Sugar-sweetened beverages and health: where does the evidence stand?1–3

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The relation between sugar-sweetened beverages (SSBs), obesity, and related health outcomes has increasingly attracted public and scientific interest. Since the late 1970s, intake of SSBs has increased more than 2-fold (1), and currently they are now the primary source of added sugar in the US diet (2). On average, SSBs contain 140–150 kcal and 35–37.5 g sugar per 12-oz serving. The prevailing mechanisms linking SSB intake to weight gain are low satiety of liquid calories and incomplete compensatory reduction in energy intake at subsequent meals, leading to an increase in total energy intake (3). SSBs also induce independent metabolic effects through their contribution to a high dietary glycemic load, leading to inflammation, insulin resistance, and impaired β cell function (3, 4). In addition, regular consumption of SSBs is associated with high blood pressure and accumulation of visceral adipose tissue and dyslipidemia through increased hepatic de novo lipogenesis.

Numerous epidemiologic studies have examined the relations between SSBs, obesity, and related cardiometabolic diseases. Whereas most studies have found positive associations, some have yielded inconsistent results, sparking controversy in the field. In general, associations are strongest and most consistent in large prospective cohort studies with long durations of follow-up and repeated measures of intake that capture long-term dietary patterns. Studies that do not adjust for the potential mediating effect of total energy intake in analyses tend to yield stronger associations; adjustment for total energy is equivalent to removing any effect of SSBs on body weight that occurs through energy intake and may thus attenuate the association (5). Furthermore, studies funded by the food industry tend to report significantly weaker associations than do non–industry-funded studies (6).

A number of reviews have been conducted to summarize the current evidence in an effort to guide clinicians, public health experts, and policymakers. However, individual reviews may be prone to bias and may vary in terms of quality. For these reasons, rigorous evaluation of published reviews can be useful for guiding public health decisions, especially for controversial topics with far-reaching implications.

In this issue of the Journal, Weed et al (7) conducted a systematic review to assess the methodologic quality of reviews or meta-analyses published in the past decade that examined the relation between SSB and health outcomes. However, rather than shedding more light on this pressing public health issue, the report obscured important relations between SSB consumption and harmful health consequences.

To assess study quality, Weed et al used the Assessment of Multiple Systematic Reviews (AMSTAR) tool to assess the quality of the studies. AMSTAR is a validated scoring system based on 11 questions specifically designed to evaluate the methodologic quality of systematic reviews (8). Systematic reviews, which include meta-analyses, use a comprehensive and criterion-based selection of relevant evidence with methods clearly stated and reproducible by others, an appraisal of validity, and an objective or quantitative summary of the evidence. In contrast, narrative reviews (including position statements by professional organizations), often written by experts in the field, are usually broader in scope but do not necessarily state criteria relevant to assessing the methodologic quality of systematic reviews (9). For example, narrative reviews typically do not include a comprehensive literature search strategy, detailed tabulation of study characteristics, data extraction methods, or an assessment of publication bias. For this reason, some studies that use AMSTAR for quality appraisal of systematic reviews have excluded narrative reviews (10).

The maximum AMSTAR score a review can receive is 11 (11 for meta-analyses and 10 for systematic reviews), with scores of 0–4 indicating low quality, 5–8 moderate quality, and 9–11 high quality (9). Overall, 17 reviews of obesity, diabetes, metabolic syndrome, and coronary heart disease were included in the report and found to be of moderate to low quality on the basis of AMSTAR scoring (mean = 4.4, median = 4, range 1–8.5) (7). Of the 17 reviews, 7 were narrative and thus did not possess many of the components relevant to the AMSTAR score. By applying the AMSTAR instrument equally to narrative and systematic reviews, the authors underestimated the quality of the reviews on SSBs and health, leading to a spurious conclusion. Not surprisingly, the studies that used a systematic or meta-analysis approach received high scores, whereas the nonsystematic narrative reviews received low scores. By lumping these 2

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types of studies together, the authors created a distorted view of the state of the literature on SSBs and health outcomes.

In addition, although the authors indicated that AMSTAR scores did not improve with year of publication or overall conclusion, older reviews are superseded as new evidence accumulates, most of which has been published in the past several years and which forms the basis of multiple health recommendations and policy initiatives (11). Thus, older reviews may be methodologically sound but irrelevant given newer data.

Other methodologic concerns also raise doubts about the validity of Weed et al’s analysis. For example, the meta-analysis of SSBs and BMI in children and adolescents by Forshee et al (12), which was supported by the beverage industry, was one of the few reviews to receive an AMSTAR score $\geq 7$, despite having gross errors that fundamentally changed the findings (5). In addition, Weed et al misreported the results from the meta-analysis by Malik et al (13) by stating that only extreme categories of SSB intake were analyzed, when in actuality a dose-response analysis that used data from all categories was included. A systematic review of reviews, like the individual reviews themselves, should be of sufficiently high quality and methodologic rigor so that reliable conclusions can be drawn.

Although more research is needed, the weight of the evidence based on previous systematic reviews and meta-analyses of prospective studies shows clear and consistent associations between SSBs and obesity and related cardiometabolic diseases. This evidence is also supported by findings from mechanistic and experimental studies. Systematic reviews have been widely used to summarize the best available evidence for clinical and public health policy and decision making. Statements from the American Heart Association, the American Academy of Pediatrics, and the US 2010 Dietary Guidelines technical review committee (14) all call for reductions in intake of SSBs to prevent obesity and improve health. These recommendations are based on previous systematic reviews and meta-analyses. Despite attempts from the beverage industry to obfuscate the issue by funding biased analyses and reviews, and by providing misleading information to consumers, many regulatory strategies to reduce intake of SSBs are already in place (11). Some states are considering taxation (11) as a means of reducing SSB intake and as a method of offsetting some of the high health care costs attributed to regular consumption of these beverages. These measures have a great potential to reduce SSB consumption and their adverse health consequences.

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