# Sugar-Sweetened Beverage Consumption and Lipid Profile: More Evidence for Interventions

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In this issue of the *Journal of the American Heart Association* (*JAHA*), McKeown et al[1] examined the association between sugar-sweetened beverage (SSB) consumption and changes in lipid profile among participants of the Framingham Offspring (N=3124) and Generation Three cohorts (N=2800). The Framingham Heart Study began recruitment of the Original Cohort in 1948 with a purpose to investigate the cause and prognosis of the cardiovascular system, lung, and other diseases.[2] The town of Framingham located 20 miles (32.2 km) west of Boston, Massachusetts, was selected as a study site because of a high response rate to a community-based tuberculosis screening project.[2] The town is also close to medical research hospitals. The early results of the study paved the road for clinical trials of discovering new preventive strategies for reducing the risk of cardiovascular disease. In 1972, children of the Original Cohort, along with their spouses, enrolled in the Offspring Cohort.[2] In 2002, adults having at least 1 parent in the Offspring Cohort enrolled in the Third Generation Cohort.[2]

In the present study, SSB consumption included any carbonated beverage with sugar, punch, lemonade, or other noncarbonated fruit drinks. The study also assessed associations of low-calorie sweetened beverage (LCSB) and 100% fruit juice consumption with changes in lipid profiles of study participants. LCSB consumption included beverage sweeteners that provide no or very few calories (<40 kcal/serving or <10 g sugar/serving). In this study, 1 serving was defined as 12 fl oz. for SSBs or LCSB and 8 fl oz. for fruit juice. The authors reported that regular (>1 serving/d) SSB consumption was associated with a decrease in high-density lipoprotein cholesterol and an increase in triglyceride at 4-year follow-up, compared with low SSB consumption (<1 serving/mo).

Fruit juice consumption was not significantly associated with the lipid profile. Several factors could contribute to the nonsignificant results for fruit juice consumption, including residual confounding. A review article reported that results from other studies on the effects of fruit juice on lipids, especially on the level of high-density lipoprotein cholesterol and triglyceride, are inconsistent.[3] These studies varied in the type of fruit juice, dose, duration, study design, and measured outcomes. Thus, a comparison of results from these studies is difficult and suggests the need for additional experimental studies.[3] However, a few facts should be weighed when considering the results and implications of any study of fruit juice for clinical and public health practice. Fruit juice can be easily overconsumed because of sweet taste, and thus, contribute to energy imbalance by increasing calorie intake.[4] Fruit juice also has no nutritional benefits over whole fruits for adults. Thus, although a limited amount of fruit juice can be consumed as a part of a healthy diet, whole fruits should be the main contributor to fruits in the American diet.[4]

Although recent regular LCSB consumption (a mean 4 years of follow-up) resulted in a temporary increase in low-density lipoprotein cholesterol and non-high-density lipoprotein cholesterol compared with lowest LCSB consumption, the cumulative changes (a mean 12.5 years of follow-up) were nonsignificant. Given that knowledge about the efficacy and safety of LCSB in a reduction of cardiometabolic risk factors is very limited,[5] this study fills important gaps in the current literature. However, sugar content in LCSB varies from 0 to 9.99 g per serving and thus, the efficacy of LCSB for reducing sugar intake also depends on the type and concentration of low-calorie sweeteners used in LCSB, complicating interpretation of results. Indeed, the US Food and Drug Administration approved 6 high-intensity sweeteners (saccharin, aspartame, acesulfame-K, sucralose, neotame, and advantame) and 2 additional high-intensity sweeteners are undergoing the US Food and Drug Administration

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investigation: steviol glycosides, obtained from the leaves of the stevia plant, and extracts derived from monk fruit.[6] The strongest level of evidence can be obtained only from experimental studies that have hard cardiovascular events (coronary heart disease, stroke, cardiovascular death, etc.) as outcomes.[5]

The reporting of adverse consequences of daily SSB consumption on dyslipidemia in this study is consistent with the results of a cross-sectional study.[7] This study adds to evidence of the adverse health effects of SSB consumption from a longitudinal study. It is challenging to recruit participants for studies that track diet changes over multiple years. In addition, the dropout rates in these types of studies are usually high. For these reasons, limited data on this research question are available from longitudinal studies. Obtaining evidence from experimental studies in nutrition is also difficult. Blinding of dietary interventions may not be feasible, and suboptimal adherence to interventions is a risk to internal validity.[8] Furthermore, long-term intervention studies, at substantial cost, are required to investigate effects on chronic disease risk.

The significant finding on the adverse effects of SSBs on the lipid profile by McKeown et al[1] is limited to the middle-aged or older adults of European descent. However, currently, there is substantial evidence that supports limiting consumption of SSBs for multiple health benefits, including reduced risk of obesity, type 2 diabetes mellitus, and cardiovascular disease.[9] According to the 2015–2020 Dietary Guidelines for Americans (the 2015–2020 DGA), the daily intake of calories from added sugars should not exceed 10% of total calories according to the 2015–2020 DGA.[4] SSBs are significant contributors to added sugars in the diet of Americans. Among U.S. adults aged 20 and over, 54% of men and 45% of women had at least 1 SSB on a given day in 2011–2014.[10] Men and women consumed an average 179 and 113 kilocalories (kcal) from SSBs, which corresponded to 6.9% and 6.1% of total daily caloric intake from beverages not counting other sources of added sugars, respectively.[10] However, the contribution from SSB to the total daily caloric intake varied by sex, race, and Hispanic origin, with the highest and lowest observed for non-Hispanic black women (8.9%) and non-Hispanic Asian women (3%), respectively.[10] Studies have shown that persons who consume SSBs have higher total calorie intake and poorer overall dietary quality. For example, in a study of the 1154 pregnant women who participated in the 1999–2006 National Health and Nutrition Examination Survey, every 12 oz. of SSBs consumed was associated with the consumption of 124 more calories (95% CI, 85, 163) and lower diet quality.[11] Researchers estimated that eliminating SSBs from their diet would result in lowering average total energy intakes of about 200 calories and improvement of diet quality by gaining about 6 points on the Alternate Healthy Eating Index modified for Pregnancy.[11]

Finding optimal ways to support healthier beverage choices among adults and children in the current SSB-easily accessible environment remains a challenge. Several factors have been identified as contributing to consumption of SSBs, such as exposure to advertisements and marketing; availability of SSBs in schools or at home; and parental consumption of SSBs.[12–15] A recent Cochrane review examined the evidence for environmental interventions to reduce SSB intake.[16] Among 58 studies eligible to be included in the Cochrane review, most studies were nonrandomized and prone to bias.[16] The combined length of intervention and follow-up ranged from 3 months to 6 years; the median duration of interventions was 10 months.[16] Nevertheless, authors have found evidence that some interventions show promising results to reduce the consumption of SSBs. These interventions included easy to follow consumer labels on SSBs and promoting healthier beverages in supermarkets. Increasing prices on SSBs in restaurants, stores, and fitness centers (compared with other drinks, including water) and improving access to healthier beverages in the home environment are among other possible interventional options. Food benefit programs with incentives for buying fruits and vegetables combined with restrictions on the purchase of SSB and multicomponent community campaigns focused on the decreased availability of SSBs in stores also have been found to be effective interventions.[16]

The prospective, multiyear longitudinal study by McKeown et al[1] provides additional evidence on the adverse effects of SSBs on lipid profile. This combined with the multiple adverse outcomes associated with SSB consumption support limiting the consumption of SSBs. While SSB consumption has decreased during the past decade in the United States,[17] SSB consumption remains high, and disparities by sociodemographic and geographic locations continue to persist.[18] Implementing interventions to address SSB consumption will require a collaborative and multisectoral approach.

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## Disclosures

None.

## References

1. McKeown N, Haslam D, Peloso G, Herman M, Dupuis J, Lichtenstein A, Smith C, McKeown N. Beverage consumption and longitudinal changes in lipid concentrations and incident dyslipidemia in U.S. adults: the Framingham heart study. *J Am Heart Assoc*. 2019;8:e014083. DOI: 10.1161/JAHA.119.014083.

2. Andersson C, Johnson AD, Benjamin EJ, Levy D, Vasan RS. 70-year legacy of the Framingham heart study. *Nat Rev Cardiol*. 2019;16:687–698.
3. Pepin A, Stanhope KL, Imbeault P. Are fruit juices healthier than sugar-sweetened beverages? A review *Nutrients*. 2019;11:1006.
4. U.S. Department of Agriculture, U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2015–2020*. 8th ed. Washington, DC: U.S. Government printing office; 2015. Available at: https://health.gov/sites/default/files/2019-09/2015-2020_Dietary_Guidelines.pdf. Accessed February 6, 2020.
5. Johnson RK, Lichtenstein AH, Anderson CAM, Carson JA, Despres JP, Hu FB, Kris-Etherton PM, Otten JJ, Towfighi A, Wylie-Rosett J; American Heart Association Nutrition Committee of the Council on Lifestyle and Cardiometabolic Health; Council on Cardiovascular and Stroke Nursing; Council on Clinical Cardiology; Council on Quality of Care and Outcomes Research; and Stroke Council. Low-calorie sweetened beverages and cardiometabolic health: a science advisory from the American Heart Association. *Circulation*. 2018;138:e126–e140.
6. US Food and Drug Administration. Additional information about high-intensity sweeteners permitted for use in food in the united states. Updated February 08, 2018. Available at: https://www.Fda.Gov/food/food-additives-petitions/additional-information-about-high-intensity-sweeteners-permitted-use-food-united-states. Accessed January 2, 2020.
7. Welsh JA, Sharma A, Abramson JL, Vaccarino V, Gillespie C, Vos MB. Caloric sweetener consumption and dyslipidemia among us adults. *JAMA*. 2010;303:1490–1497.
8. Trepanowski JF, Ioannidis JPA. Perspective: limiting dependence on nonrandomized studies and improving randomized trials in human nutrition research: why and how. *Advances in Nutrition*. 2018;9:367–377.
9. Malik VS, Hu FB. Sugar-sweetened beverages and cardiometabolic health: an update of the evidence. *Nutrients*. 2019; 11:E1840.
10. Rosinger A, Herrick K, Gahche J, Park S. Sugar-sweetened beverage consumption among U.S. adults, 2011–2014. *NCHS Data Brief*. 2017;1–8.
11. Gamba RJ, Leung CW, Petito L, Abrams B, Laraia BA. Sugar sweetened beverage consumption during pregnancy is associated with lower diet quality and greater total energy intake. *PLoS One*. 2019;14:e0215686.
12. Imoisili OE, Park S, Lundeen EA, Yaroch AL, Blanck HM. Daily adolescent sugar-sweetened beverage intake is associated with select adolescent, not parent, attitudes about limiting sugary drink and junk food intake. *Am J Health Promot*. 2020;34:76–82.
13. Bogart LM, Elliott MN, Ober AJ, Klein DJ, Hawes-Dawson J, Cowgill BO, Uyeda K, Schuster MA. Home sweet home: parent and home environmental factors in adolescent consumption of sugar-sweetened beverages. *Academic Pediatrics*. 2017;17:529–536.
14. Harris JL, Romo-Palafox M, Choi Y, Kibwana A. Children's drink facts 2019. Sales, nutrition, and marketing of children's drinks. UConn Rudd center for food policy & obesity. 2019. Available at: http://uconnruddcenter.org/files/Pdfs/FACTS2019.pdf. Accessed February 6, 2020.
15. Taber DR, Stevens J, Evenson KR, Ward DS, Poole C, Maciejewski ML, Murray DM, Brownson RC. State policies targeting junk food in schools: racial/ethnic differences in the effect of policy change on soda consumption. *Am J Public Health*. 2011;101:1769–1775.
16. von Philipsborn P, Stratil JM, Burns J, Busert LK, Pfadenhauer LM, Polus S, Holzapfel C, Hauner H, Rehfuess E. Environmental interventions to reduce the consumption of sugar-sweetened beverages and their effects on health. *Cochrane Database Syst Rev*. 2019;6:CD012292.
17. Bleich SN, Vercammen KA, Koma JW, Li Z. Trends in beverage consumption among children and adults, 2003–2014. *Obesity (Silver Spring)*. 2018;26:432–441.
18. Lundeen EA, Park S, Pan L, Blanck HM. Daily intake of sugar-sweetened beverages among US adults in 9 states, by state and sociodemographic and behavioral characteristics, 2016. *Preventing Chronic Disease*. 2018;15:E154.


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