

14. Makarem N, Bandera EV, Lin Y, Jacques P, Hayes RB, Parekh N. Consumption of Sugars, Sugary Foods and Sugary Beverages in Relation to Adiposity-Related Cancer Risk in the Framingham Offspring Cohort (1991-2013). *Cancer Prev Res (Phila)*. 2018.
15. Hodge AM, Bassett JK, Milne RL, English DR, Giles GG. Consumption of sugar-sweetened and artificially sweetened soft drinks and risk of obesity-related cancers. *Public Health Nutr*. 2018;1-9.
16. Boyle P, Koechlin A, Autier P. Sweetened carbonated beverage consumption and cancer risk: meta-analysis and review. *Eur J Cancer Prev*. 2014;23(5):481-90.
17. World Cancer Research Fund / American Institute for Cancer Research. Food N, Physical Activity, and the Prevention of Cancer: a Global Perspective. Washington DC: AICR, 2007. Available at <https://www.wcrf.org/sites/default/files/Second-Expert-Report.pdf>.
18. Zhang X, Albanes D, Beeson WL, van den Brandt PA, Buring JE, Flood A, et al. Risk of colon cancer and coffee, tea, and sugar-sweetened soft drink intake: pooled analysis of prospective cohort studies. *J Natl Cancer Inst*. 2010;102(11):771-83.
19. Friberg E, Wallin A, Wolk A. Sucrose, high-sugar foods, and risk of endometrial cancer—a population-based cohort study. *Cancer Epidemiol Biomarkers Prev*. 2011;20(9):1831-7.
20. World Cancer Research Fund / American Institute for Cancer Research. Continuous Update Project Report. Food N, Physical Activity, and the Prevention of Endometrial Cancer. 2013. Available at <http://www.dietandcancerreport.org>.
21. Inoue-Choi M, Robien K, Mariani A, Cerhan JR, Anderson KE. Sugar-sweetened beverage intake and the risk of type I and type II endometrial cancer among postmenopausal women. *Cancer Epidemiol Biomarkers Prev*. 2013;22(12):2384-94.
22. Genkinger JM, Li R, Spiegelman D, Anderson KE, Albanes D, Bergkvist L, et al. Coffee, tea, and sugar-sweetened carbonated soft drink intake and pancreatic cancer risk: a pooled analysis of 14 cohort studies. *Cancer Epidemiol Biomarkers Prev*. 2012;21(2):305-18.

23. Mueller NT, Odegaard A, Anderson K, Yuan JM, Gross M, Koh WP, et al. Soft drink and juice consumption and risk of pancreatic cancer: the Singapore Chinese Health Study. *Cancer Epidemiol Biomarkers Prev*. 2010;19(2):447-55.
24. Navarrete-Munoz EM, Wark PA, Romaguera D, Bhoo-Pathy N, Michaud D, Molina-Montes E, et al. Sweet-beverage consumption and risk of pancreatic cancer in the European Prospective Investigation into Cancer and Nutrition (EPIC). *Am J Clin Nutr*. 2016;104(3):760-8.
25. Gallus S, Turati F, Tavani A, Polesel J, Talamini R, Franceschi S, et al. Soft drinks, sweetened beverages and risk of pancreatic cancer. *Cancer Causes Control*. 2011;22(1):33-9.
26. King MG, Olson SH, Paddock L, Chandran U, Demissie K, Lu SE, et al. Sugary food and beverage consumption and epithelial ovarian cancer risk: a population-based case-control study. *BMC Cancer*. 2013;13:94.
27. Stepien M, Duarte-Salles T, Fedirko V, Trichopoulou A, Lagiou P, Bamia C, et al. Consumption of soft drinks and juices and risk of liver and biliary tract cancers in a European cohort. *Eur J Nutr*. 2016;55(1):7-20.
28. Poulouse SM, Miller MG, Scott T, Shukitt-Hale B. Nutritional Factors Affecting Adult Neurogenesis and Cognitive Function. *Adv Nutr*. 2017;8(6):804-11.
29. Sakurai M, Nakamura K, Miura K, Takamura T, Yoshita K, Nagasawa SY, et al. Sugar-sweetened beverage and diet soda consumption and the 7-year risk for type 2 diabetes mellitus in middle-aged Japanese men. *Eur J Nutr*. 2014;53(1):251-8.
30. Vyas A, Rubenstein L, Robinson J, Seguin RA, Vitolins MZ, Kazlauskaitė R, et al. Diet drink consumption and the risk of cardiovascular events: a report from the Women's Health Initiative. *J Gen Intern Med*. 2015;30(4):462-8.

Sugar-sweetened beverages: good, bad or just ugly?

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Chances are you've heard a lot about sugar-sweetened beverages lately. What are sugar-sweetened beverages, and do we need to be concerned about them?

What are sugar-sweetened beverages?

Sugar-sweetened beverages, or SSBs for short, are drinks that have added sugar. This includes sodas, fruit drinks like punch and lemonade, sports drinks, energy drinks, and even sweetened tea and coffee. In fact, added sugar is the main and usually the only energy source in these drinks. Diet sodas with non-caloric sweeteners are not considered SSBs.

What are the health risks related to SSBs?

Consuming too much added sugar is problematic for many reasons. Foremost, added sugars are *empty calories*: they add calories to your diet with no nutritional benefit. Having too many foods and drinks with added sugars can then quickly lead to weight gain. Too much added sugar is also linked to increased blood pressure and an increased risk of heart disease among adults, even after accounting for lifestyle factors like diet, weight, and smoking⁽¹⁻³⁾.

SSBs receive a lot of attention because they are the main source of added sugar in the American diet. Overall, 47% of Americans' added sugar intake is from beverages⁽⁴⁾. SSBs are also concerning



because drinks don't trigger our bodies to feel full the way that foods do. Normally after we eat a snack or a meal, our bodies produce satiety signals that make us feel full and we stop eating. But liquids don't have that same effect, and the extra calories from drinking SSBs can quickly add up.

Strong evidence links SSB intake to a greater weight gain over time in children and adults⁽⁵⁻⁷⁾. For example, just one SSB per day may lead to a weight gain of one-quarter to one-half a pound per year for adults⁽⁵⁾. SSB intake may specifically increase abdominal fat⁽⁸⁾, or fat around the waistline, which is related to poor metabolic health. Greater SSB intake is also linked to an increased risk of metabolic syndrome, prediabetes, and diabetes^(6, 8-10). These facts are concerning because overweight, obesity, and diabetes are established risk factors for many types of cancer^(11, 12). Additionally, individuals who consume more SSBs are often those who are already at increased risk of cancer and other chronic diseases due to socioeconomic factors and lack of access to healthcare.

Do SSBs cause cancer?

Sugar from foods or drinks gets broken down in our gut, and one part of sugar, glucose, moves into our blood stream. Glucose is a critical energy source for our bodies; the brain alone uses 20% of all glucose-derived energy⁽¹³⁾. When our blood glucose levels

SSB Intake in New Hampshire

Most (65%) adults in New Hampshire drink an SSB at least monthly; 1 in 5 adults drink SSBs daily. SSB intake is also frequent among high schoolers: 63% of New Hampshire high schoolers drink SSBs at least once a week; 13% drink SSBs daily. Additionally, SSB intake is more common among those with lower household income levels, suggesting that the health risks related to high SSB intake may have a disproportionate effect based on socioeconomic status.

More information on state-level trends in SSB intake is available from the Behavioral Risk Factor Surveillance System and the Youth Risk Behavior Survey, two studies administered by the Centers for Disease Control and Prevention (www.cdc.gov).



Recommended Added Sugar Intake

The 2015-2020 Dietary Guidelines for Americans recommends limiting added sugar intake to <10% of our daily calories; the American Heart Association recommends an even lower limit of ≤5%. That translates to 9 teaspoons per day for most men and 6 teaspoons per day for most women. One 20-ounce bottle of soda has about 16 teaspoons of added sugar, far more than these recommended limits.

Image credit: The American Heart Association: Added Sugars.



rise after eating or drinking, our body reacts by producing insulin, and the release of insulin triggers the release of other substances including insulin-like growth factor 1 (IGF-1). These are critical steps for our bodies to use glucose as energy. However, insulin and IGF1 are also hormones that can promote the growth of existing tumor cells⁽¹²⁾. Because SSBs provide a high dose of sugar, some researchers have hypothesized that frequent SSB intake may cause dramatic spikes in our blood glucose levels, and the resulting release of insulin and IGF1 in response may speed the development of existing tumor cells.

Obesity-Related Cancers Combined

In a study of 3,184 adults who were enrolled in the Framingham Offspring cohort and followed for about 20 years, there was no association between SSB intake and the risk of three common obesity-related cancers: breast, prostate, and colorectal cancer⁽¹⁴⁾. In that study, researchers found there was an increased risk of developing these cancers for adults with the greatest sugary drink intake defined as SSB and fruit juice combined, but this was only true for adults with excessive central adiposity as measured by their waist circumference. Thus, these findings suggest that a high intake of sugary drinks may exacerbate cancer risk among those with the greatest abdominal fat or with poor metabolic health. In comparison, a large study in Australia that followed more than 35,000 adults over time found a positive association between increased SSB intake and the risk of obesity-related cancers; that study looked at 11 different obesity-related cancer sites combined⁽¹⁵⁾. Interestingly, the findings from that study may have been driven by the association between SSB intake and greater abdominal fat, which was also measured by waist circumference. Conversely, no associations were found between carbonated SSB intake and 13 different cancers in a review and combined analysis of 37 studies⁽¹⁶⁾; non-carbonated SSBs were not included in that review. To note, the research group that conducted that review and combined analysis received funding from the Coca Cola Company.

Colorectal Cancer

A 2007 review conducted by the World Cancer Research Fund and the American Institute for Cancer Research found suggestive but limited evidence that a greater sugar intake may increase the risk of colorectal cancer, but analyses did not look specifically at SSBs⁽¹⁷⁾. In contrast, a more recent pooled analysis of 13 studies that included more than 730,000 adults found no evidence linking SSBs intake with an increased colorectal cancer risk⁽¹⁸⁾.

Endometrial Cancer

Data across studies suggest that a diet high in added sugars may increase the risk of developing endometrial cancers^(19, 20). Further, the Iowa Women's Health Study found that SSB intake increased

the risk of type 1, but not type 2, endometrial cancer among 23,039 postmenopausal women⁽²¹⁾. More studies are needed to understand if these relationships are consistent across different populations.

Pancreatic Cancer

Findings from studies looking at SSB intake and pancreatic cancer have been mixed. In a pooled analysis of 14 cohort studies where adults were followed-up over time, there was a suggestive association between increased SSB intake and pancreatic cancer among men⁽²²⁾. In the large Singapore Chinese Health Study, more than two servings of soft drinks per week was associated with an increased risk of pancreatic cancer⁽²³⁾. In contrast, researchers from the European Prospective Investigation into Cancer and Nutrition study (a.k.a., EPIC) examined data on more than 470,000 adults and found no link between SSB intake and pancreatic cancer⁽²⁴⁾, and a review of the data from 11 other studies also found no association between SSB intake and pancreatic cancer risk⁽²⁵⁾.

Other Cancer Sites Studied To Date

The findings from other large studies to date do not support a direct association between SSB intake and epithelial ovarian cancer⁽²⁶⁾ or liver and biliary tract cancers⁽²⁷⁾.

Summary

Several large studies have examined the relationship between SSB intake and cancer risk while also accounting for sociodemographics and other lifestyle factors that might impact cancer risk such as diet, weight, and smoking. It is important to note that studying SSB intake and cancer risk is challenging. It is difficult to accurately measure what people eat and drink, especially over time, and studies inevitably use different methods of measuring other lifestyle factors that relate to cancer risk.

However, while findings from individual studies are mixed, the bulk of the evidence does not conclusively link SSB intake directly to cancer risk, with the exception of type 1 endometrial cancer among postmenopausal women. *Yet it is likely that frequent SSB intake increases the risk of obesity-related cancers because of the link to excess weight gain.* In fact, the World Cancer Research Fund and the American Institute for Cancer Research recommend avoiding SSBs to control weight gain and reduce cancer risk⁽¹⁷⁾. Additionally, because of the high sugar content, a high SSB intake can increase the risk of diabetes, heart disease and other negative health outcomes including dental cavities and declining cognitive function among older adults⁽²⁸⁾.

What can I do?

Cutting SSBs out of your diet can be an effective step towards weight management for children and adults, which is important for reducing cancer risk. Instead of SSBs, reach for water,

unsweetened iced-teas, or seltzers. If you're not sure if your drink has added sugar, look at the nutritional facts panel. And remember to be careful with 100% fruit juices, too. While 100% juice provides many nutritional benefits, 100% juice is still high in calories, and drinking too much can also lead to weight gain. Finally, while diet sodas are not SSBs, the health effects of diet sodas are not fully understood. For example, some studies suggest that a daily intake of diet soda may increase the risk of diabetes⁽²⁹⁾ and cardiovascular disease⁽³⁰⁾.

Check the Label

The nutrition facts panel on the side of a can or bottle of SSB defines how much sugar it contains. For this example of a popular 20-ounce bottle of cola, there are 65 grams of sugar. One teaspoon of sugar has 4 grams of sugar. To convert that into teaspoons of sugar, divide by 4. Thus, this one 20-ounce bottle of cola has 65/4 or about 16 teaspoons of sugar.

Nutrition Facts	Amount/Serving	% DV*
Serv. Size 1 Bottle	Total Fat 0g	0%
	Sodium 75mg	3%
	Total Carb. 65g	22%
Calories 240	Sugars 65g	
	Protein 0g	

*Percent Daily Values (DV) are based on a 2,000 calorie diet.

Not a significant source of fat cal., sat. fat, trans fat, cholest., fiber, vitamin A, vitamin C, calcium and iron.

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References

1. Brown IJ, Stamler J, Van Horn L, Robertson CE, Chan Q, Dyer AR, et al. Sugar-sweetened beverage, sugar intake of individuals, and their blood pressure: international study of macro/micronutrients and blood pressure. Hypertension. 2011;57(4):695-701.
2. Yang Q, Zhang Z, Gregg EW, Flanders WD, Merritt R, Hu FB. Added sugar intake and cardiovascular diseases mortality among US adults. JAMA Intern Med. 2014;174(4):516-24.
3. Johnson RK, Appel LJ, Brands M, Howard BV, Lefevre M, Lustig RH, et al. Dietary sugars intake and cardiovascular health: a scientific statement from the American Heart Association. Circulation. 2009;120(11):1011-20.
4. <https://health.gov/dietaryguidelines/2015/guidelines/>. USDoHaHSaUSDoADGfAtEDAa.
5. Malik VS, Pan A, Willett WC, Hu FB. Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. Am J Clin Nutr. 2013;98(4):1084-102.
6. Schulze MB, Manson JE, Ludwig DS, Colditz GA, Stampfer MJ, Willett WC, et al. Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. JAMA. 2004;292(8):927-34.
7. Stern D, Middaugh N, Rice MS, Laden F, Lopez-Ridaura R, Rosner B, et al. Changes in Sugar-Sweetened Soda Consumption, Weight, and Waist Circumference: 2-Year Cohort of Mexican Women. Am J Public Health. 2017;107(11):1801-8.
8. Ma J, McKeown NM, Hwang SJ, Hoffmann U, Jacques PF, Fox CS. Sugar-Sweetened Beverage Consumption Is Associated With Change of Visceral Adipose Tissue Over 6 Years of Follow-Up. Circulation. 2016;133(4):370-7.
9. Ma J, Jacques PF, Meigs JB, Fox CS, Rogers GT, Smith CE, et al. Sugar-Sweetened Beverage but Not Diet Soda Consumption Is Positively Associated with Progression of Insulin Resistance and Prediabetes. J Nutr. 2016;146(12):2544-50.
10. Malik VS, Popkin BM, Bray GA, Despres JP, Willett WC, Hu FB. Sugar-sweetened beverages and risk of metabolic syndrome and type 2 diabetes: a meta-analysis. Diabetes Care. 2010;33(11):2477-83.
11. National Cancer Institute. Obesity and Cancer. January 17 Aahwcca-cc-proo-f-s.
12. Giovannucci E, Harlan DM, Archer MC, Bergenstal RM, Gapstur SM, Habel LA, et al. Diabetes and cancer: a consensus report. Diabetes Care. 2010;33(7):1674-85.
13. Mergenthaler P, Lindauer U, Dienel GA, Meisel A. Sugar for the brain: the role of glucose in physiological and pathological brain function. Trends Neurosci. 2013;36(10):587-97.