

# The Negative Impact of Sugar-Sweetened Beverages on Children's Health

## Healthy Eating Research

Building evidence to prevent childhood obesity

A Research Synthesis, November 2009

During the past four decades, the obesity rate for children ages 6 to 11 has more than quadrupled, from 4.2 percent to 17 percent, and more than tripled for adolescents ages 12 to 19, from 4.6 percent to 17.6 percent.<sup>1,2</sup> A substantial body of research has determined that increased SSB consumption leads to excess weight gain and a higher risk of obesity among youth.<sup>3,4,5</sup>

Over nearly the past 30 years, U.S. children and adolescents have dramatically increased their consumption of sugar-sweetened beverages (SSBs), including soda, fruit drinks and punches, and sports drinks (see sidebar for a more complete definition).<sup>6,7</sup> Such consumption has been linked to less healthy diets and a number of other negative health consequences, including decreased bone density, dental decay, headaches, anxiety and loss of sleep.<sup>8,9,10</sup> Interventions to lower SSB consumption have been linked to lower risk of overweight, and weight loss among overweight adolescents.<sup>11,12</sup> This research synthesis examines the evidence regarding the various health impacts of SSB consumption, presents initial conclusions based on these studies, and identifies areas for further research.

### Key Research Results

- Children and adolescents in the United States have been steadily increasing consumption of a wide variety of SSBs over nearly 30 years.<sup>14,15</sup> In 2004, adolescents consumed an average of 300 calories per day from SSBs, accounting for 13 percent of their daily caloric intake. Boys and girls of all ages, economic status and racial/ethnic backgrounds are now consuming high levels of SSBs.
- The preponderance of research shows that SSB consumption leads to excess caloric intake and weight gain, as well as increased obesity rates among children and adolescents.<sup>16,17,18</sup> Weaker studies, some of which are funded by the beverage industry, have shown less consistent associations.<sup>19,20</sup>
- SSB consumption reduces intake of important nutrients by replacing milk consumption<sup>21</sup> and is associated with lower bone mineral density and an increased risk of bone fractures among girls.<sup>22</sup>
- Substituting other beverages, such as water, for SSBs could reduce over-consumption of calories and improve nutrition.<sup>23</sup>
- Because SSBs frequently contain high levels of caffeine, their consumption can cause numerous other

### Definition of Sugar-Sweetened Beverages (SSBs)<sup>13</sup>

Sugar-sweetened beverages (SSBs) include all sodas, fruit drinks, sport drinks, low-calorie drinks and other beverages that contain added caloric sweeteners, such as sweetened tea, rice drinks, bean beverages, sugar cane beverages, horchata and nonalcoholic wines/malt beverages.

- a. Sport drinks include all beverages marketed for rehydration for athletes.
- b. Fruit drinks include all fruit drinks, fruit juices and fruit nectars with added sugar.
- c. Sodas include all carbonated beverages with added sugar.
- d. Other SSBs include sweetened tea, rice drinks, bean beverages, sugar cane beverages, horchata, nonalcoholic wines/malt beverages, etc.<sup>1</sup>

(It should be noted that this is intended as a comprehensive definition of SSBs, but that not all studies cited in this synthesis use this entire definition. For instance, some studies look only at sodas.)

<sup>1</sup> Future discussion of beverage categories should determine definition and impact of "low-calorie" SSBs, which are a very small, but growing beverage category. Additional attention also should be paid to defining the energy drink category. Such beverages generally include caffeine and other substances in addition to sweeteners.

health problems, including anxiety, withdrawal and poor-quality or reduced sleep. Consumption also has been linked to tooth decay.<sup>24,25,26,27,28</sup>

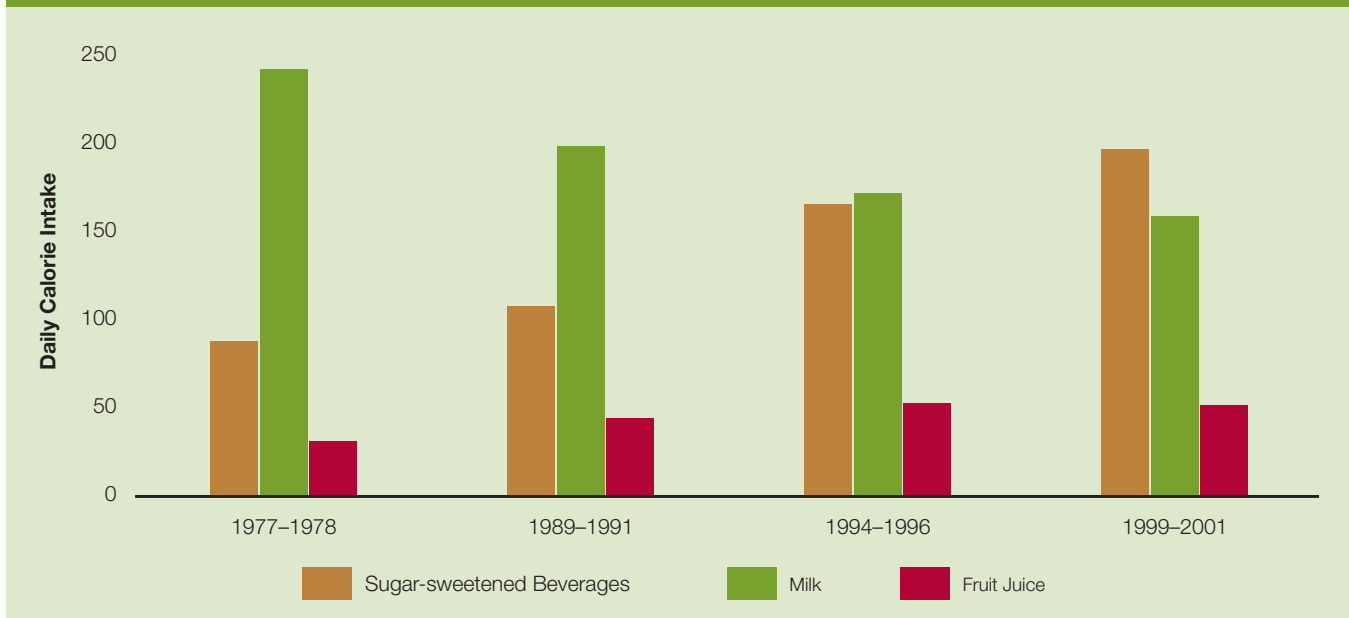
### Details on Key Research Results

Children and adolescents in the United States have been steadily increasing consumption of a wide variety of SSBs over nearly 30 years.<sup>29,30</sup> By 2004, adolescents consumed an average of 300 calories per day from SSBs, accounting for 13 percent of their daily caloric intake. Boys and girls of all ages, economic status and racial/ethnic backgrounds are now consuming high levels of SSBs.



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Figure 1. Trends in Youth (ages 2–18) Beverage Consumption: Daily Caloric Intake by Beverage Type and Year



Source: Nielsen S and Popkin B. “Changes in Beverage Intake Between 1977 and 2001.” *American Journal of Preventive Medicine*. 27(3): 205–210, October 2004.

The overall rise in caloric intake from SSBs has been driven by increasing numbers of children consuming SSBs, increasing portion sizes and increasing consumption frequency. From 1977–78 to 1994–96, the percentage of children drinking SSBs on a given day increased from 75 percent to 85 percent, the number of times per day children drank SSBs increased from 2 to 2.6, and the average SSB serving size increased by 44 percent, from 13.1 to 18.9 fluid ounces.<sup>31</sup> As shown in figure 1, between 1977 and 2001, the number of daily calories youths consumed from SSBs and fruit juice increased, while the number coming from milk decreased. All of these factors contribute to the fact that, by 2004, children ages 6 to 11 were consuming 184 calories from SSBs per day, or 9 percent of their daily caloric intake, and children ages 2 to 5 were consuming 124 calories, or 7 percent of their daily total. Although soda accounts for half of all SSB consumption among youth, fruit drinks, sports drinks and other beverages contribute an increasing proportion of total SSB consumption. As figure 2 indicates, among children ages 2 to 5, fruit drinks contribute the majority of calories consumed from SSBs, whereas for adolescents the majority comes from soda.<sup>32</sup>

An analysis of data from 1988 to 2004 found that while, in the past, children in higher-income families consumed more SSBs than those in lower-income families, youth now consume high levels of SSBs regardless of family income. SSB consumption is similarly high for both boys and girls, as well as for youth in all racial and ethnic groups. However, consumption is rising faster among black and Mexican-American youth than among white youth.<sup>33</sup>

**The preponderance of research shows that SSB consumption leads to excess caloric intake and weight gain, as well as increased obesity rates among children and adolescents.<sup>34,35,36</sup>**

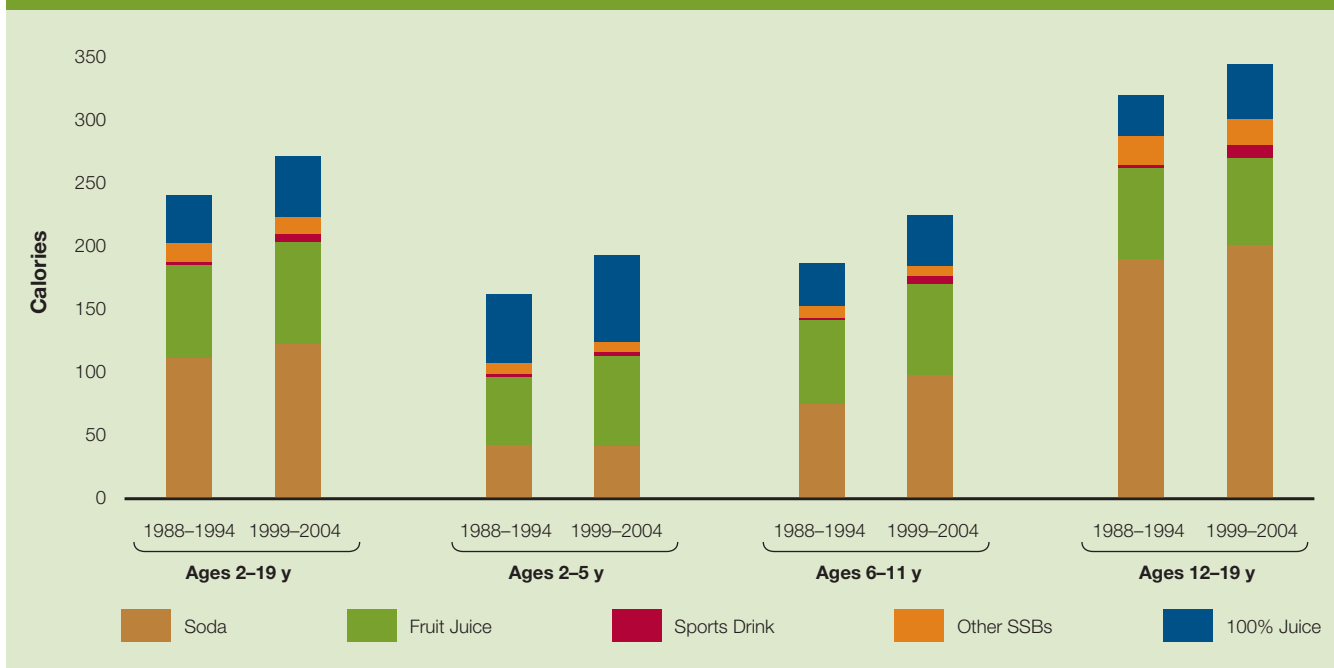
Many independent studies suggest that SSB consumption is associated with excess caloric intake and weight gain, which in turn leads to higher obesity rates among children.

Consistent with findings among adults, studies altering the amount of SSBs in children’s diets, as well as stronger, longitudinal studies following children’s SSB consumption and weight change over time, have consistently found a relationship between higher SSB consumption and weight gain.<sup>37,38,39</sup> In contrast to the clear findings from longitudinal studies and randomized trials, weaker studies looking at SSB consumption and weight at one point in time have shown mixed results. Two reviews indicate that studies funded by the beverage industry have shown less consistent associations.<sup>40,41</sup>

Although the precise relationship between SSB consumption and excess weight gain is under debate, two possibilities are that:

- individuals do not compensate for excess liquid calories by reducing consumption of calories from solid food;<sup>42,43,44</sup> and
- consumption of sweetened beverages may induce hunger and thereby increased consumption of other foods.<sup>45</sup>

Figure 2. Per Capita Daily Contribution of SSBs and 100% Fruit Juice to Caloric Intake



Source: Wang Y, Bleich S and Gortmaker S. "Increasing Caloric Contribution from Sugar Sweetened Beverages and 100% Fruit Juices Among US Children and Adolescents, 1988-2004." *Pediatrics*. 121(6): e1604-e1614, June 2008.

### The Connection between SSB Consumption and Type 2 Diabetes

Because of its association with weight gain, increased SSB consumption has been linked with higher rates of type 2 diabetes among adults.<sup>46</sup> There also are strong connections between increases in obesity rates and increases in rates of type 2 diabetes.<sup>47</sup>

The connection between excess weight gain and type 2 diabetes is very strong: rates of diabetes increase along with increases in body mass index (BMI).<sup>48</sup> Healthy-weight adults have a 20 percent lifetime risk of diabetes, but for those who are overweight or obese, the risk rises to 30 percent or 70 percent, respectively.<sup>49</sup>

As among adults, there have been increases in the rates of both obesity and type 2 diabetes among adolescents.<sup>50</sup> There is also research describing connections between SSB consumption and risk factors for diabetes among youth. For example, a school-based intervention that lowered SSB consumption among adolescents significantly reduced plasma insulin levels, a risk factor for type 2 diabetes.<sup>51</sup> Additionally, one small study found that increased sugar consumption among Latino children was linked to increases in risk factors for diabetes.<sup>52</sup>

**SSB consumption reduces intake of important nutrients by replacing milk consumption and is associated with lower bone mineral density and an increased risk of bone fractures among girls.<sup>53</sup>**

Longitudinal studies have shown that children who increase their SSB consumption reduce their milk consumption, while cross-sectional studies have found that children who drink more SSBs consume less milk.<sup>54,55,56,57,58</sup> SSB consumption also is associated with inadequate intake of a number of important nutrients, including calcium, iron, folate and vitamin A.<sup>59,60,61,62</sup> SSB consumption, particularly of soda, is associated with lower bone mineral density and decreased bone mass accrual among girls at a critical stage in bone development, potentially impacting bone health throughout their lives.<sup>63</sup> Such consumption also has been linked to a higher risk of bone fractures among girls.<sup>64,65</sup>

**Substituting other beverages, such as water, for SSBs could reduce over-consumption of calories and improve nutrition.<sup>66</sup>**

Substituting unsweetened beverages for SSBs could reduce excess consumption of calories and improve nutrition, although different substitutions would likely have different effects. For instance, children and adolescents consume significantly fewer calories on days when they drink water instead of SSBs.<sup>67</sup>

Also, substituting low-fat or skim milk for some SSB consumption could improve youth nutrition without increasing weight gain, particularly in young children.<sup>68</sup> While replacing SSBs with no-calorie “diet sodas” may reduce caloric intake, such beverages may not be a healthy alternative for children given potential negative effects on oral health, increased caffeine intake and the fact that the long-term effects of non-caloric sweeteners (e.g., aspartame, stevia, sucralose, etc.) on children are still unknown.<sup>69</sup>

**Because SSBs frequently contain high levels of caffeine, consumption can cause numerous health problems beyond excess weight gain, including anxiety, withdrawal and poor-quality or reduced sleep. Consumption also has been linked to tooth decay.<sup>70,71,72</sup>**

SSB consumption, particularly of soda and energy drinks, can lead to caffeine-intake levels that can have serious, negative impacts on the health of children and adolescents. A typical 20-oz. bottle of cola can contain 50–75 mg of caffeine, and a 16-oz. energy drink can contain as much as 150 mg.<sup>73</sup> A study published in 2004 found that children ages 1 to 5 in the 90<sup>th</sup> percentile of caffeine intake consumed 37 mg of caffeine per day, and children ages 6 to 9 in the 90<sup>th</sup> percentile consumed 45 mg per day.<sup>74</sup> Caffeine consumption increases substantially in adolescence. One study of U.S. high school students noted an average caffeine consumption of 63 mg/day.<sup>75</sup>

Studies testing doses of 50–150 mg of caffeine per day among children and adolescents have found it can cause withdrawal symptoms, decrease alertness and headaches, and possibly increase anxiety.<sup>76,77,78</sup> Caffeine also has been associated with poor sleep quality and reduced sleep duration among adolescents.<sup>79,80</sup> In turn, insufficient sleep among adolescents has been associated with motor vehicle accidents, irritability, behavior problems, and vulnerability to drug and alcohol use.<sup>81,82</sup> Insufficient sleep also has predicted excess weight gain among children, adolescents and adults, potentially strengthening the relationship between SSB consumption and the risk of obesity.<sup>83,84,85,86,87,88</sup>

Numerous studies also have linked SSBs with an increased risk of tooth decay among children,<sup>89</sup> and some have found that the acidity levels commonly found in sodas and sports drinks erode tooth enamel.<sup>90</sup> Children who consume more soda and sucrose, which many SSBs contain, are at increased risk of decayed, missing and filled teeth.<sup>91</sup>

## Youth Access to SSBs

Children and adolescents currently have access to SSBs both in school and at home. On a typical weekday between 55 percent and 70 percent of all SSB consumption occurred in the home, with younger children consuming a higher proportion at home.<sup>92</sup>

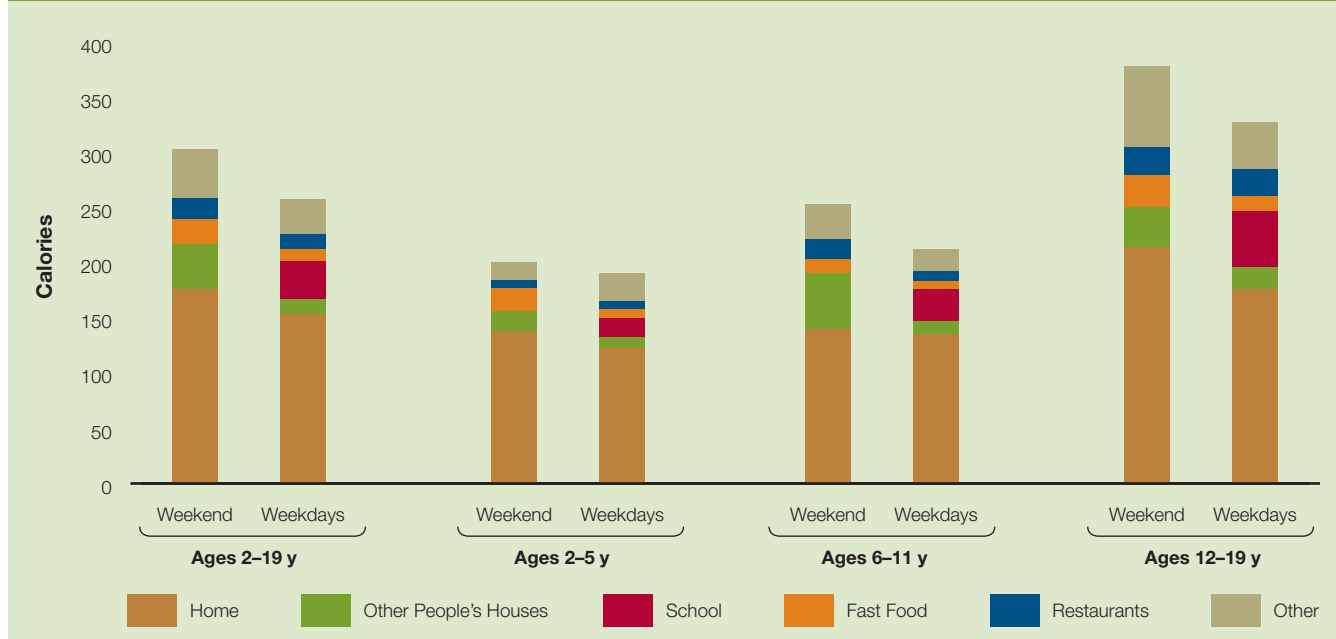
In recent years, many schools and school districts have begun to restrict access to SSBs. An evaluation by the American Beverage Association (ABA) found that, following its 2004 Memorandum of Understanding with the Alliance for a Healthier Generation, there was a substantial reduction in beverage calories shipped to participating schools. Between 2004 and the 2007–08 school year, there was a 58 percent reduction in total beverage calories shipped to schools, and a 65 percent reduction in shipment of non-diet soft drinks.<sup>93</sup> However, even after these substantial reductions, access to SSBs in schools across the country made an estimated 125 billion calories available to students.<sup>94</sup> A 2006 analysis of state action found that the median percentage of schools allowing soda or sugar-sweetened fruit drinks was 62.5 percent and the median allowing sports drinks was 72.7 percent.<sup>95</sup> Recent research also indicates that youth who consume fewer SSBs at school because they are less available do not compensate by increasing their consumption at home or elsewhere.<sup>96</sup>

To complement efforts to change school environments, replacement of youth SSB consumption with water at home and in other out-of-school settings could save families billions of dollars annually. Assuming youth consume two 12 oz servings of SSBs per day, at \$0.50 per serving, consumers could save \$24 billion dollars per year by replacing youth SSB with water. As discussed above in this synthesis, changing from SSBs to water also would positively impact the health of children and youth.

## Conclusions and Implications

SSB consumption—which has risen dramatically among U.S. children and adolescents, especially among black and Mexican-American youth—has been clearly linked to excess weight gain and increased risk of obesity among youth.<sup>97,98,99</sup> The combined risks of obesity and other negative health consequences require sustained effort to reduce or eliminate SSB consumption among children and adolescents. Reducing SSB consumption would have no negative effects on children’s health and would reduce the risk of childhood obesity and many other health problems, including type 2 diabetes, poor nutrition, excess caffeine consumption and dental decay.

Figure 3: Location Where Children and Adolescents Consume SSBs and 100% Fruit Juice



Note: This figure displays the consumption of calories from SSBs and 100% fruit juice per capita, combined according to consumption location. "Restaurants" include self-serve buffets, cafeterias, delicatessens, restaurants, stores and take-out restaurants. "Other" includes in transit (boats, cars, planes), community-feeding programs, work, day camp, day care and other locations.

Source: Wang Y, Bleich S and Gortmaker S. "Increasing Caloric Contribution from Sugar Sweetened Beverages and 100% Fruit Juices Among US Children and Adolescents, 1988-2004." *Pediatrics*. 121(6): e1604-e1614, June 2008.

### Areas for Additional Research

While the link between SSB consumption and excess weight gain is clear, additional research is needed to quantify the effects on weight and health that reducing youth SSB consumption could have. Nationally representative studies also should evaluate the impact energy drinks and other high-caffeine SSBs have on child and adolescent caffeine intake and health. Additional information also is needed on the extent of SSB marketing, the targeting of that marketing to specific populations and its impact on children's health. Most important, research should focus on evaluating broadly applicable interventions and policy approaches to reducing SSB consumption among children and adolescents. Increased attention also should be paid to shifting norms and preferences related to SSBs and other beverages among children, adolescents and parents.

### For More Information:

For more information about the potential effects of sugar-sweetened beverage taxes on consumer behavior and health, and food and beverage marketing to children, please consider these resources, both available on the *Healthy Eating Research* Web site, at [www.healthyeatingresearch.org](http://www.healthyeatingresearch.org):

*Sugar-Sweetened Beverage Taxes and Public Health*

*Food and Beverage Marketing to Children and Adolescents: What Changes are Needed to Promote Healthy Habits*

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### **About Healthy Eating Research**

*Healthy Eating Research* is a national program of the Robert Wood Johnson Foundation. Technical assistance and direction are provided by the University of Minnesota School of Public Health under the direction of Mary Story, Ph.D., R.D., program director, and Karen M. Kaphingst, M.P.H., deputy director. The Healthy Eating Research program supports research to identify, analyze and evaluate environmental and policy strategies that can promote healthy eating among children and prevent childhood obesity. Special emphasis is given to research projects that benefit children in low-income and racial/ethnic populations at highest risk for obesity.

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### **About the Robert Wood Johnson Foundation**

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