



The Health Harms of Artificially Sweetened Beverages

Introduction

“Is diet soda healthy?” This seemingly simple question has been a source of confusion for consumers and scientists for years. In 2016, it emerged as a prominent policy question in jurisdictions considering a sugary drink tax when two jurisdictions – Philadelphia, PA, and Cook County, IL – voted to tax both sugary drinks and artificially sweetened beverages (ASB), such as diet soda. In contrast, five other jurisdictions – Boulder, CO, and Albany, Berkeley, Oakland, and San Francisco, CA – limited their taxes to drinks with added sugar.

The rationales for taxing sugary drinks include preventing disease by reducing consumption of unhealthy products and raising awareness of adverse health effects. Taxing ASBs is more controversial because there is more debate over the role of ASBs in weight management and chronic disease prevention.

This research brief summarizes the evidence on ASBs and their effect on individuals’ risk of disease, and whether risks may be offset by potential benefits such as weight loss. The brief is designed to summarize existing evidence from recent systematic reviews and randomized trials. As we describe at the conclusion, the implications of the evidence may differ depending on whether it is used for policy purposes or individual behavioral choices.

Do ASBs increase disease risk?

Type 2 diabetes,¹ stroke,² and hypertension³ are examples of negative health outcomes that have been linked to ASBs in observational studies. For each of these conditions, multiple cohort studies that followed adults over time found that people who consumed ASBs were more likely to develop the negative outcome compared to people who did not consume ASBs. However, these studies suffer from important limitations: only a few studies measure each individual outcome, the effect sizes are often small (~5-10% increase in risk per serving), and there are several potential biases that we describe below.

Even for diseases for which there are a larger number of studies and larger effect sizes, as with type 2 diabetes, the



ASBs have been associated with a higher risk of chronic diseases, but this evidence may be biased by several factors.



strength of evidence is questionable. Imamura and colleagues combined the results of 10 prospective cohort studies and found that consumption of ASBs increased the risk of type 2 diabetes by 25%. However, the evidence was characterized as “low” quality for multiple reasons.¹

In a review on sugary drinks, ASBs, and type 2 diabetes, experts concluded that sugary drinks, not ASBs, increased adults' risk of diabetes.

One reason is reverse causality, meaning that people who are already prone to diabetes may adjust their diet by consuming ASBs. De Koning and colleagues illustrated how factors such as this can produce misleading results. In a study of 40,389 men, they found that consuming ASBs was associated with a greater risk of type 2 diabetes, but this association was eliminated after adjusting for pre-existing risk factors (e.g., family history of type 2 diabetes) and attempts to diet.⁴

Another source of bias is “publication bias,” where studies are more likely to be published if they report a statistically significant result. Imamura and colleagues found evidence that publication bias may have increased the association between ASBs and type 2 diabetes.¹ Due to these biases, they did not conclude that ASBs increase the risk of diabetes. However, they did conclude that sugary drinks were associated with a greater risk of type 2 diabetes.

These biases exacerbate other well-established limitations of cohort studies, such as relying on self-reported measures of ASB consumption that may be inaccurate. These limitations remain a concern even when there is a large body of evidence, as with type 2 diabetes. For other negative health outcomes, such as excess weight,⁵ hypertension,³ and stroke,² evidence on ASBs comes from fewer studies and is even less consistent.

Pereira, for example, pointed out that the association between ASBs and body weight has been positive in some studies and negative in others.⁵ As with Imamura and colleagues, Pereira cautioned that reverse causality may explain any positive association.⁵ Narain and colleagues reported that ASB consumption was associated with a greater risk of stroke, but the conclusions were based on only one study of two select cohorts that may not reflect the general populations.²

Other diseases, such as chronic kidney disease, have also been associated with ASB consumption in at least one individual cohort study.⁶ However, the number of studies is even smaller for these other diseases. Furthermore, as we describe in the next section, it is difficult to conclude that ASBs are the cause of disease without exploring the causal mechanisms.

Why would ASBs affect disease?

Even meta-analyses that suggested ASBs increase disease risk pointed out the uncertainty as to how this would happen – i.e., what biologic mechanisms would explain the effect? Kim and Je, for



The biologic link between sugary drinks and disease risk is clear. There is more uncertainty on how low-calorie sweeteners in ASBs would increase disease risk.

example, found that each serving of ASBs per day was associated with a nine percent greater risk of hypertension, but they could not explain why ASBs would increase hypertension.³

Randomized, clinical trials (RCTs) and mechanistic studies are useful for studying the short-term biologic mechanisms that would explain how ASBs or sugary drinks affect disease. These studies are generally less biased than cohort studies because they randomly assign people to short-term diets that are carefully controlled. Numerous mechanistic studies have established how sugary drinks increase insulin resistance, de novo lipogenesis, and other mechanisms that would explain disease risk. The biologic link between sugary drinks and disease risk is clear through studies such as these.

There is less evidence on how low-calorie sweeteners in ASBs would increase disease risk. Scientists have speculated about several mechanisms, such as ASBs potentially increasing sweet preference, affecting satiety mechanisms, increasing glucose absorption, or changing the gut microbiome in ways that would affect calorie absorption or appetite.^{7,8} These mechanisms are plausible, but again, the evidence base is thin. In 2012, the American Heart Association and American Diabetes Association reviewed several mechanisms as part of a joint statement on non-nutritive sweeteners.⁹ They described their review as “notably limited by the lack of an extensive evidence base,” due to the field’s reliance on animal experiments, and concluded that “the paucity of data from well-designed human trials” was a severe limitation.

Can ASBs help people lose weight?

A common argument in favor of consuming ASBs is that these drinks help people lose weight if they are used as a replacement for sugary drinks. Intuitively, if a person trades a high-calorie, sugary drink for a low-calorie, artificially sweetened drink, it would reduce both caloric and sugar intake.

There is some evidence to support this rationale, as two recent meta-analyses of RCTs concluded that consuming low-calorie sweeteners in place of sugar led to reductions in body weight, and one of the meta-analyses also found low-calorie sweeteners reduced body mass index, fat mass, and waist circumference.^{10,11} However, both meta-analyses were funded by the International Life Sciences Institute, which includes Coca-Cola and PepsiCo, among many other large food and beverage companies. There is a need for more non-industry-funded meta-analyses of how ASBs affect weight loss or weight maintenance.

Several industry-funded studies have reported that ASBs help people lose weight. More non-industry-funded studies are needed.



One of the strongest and most commonly cited studies on ASBs and weight loss was a 2012 randomized trial by Ebbeling and colleagues, who found that some adolescents lost more weight if they were encouraged to substitute diet drinks for sugary drinks.¹² The effect was limited to Hispanics, who represented a small portion of the sample (n=46), and was not seen in the larger group of non-Hispanic participants (n=178). The authors concluded, “these data must be interpreted cautiously in view of the small size of the Hispanic subgroup.”¹²

When balancing the evidence on risks versus benefits, it is important to consider whether the evidence is being used for policy making or individual behavior choices.

The limitations do not negate the possibility that ASBs may help lose weight, particularly if they are a substitute for sugary drinks. As in previous sections, though, the limitations make it difficult to draw definitive conclusions.

Conclusion

Compared to sugary drinks, the science on ASBs is still in its infancy. There is some evidence that ASBs increase disease risk, particularly for type 2 diabetes, but even authors who reported this did not draw firm conclusions. The volume of evidence is small and the sources of bias are problematic. Evidence on disease risk is also limited to adults; the long-term effects of ASB consumption in kids is almost entirely unknown. Some studies suggest that ASBs may help kids or adults lose weight, but that evidence base is also relatively small. Many questions about ASBs are still unresolved, such as whether different artificial sweeteners (e.g., aspartame, saccharin) have different health effects.¹³

When balancing the evidence on risks versus benefits, it is important to consider how the evidence would be applied. From a policy perspective, the evidence is not robust enough to justify taxing ASBs due to health risks alone. On an individual level, though, because ASBs may pose health risks while their value for weight loss is uncertain, it is prudent to choose healthier drinks such as water.

Methods

This research brief summarizes: 1) reviews or meta-analyses of prospective cohort studies that analyzed the association between ASB consumption and disease risk, 2) randomized trials that studied the metabolic and health effects of ASB consumption, and 3) randomized trials that studied the effect of ASB consumption on weight loss. Reviews and meta-analyses were restricted to those published in the last 5 years, to ensure that this brief reflected the latest science. All studies were obtained through PubMed searches.



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