level 4: noncalorically sweetened beverages												
Lipton Green Tea to Go, decaffinated[3]	0	0	0	0	0	70	0	0	0	0	0	0
Diet Pepsi[5]	0	0	0	0	24	25	20	0	0	0	0	0
Diet Coke[6]	0	0	0	0	31	70	0	0	0	0	0	0
Level 5: caloric beverages with some nutrients												
Fruit and vegetable juices												
Orange juice (Minute Maid)[7]	110	0	0	24	0	15	450	0	72	20	0	60
Tropicana Light'n Healthy[8]	50	0	0	10	0	10	450	1000	72	200	0	28
Concord grape juice (Welch's)[9]	170	0	0	40	0	20	0	0	60	0	0	0
Apple juice (Minute Maid)[7]	110	0	0	26	0	0	0	0	72	0	0	0
Fruit medley (Minute Maid)[7]	170	0	0	36	0	20	340	0	60	0	0	0
Cranberry juice cocktail[2]	137	0	0	31	0	5	0	0	52	0	0	0
Apple juice (unsweetened)[2]	112	0	0	24	0	7	295	100	12	170	0	0
V8 Tomato Juice[10]	50	0	0	8	0	590	470	2000	60	20	0	0
Carrot juice[2]	94	0	0	9	0	68	689	45130	21	57	0	9
Milk												
Whole (3.25% fat)[2]	146	8	4.5	13	0	98	350	249	0	276	98	12
2% fat vitamin A–fortified[2]	122	4.8	3.1	13	0	100	366	461	0	285	105	12
Wendy's Frosty[11]	217	5	4	27	0	129	0	520	0	12	0	0
Sports drinks												
Gatorade X Factor[12]	50	0	0	14	0	110	30	0	0	0	0	0
POWERade line[6]	64	0	0	15	0	53	32	0	0	0	0	0
POWERade Raize[6]	110	0	0	29	36	46	32	0	0	0	0	0
Alcoholic beverages[2]												
Beer, regular (12 fl oz)	139	0	0	0	0	14	96	0	0	14	0	21
Light beer, Bud Light (12 fl oz)	110	0	0	0	0	11	92	0	0	11	0	0
Beer, ale	155	0	0	13	0	14	77	0	0	17	0	0
Red table wine (3.5 fl oz)	74	0	0	0	0	0	115	0	0	8	0	2
White table wine (3.5 fl oz)	70	0	0	0	0	5	82	0	0	9	0	0
Level 6: calorically sweetened beverages												
Pepsi Cola[5]	100	0	0	27	25	25	10	0	0	0	0	0
Coca-Cola Classic[6]	105	0	0	26	23	33	0	0	0	0	0	0

(*Continued*)

TABLE 3 (*Continued*)

	Calories	Total fat	SFA	Sugars	Caffeine	Sodium	Potassium	Vitamin A	Vitamin C	Calcium	Vitamin D	Folate
	kcal	*g*[1]	*g*	*g*	*mg*	*mg*	*mg*	*IU*	*mg*	*mg*	*IU*	*μg*
Tropicana Fruit Punch (3% juice)[8]	110	0	0	29	0	50	0	0	0	0	0	0
Fruitopia (10% juice varieties)[13]	110	0	0	29	0	75	0	0	100	0	0	0
Nestea Cool[14]	82	0	0	22	11	68	0	0	0	0	0	0
Lipton Original Iced Tea[3]	60	0	0	17	20	50	0	0	0	0	0	0
Arizona Green Tea[15]	70	0	0	17	10	20	0	0	0	0	0	0
Kool-Aid Splash Grape Berry Punch[2]	116	0	0	30	0	35	12	0	0	0	0	0
Jamba Juice, banana berry smoothie[16]	149	0.5	0	31	0	36	0	62	5	62	0	0
Sweetened coffee drinks[17]												
Starbucks Frappuccino, coffee flavored	160	2.5	1.7	25	70	93	0	100	0	220	0	0
Starbucks Caffe Mocha, no whipped cream	240	10	5	24	65	125	0	0	0	0	0	0

[1] Amounts are per 8 fl oz, or 237 mL. SFA, saturated fatty acid.
[2] Data from the US Department of Agriculture, Agricultural Research Services, Nutrient Data Laboratory: National Nutrient Database for Standard Reference. Internet: http://www.nal.usda.gov/fnic/foodcomp/search/.
[3] lipton.com.
[4] silkissoy.com.
[5] pepsi.com.
[6] coca-cola.com.
[7] minutemaid.com.
[8] tropicana.com.
[9] welchs.com.
[10] v8juice.com.
[11] wendys.com.
[12] gatorade.com.
[13] fruitopia.com.
[14] nestea.com.
[15] arizonabev.com.
[16] jambajuice.com.
[17] starbucks.com.

cluster of disorders that includes insulin resistance, glucose intolerance, hypertension, hypertriglyceridemia, and low concentrations of HDL. In the Coronary Artery Risk Development in Young Adults (CARDIA) Study, milk consumption was inversely associated with the 10-y cumulative incidence of the metabolic syndrome in overweight individuals (106). A pooled analysis of 10 prospective studies also indicated a beneficial effect of milk consumption in reducing the risk of coronary heart disease and ischemic stroke (107). In a short-term clinical trial, 2 dietary patterns were used—one emphasizing fruit and vegetables and the other emphasizing fruit and vegetables, low-fat dairy products, higher protein and fiber intakes, and a lower fat intake (Dietary Approaches to Stop Hypertension; DASH diet). Both dietary patterns significantly reduced blood pressure in normotensive or stage I hypertensive men and women of diverse ethnic backgrounds. The DASH diet had a significantly greater effect on reducing blood pressure than did the fruit and vegetables diet and is one of the dietary patterns recommended by the recent US Dietary Guidelines (108, 109). It is interesting that the DASH diet actually recommended more fruit and vegetables than did the fruit and vegetable diet, so there might be confounding factors involved. Moreover, in a carefully conducted multicenter trial, an increase of 3 glasses of low-fat milk daily had no effect on blood pressure (110).

Among the evidence for possible adverse effects of milk consumption, a meta-analysis of case-control studies reported a 70% greater risk of prostate cancer in men with the highest milk consumption levels (111). Other studies have suggested an increased risk of aggressive ovarian cancer in persons consuming >3 fl oz dairy products/d, although the literature is not consistent (112). It has been speculated that this adverse effect of milk may be related to its well-documented effect on circulating concentrations of insulin-like growth factor I (110, 113, 114), which has been associated with increases of many cancers in both humans and animals (114).

Level 4: noncalorically sweetened beverages

Noncalorically sweetened beverages (diet sodas and other "diet" drinks) are preferable to calorically sweetened beverages because they provide water and sweetness but no calories. FDA-approved noncaloric sweeteners are considered safe, although other than FDA surveillance data there is no evidence from long-term studies in humans available to this Panel and is most likely lacking.

Raben et al (3) showed that beverages sweetened with noncaloric sweeteners were associated with weight loss when ingested in amounts similar to calorically sweetened beverages where

weight gain and increased blood pressure occurred. A new literature is emerging that seems to suggest that the high sweetness in these beverages may contribute to conditioning for a high preference for sweetness (115, 116) and thus these noncalorically sweetened beverages would be less desirable than water, tea, or coffee.

Level 5: caloric beverages with some nutrients

Fruit juices (100% juice) provide most of the nutrients of their natural source, but they have a relatively high energy content and may lack fiber and other beneficial nonnutrient compounds present in the whole produce. There is no specific need to consume fruit juices, and consumption of whole fruits should be encouraged for satiety and energy balance. The US Dietary Guidelines Committee (100) recommended that no more than one-third of the daily intake of fruit be in the form of juices. Fruit smoothies are usually high-calorie versions of fruit drinks and, therefore, are not recommended.

Vegetable juices (eg tomato and multi-vegetable juices) are a healthy alternative to fruit juices. They have fewer calories per 100 mL (3.4 fl oz) than does orange juice but usually have significant amounts of added sodium. For example, tomato juice and vegetable cocktails have over 975 mg of sodium per 12 fl oz (357 mL). As with fruit juices, whole tomatoes and vegetables should be encouraged for satiety and energy balance rather than vegetable juices.

Whole (full-fat) milk contains 236 kcal/12 fl oz (255 mL) and has a higher energy density and saturated fat content than do reduced-at milk (2% fat, 180 kcal/12 fl oz), low-fat milk (1%, 150 kcal/12 fl oz), and skim or nonfat milk (135 kcal/12 fl oz). The adverse health effects of saturated fats have been well documented in numerous studies, especially with respect to an increased risk of cardiovascular diseases (117). Whole-fat dairy products are a significant source of saturated fat in the American diet. Whole-fat milk contributes significantly to the saturated fat intake in the United States, which has been found in NHANES III data to be 20% higher than the desirable level of ≤10% of daily energy intake.

Sports drinks contain from 50% to 90% of the energy (75–140 kcal/12 fl oz, or 255 mL) contained in calorically sweetened soft drinks (158 kcal/12 fl oz) and provide small amounts of sodium, chloride, and potassium. Although a well-balanced nutritious diet provides the same ingredients, the carbohydrates, water, and sodium in sports drinks are advantageous during endurance activities (ie, when the sweat rate is >8 L/d, when strenuous exercise lasts >60 min, or when there is a deficiency of sodium or carbohydrates) (118). The Panel recommends sports drinks be consumed sparingly, except by endurance athletes because these beverages provide calories.

Alcoholic beverages consumed in moderation have some health benefits for adults. Moderate intake is defined as the daily consumption of no more than one drink for women and 2 for men (119, 120). Alcoholic beverages contain calories. A standard alcoholic drink is defined as one that contains ≈14 g alcohol (121). The amounts of a sample of alcoholic beverages and their energy contents are provided in **Table 4**. Alcohol provides ≈7 kcal/g (≈100 kcal) per standard alcoholic drink. Wine-, malt-, and spirit-based coolers containing 3–7% alcohol are widely available and are often marketed to young people and packaged to look like sodas. Many of these beverages contain added sugars. An 8-fl oz (237-mL) cooler may contain more alcohol than an 8-fl oz of beer, and some coolers contain >250 kcal (compared with 104 kcal in a 8-fl oz soft drink). The health effect of coolers has not been studied.

TABLE 4
Comparison of the energy contents of different alcoholic beverages

Beverage	Energy	Amount
	kcal	*fl oz (mL)*
Beer	140	12 (355)
Light beer	100	12 (355)
Wine cooler	110–275	12 (355)
Wine	115	5 (148)
Spirits, 80 proof	100	1.5 (44)
Standard alcoholic drink	98	14 (414)
Soft drink	150	12 (355)

Although excessive alcohol (ethanol) consumption has been linked to serious health and social problems, moderate alcohol consumption has been associated with some health benefits (122). The relation between alcohol consumption and mortality is often described as J-shaped, meaning that light-to-moderate consumption compared with abstention or high consumption is associated with lower rates of mortality—mostly from coronary heart disease (123) and ischemic stroke (124)—whereas heavy alcohol consumption is associated with higher rates of mortality from many causes. The benefits of moderate alcohol consumption, which in addition to cardiovascular diseases may include a reduced risk of type 2 diabetes (125, 126) and gallstones (127, 128), appear to be derived mainly from alcohol itself. Although short-term studies have shown beneficial effects of red wine on blood pressure, platelet aggregation, and serum lipids, epidemiologic evidence does not support added health benefits specific to flavonoids in red wine or dark beer (123, 129). Alcoholic beverages, even at moderate intakes, are linked with an increased risk of birth defects (130) and breast cancer (131, 132). The increased risk of breast cancer appears to be caused, at least in part, by the interference of alcohol with the absorption and metabolism of folate. Therefore, pregnant women should not drink alcoholic beverages, and other women who consume alcohol should also consume adequate folate, preferentially from a supplement (400 μg/d) (133, 134). Heavy alcohol consumption is associated with several cancers, in addition to breast cancer (135), and other significant health problems such as cirrhosis of the liver (136), hypertension (137), hemorrhagic stroke (121), cardiomyopathy (138), atrial fibrillation (139), and dementia (140).

Level 6: calorically sweetened beverages

The least recommended beverages by the Panel are calorically sweetened beverages with a high energy density and no, or very small amounts of, other nutrients. These include carbonated (fizzy) and noncarbonated (still) beverages, which are usually sweetened with high-fructose corn syrup or sucrose. Our recommendation is to consume calorically sweetened soft drinks and juice drinks sparingly. Caloric sweeteners have been linked to dental caries, increased energy intake, weight gain, and type 2 diabetes (2–4, 47, 100).

In the quantities consumed today, soft drinks and fruit drinks most likely contribute to the obesity epidemic by facilitating excess energy intake. As noted in the Introduction, animal and human literature show that these beverages are not satiating, and compensation in terms of reduction in the intake of other foods

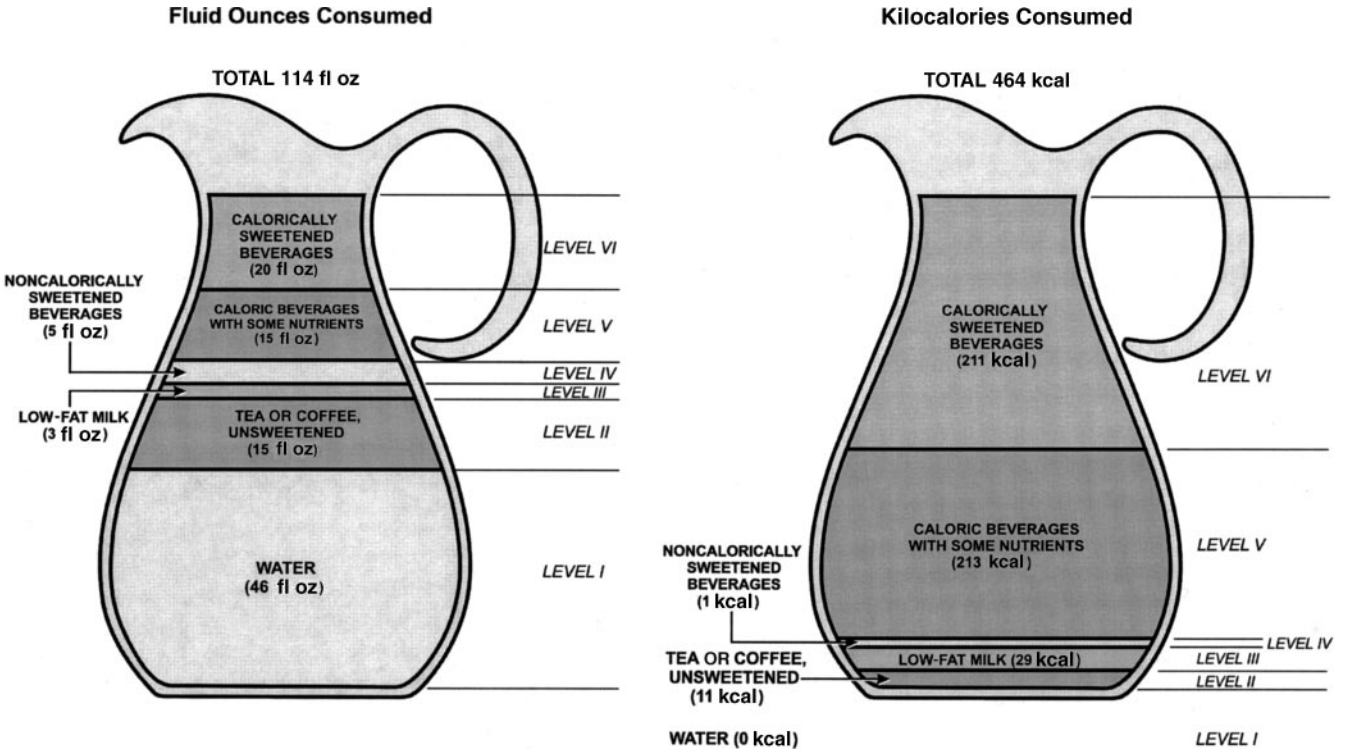

FIGURE 1. Average daily beverage intake patterns for US adults aged ≥19 y, 1999–2002. 1 fl oz = 29.57 mL.

and beverages is poor, with the net effect being increased energy intake and obesity (2–4, 8, 10, 141–144). It is possible that the fructose content has an added effect (145).

There is also evidence linking calorically sweetened beverages with an increased risk of type 2 diabetes. One recent prospective study using data from the Nurses' Health Study found that women consuming one or more servings of sugar-sweetened soft drinks per day had a significantly higher risk of developing type 2 diabetes than did those who consumed less than one serving per month (4). Others suggest that soft drinks are replacing milk in the diet (1, 144).

We note that soft drinks and fruit drinks are not the only high-calorie beverages. New drinks are constantly being offered that fit the same profile, eg, very-high-calorie smoothies. We did not systematically review these newer beverages. At the same time, the Panel recommends a significantly reduced intake of calorically sweetened beverages.

What is the proportion of energy from beverages a person should consume? A summary of the beverage intake pattern of adults aged ≥19 y in the United States from the 1999–2002 NHANES, conducted in a nationally representative population sample, is shown in **Figure 1**; the pattern of energy obtained from the different categories of beverages is also shown. The pattern for adults aged ≥19 y was selected. Water, tea, and coffee intakes—the unsweetened beverages—accounted for 70% of the total volume but contributed only 2% of the calories. In contrast, the calorically sweetened soft drinks and fruit drinks provided 46% of the calories. As noted earlier, the proportion of energy from beverages for the average American aged >2 y was 21%. Hence, US adults aged ≥19 y consumed 464 calories/d from beverages. A reduced intake of caloric beverages that provide no nutritional benefit is needed to reduce this high energy intake from beverages; these beverages are not needed to fulfill the daily energy intake of any individual.

Many IOM/Food and Nutrition Board dietary requirements panels, as well as the 2005 US Department of Health and Human Services–USDA Dietary Guidelines Advisory Committee have developed sample healthful menus that fulfill the recommended intakes for macronutrients, micronutrients, fiber, and water of average adults. The total beverage requirement is based on the overall composition of an individual's diet and his or her physiologic needs for water. Our review used one such sample menu (12) to estimate the contribution of beverages to nutrient intake (Table 2). In this and similar examples, the contribution of beverages to total energy intake was 14%. These calories are contributed primarily by low-fat milk (9%), which is a naturally nutrient-rich beverage. Excluding milk, the other caloric beverages contributed 5% to the total caloric intake, or ≈114 kcal/d.

The sample man described in Table 2 has an energy requirement of 2200 kcal, which requires a total beverage intake of ≈98 fl oz (2.9 L). In his diet, water contributed ≈25 fl oz (26%); an additional 52 fl oz (54%) came from tea and coffee, leaving <20 fl oz (21%) from milk and juice or other calorically sweetened beverages. This distribution is ideal for a man with low levels of activity, particularly the high consumption of nonsweetened beverages—water, tea, and coffee. This distribution of beverages could consist of 100% water or could represent any of many combinations, with the goal to get ≥80% of beverage intake from very-low-calorie beverages. Thus, the Panel suggests a distribution in which ≈ 80% of beverages consist of water, unsweetened tea, and unsweetened coffee and only ≈20% of low-fat milk,

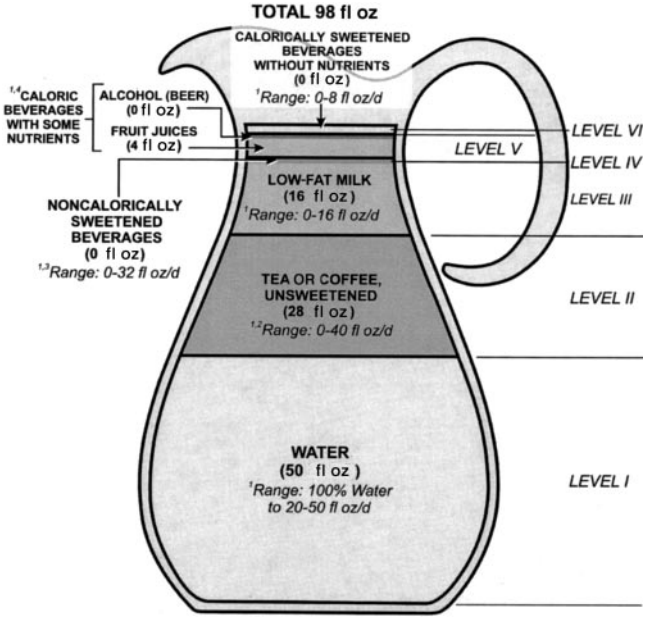

FIGURE 2. Suggested beverage consumption patterns (10% of energy from beverages) for a person with a 2200-kcal daily energy requirement. The values 50, 28, 16, and 4 fl oz are shown for illustrative purposes only; the total should sum to 98 fl oz, as shown at the top of the figure. [1]The Beverage Guidance Panel's suggested range for each beverage. [2]Range: caffeine is a limiting factor up to 400 mg/d, or ≈32 fl oz coffee/d (can replace water). [3]Can substitute for tea and coffee with the same limitations regarding caffeine. [4]100% fruit juices, 0–8 fl oz/d; alcoholic beverages, 0–1 drink/d for women and 0–2 drinks/d for men; whole milk, 0 fl oz/d. 1 fl oz = 29.57 mL.

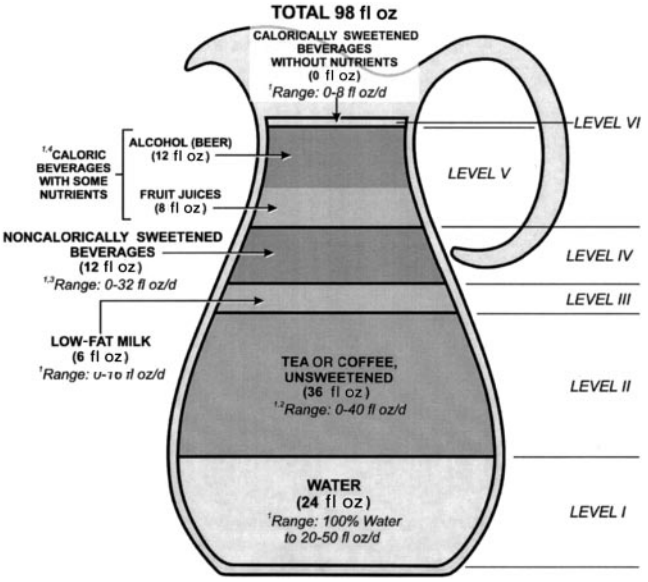

FIGURE 3. Acceptable beverage consumption patterns (14% of energy from beverages) for a person with a 2200-kcal daily energy requirement. The values 24, 36, 6, 12, 8, and 12 fl oz are shown for illustrative purposes only; the total should sum to 98 fl oz, as shown at the top of the figure. [1]The Beverage Guidance Panel's suggested range for each beverage. [2]Range: caffeine is a limiting factor up to 400 mg/d, or ≈32 fl oz coffee/d (can replace water). [3]Can substitute for tea and coffee with the same limitations regarding caffeine. [4]100% fruit juices, 0–8 fl oz/d, alcoholic beverages, 0–1 drink/d for women and 0–2 drinks/d for men; whole milk, 0 fl oz/d. 1 fl oz = 29.57 mL.

juice, alcohol, and calorically sweetened beverages (**Figures 2** and **3**).

The graphic design (Figure 2) developed by the Beverage Guidance Panel summarizes the relative importance of each beverage presented in this review. We suggest that the proportions of beverages shown in Figure 2 should be consumed by any person, but the actual amounts of fluids shown are based on a person with an energy intake requirement of 2200 kcal and a dietary intake pattern presented by the IOM in its publication and summarized in Table 2. The suggested pattern shown in Figure 2 would provide at most 10% of total energy from beverages. An acceptable intake pattern (Figure 3) would provide 14% of energy from beverages. On the basis of this review and our knowledge of health and nutrition, the Panel recommends the following range of intake for beverages:

Level 1: water, 20–50 fl oz/d.

Level 2: tea and coffee (unsweetened), 0–40 fl oz/d (can replace water; caffeine is a limiting factor up to 400 mg/d, ≈32 fl oz coffee/d).

Level 3: low-fat and skim milk and soy beverages, 0–16 fl oz/d.

Level 4: noncalorically sweetened beverages, 0–32 fl oz/d (could substitute for tea and coffee with the same limitations as for caffeine).

Level 5: caloric beverages with some nutrients, 0–8 fl oz 100% fruit juices/d, 0–1 alcoholic drink/d for women and 0–2 drinks/d for men (one drink = 12 fl oz beer, 5 fl oz wine, or 1.5 fl oz distilled spirits), and 0 fl oz whole milk/d.

Level 6: calorically sweetened beverages, 0–8 fl oz/d.

CONCLUSIONS AND RECOMMENDATIONS

The obesity epidemic provides the rationale for developing the Beverage Guidance System. Because some beverages provide primarily energy and can contribute significantly to a positive energy balance, reducing their consumption is an important component of a broader strategy to reduce energy intake. Although this Beverage Guidance System provides a sense of the relative energy density, nutrient density, health benefits, and health risks linked with each category of beverages (and also the relative importance of each beverage), it is not possible to provide clear guidance regarding specific quantities. However, in Table 2 we provide an example for adults who have an energy requirement of 2200 kcal/d. In this case, beverages provide 14% of the total energy from calories.

The current high intake of calorically sweetened beverages contributes importantly to the excess caloric intake and is an important factor underlying the development of obesity in the United States. The evidence from nationally representative surveys shows that both portion sizes and the number of servings of these beverages have increased. If the caloric intake is to be reduced, a decreased intake of these beverages should be part of the solution.

The Beverage Guidance Panel has identified some research and development issues that the food industry could address. For example, the calorie content of sweetened beverages could be reduced by 75–80% from current levels and low-calorie alternatives could be developed. The Panel notes that evidence indicates that calorically sweetened beverages have replaced milk in the US diet, which has resulted in a reduction in the net intake of key essential nutrients. There is a need among children and adolescents to reverse this trend.

The fortification of noncaloric beverages, such as flavored bottled water, with essential nutrients is also of concern. Many vitamins and minerals are in the FDA's Generally Recognized As Safe (GRAS) list and, therefore, have few restrictions concerning their addition to foods. However, international guidelines for food fortification clearly state that it should be based on demonstrated need. The Food and Agriculture Organization guidelines state that to justify fortification "there should be a demonstrated need for increasing the intake of an essential nutrient in one or more target groups" (146). Furthermore, although these fortified beverage products may provide micronutrient levels comparable with those in some natural foods, they lack fiber, phytochemicals, and other natural compounds that come from naturally nutrient-rich beverages. Although not fully characterized, these may contribute to the demonstrated health benefits of whole foods, such as fruit and vegetables. Thus, this new type of noncaloric beverage, which provides some vitamins or minerals, should not be regarded as equivalent to other foods that are naturally rich in micronutrients. The consumption of calorically fortified beverages, such as soft drinks—which are fortified with these same minerals and vitamins—may even further increase the already excessive caloric intake of the American population.

There is a potential need to add minerals to bottled water. For example, a careful review of the concentration of fluoride in bottled waters should be undertaken to determine whether these waters might need added fluoride. Currently, maximum concentrations of fluoride exist for bottled water (domestic and imported) but minimum concentrations do not.

Many government documents have discussed the benefits and risks of various beverages, but the results are often too vague or general and are affected by a lack of a clear focus on the calorically sweetened beverages that provide a significant source of calories in our diet. This Beverage Guidance Panel recommends that these beverages be replaced over time by other beverages with more nutritional value and fewer calories.

The Panel also notes the need for further research regarding the health effects of dairy products and reduced or noncalorically sweetened beverages. An ideal beverage intake pattern recommended by the Panel, and another pattern that is less than ideal but acceptable, is shown in Figure 2. Furthermore, in our view and in agreement with the IOM, it is important that >60%, if not 100%, of fluid needs are provided by calorie-free beverages. This is important because, as we recognize, fluid needs vary widely among people, and persons with higher-than-average needs should increase their fluid intake from calorie-free beverages, preferably water.

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relation to risk of cholecystectomy in women. Am J Clin Nutr 2003; 78:339–47.
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Erratum

Popkin BM, Armstrong LE, Bray GM, Caballero B, Frei B, Willett WC. A new proposed guidance system for beverage consumption in the United States. Am J Clin Nutr 2006;83:529–42.

Page 533, left-hand column, fourth full paragraph: the sentence "Fortified soymilk is a good alternative for individuals who prefer not to consume cow milk, although consumers should be aware that soymilk cannot be legally fortified with vitamin D…" is erroneous. Currently, soy milk is legally fortified with vitamin D.

Erratum

Matthan NR, Jalbert SM, Ausman LM, Kuvin JT, Karas RH, Lichtenstein AH. Effect of soy protein from differently processed products on cardiovascular disease risk factors and vascular endothelial function in hypercholesterolemic subjects. Am J Clin Nutr 2007;85:960–6.

Page 961, right-hand column, next-to-last sentence in the second full paragraph: the total isoflavone content, as aglycones, was determined by Iowa State University (Ames, IA)—not its sister institution, the University of Iowa.