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Research report

Artificial sweeteners are not the answer to childhood obesity

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ABSTRACT

While no single factor is responsible for the recent, dramatic increases in overweight and obesity, a scientific consensus has emerged suggesting that consumption of sugar-sweetened products, especially beverages, is casually linked to increases in risk of chronic, debilitating diseases including type 2 diabetes, cardiovascular disease, hypertension and stroke. One approach that might be beneficial would be to replace sugar-sweetened items with products manufactured with artificial sweeteners that provide sweet tastes but with fewer calories. Unfortunately, evidence now indicates that artificial sweeteners are also associated with increased risk of the same chronic diseases linked to sugar consumption. Several biologically plausible mechanisms may explain these counterintuitive negative associations. For example, artificial sweeteners can interfere with basic learning processes that serve to anticipate the normal consequences of consuming sugars, leading to overeating, diminished release of hormones such as GLP-1, and impaired blood glucose regulation. In addition, artificial sweeteners can alter gut microbiota in rodent models and humans, which can also contribute to impaired glucose regulation. Use of artificial sweeteners may also be particularly problematic in children since exposure to hyper-sweetened foods and beverages at young ages may have effects on sweet preferences that persist into adulthood. Taken as a whole, current evidence suggests that a focus on reducing sweetener intake, whether the sweeteners are caloric or non-caloric, remains a better strategy for combating overweight and obesity than use of artificial sweeteners.

Introduction

It is widely acknowledged that rates of overweight and obesity among adults have risen significantly not only within the U.S., but also worldwide, over the past several decades (Flegal, Carroll, Kit, & Ogden, 2012). At the same time, rates of excess body weight have also risen dramatically among children and adolescents; for example, it is estimated that almost 35% of children between the ages of 12 and 19 in the U.S. are overweight, with a body mass index (BMI) above the 85th percentile (Ogden, Carroll, Kit, & Flegal, 2014). From a public health perspective, overweight and obesity are of particular concern because they are associated with increased risk for a variety of chronic and debilitating diseases including cancers, cardiovascular disease and diabetes (Ng et al., 2014). The full magnitude of the effects of overweight and obesity during childhood on health outcomes will take years to emerge. However, current data suggest that not only is overweight during childhood a strong predictor of overweight during adulthood (e.g. Clarke & Lauer, 1993; Freedman et al., 2005; Serdula et al., 1993), but that diseases once confined to adulthood, such as type 2 diabetes, are now diagnosed in increasing numbers in children and adolescents (Dabelea et al., 2014; Demmer, Zuk, Rosenbaum, & Desvarieux, 2013). Thus, formulating effective strategies to reduce the prevalence of overweight, obesity, and attendant health consequences in childhood is important not only for improving the quality of life for children now, but for preventing the emergence of life-long problems, including cognitive deficits as described in other papers in this volume.

The goal of the present paper is to consider scientific evidence related to one approach that has been advocated as a possible strategy to reduce overweight and obesity in children, replacing caloric sugars like sucrose or high-fructose corn syrup with sweeteners that satisfy the desire for sweet tastes without the detrimental effects strongly associated with sugar intake. Currently, in the U.S., six such sweeteners are approved for use in foods and beverages, including aspartame, sucralose, saccharin, and acesulfame potassium, with another two plant-derived sweeteners receiving Generally Regarded as Safe designations (US Food and Drug Administration, 2014). While these sugar substitutes are referred to by a number of names, including artificial, high-intensity, low-calorie, or non-caloric sweeteners, in the present paper the term artificial sweetener will be used. Each provides little or no energy, in most cases because it activates sweet taste receptors at very low concentrations relative to sugar, with estimates of the potency of artificial sweeteners currently approved in the U.S. ranging from about 200 times to up to 20,000 times the sweetness of sugar (US Food and Drug Administration, 2014). Because they provide little or no energy, so

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goes the argument, the number of calories consumed will be reduced when artificial sweeteners are used in place of caloric sugars. However, it is not clear that scientific evidence actually supports such a belief. Instead, as described below, artificial sweeteners may actually contribute to increasing the negative outcomes they have been employed to mitigate.

Obesity, sugary drinks and disease

The causes of overweight and obesity are multifactorial, and the focus on any single factor no doubt oversimplifies the issue. Nevertheless, with regard to recent and rapid increases in the prevalence of obesity, scientific evidence has implicated a number of dietary factors as likely contributors. Most recently, special attention has been focused on the extremely high levels of consumption of sugars in general, and sugar-sweetened beverages in particular. For example, in the U.S. overall consumption of sugar-sweetened soft drinks in 2001 was roughly 37 gallons per capita (USDA, Economic Research Service, 2008). In 2012 over 70% of adults reported that they consumed sugar-sweetened beverages (SSB; soft drinks or fruit drinks with added sugar; Kumar et al., 2014), with over 25% reporting daily intake. A recent meta-analysis also showed strong links between SSB consumption and increased body weight (Malik, Pan, Willett, & Hu, 2013). Further, regular consumption of SSB in adults has been directly associated with a variety of negative outcomes. For example, a number of long-term prospective cohort studies have documented increased risk for overweight and obesity, cardiovascular disease, hypertension and stroke, type 2 diabetes, and metabolic syndrome in adults who regularly consume SSB (typically one serving or more per day; see Malik et al., 2013).

Intake of sweetened foods and beverages is problematic not only for adults but may be even more of an issue for children and adolescents, as data suggest that exposure to foods during early development can have effects on food choices and preferences that persist throughout life (e.g. Mennella & Castor, 2012). From very early in life, sweet tastes elicit behavioral responses suggesting they are highly pleasant, and newborns of many mammalian species display strong preferences for sweet tastes relative to water (for review, see Mennella, 2014). While strong preferences may not always translate into high levels of intake, current data indicate that children and adolescents do consume high levels of sweetened beverages, including sweetened milks, fruit-flavored drinks, soda and sports drinks. For example, roughly 70% of children aged 2–19 years currently consume sugar-sweetened beverages daily (Han & Powell, 2013; Mesirow & Welsh, 2015). Even among young children, sweetened beverage is highly prevalent, with intake of at least one type of sweetened beverage reported in more than 90% of children aged 3–5 (e.g. Nickelson, Lawrence, Parton, Knowlden, & McDermott, 2014) and one study reporting *daily* SSB consumption among approximately 10% of *2-year-olds* (DeBoer, Scharf, & Demmer, 2013). As seen in adults, regular consumption of SSB in children and adolescents is associated with increased risk for overweight and obesity (DeBoer et al., 2013; Fiorito, Marini, Francis, Smiciklas-Wright, & Birch, 2009; Zheng et al., 2014, 2015).

Artificial sweeteners, obesity, and disease

The strong and consistent associations among SSB intake, obesity, and diseases like diabetes have led to increasing emphasis on reducing the availability and consumption of sugars and sugar-sweetened beverages among children and adults (Hu, 2013). But reducing intake of sugary foods and beverages has not proved simple, as evidenced by persistently high levels of intake. While the promise has been that artificial sweeteners will promote healthy outcomes like reductions in overweight and obesity this is a promise that lacks clear and consistent supporting evidence. It is critical to recognize that even if diet soda consumption can produce weight loss compared to SSB, this does not necessarily indicate that artificial sweeteners are healthy, only that they may be less problematic than SSB. Among interventional studies in which sugar-sweetened versions of foods or beverages have been replaced by artificially-sweetened versions, results do not consistently indicate that artificial sweeteners themselves play any specific role in promoting weight loss in overweight individuals. For example, one early study compared weight loss in overweight women who were encouraged to increase their consumption of the artificial sweetener aspartame to those who were advised to eliminate aspartame from their diets (Blackburn, Kanders, Lavin, Keller, & Whatley, 1997). The results clearly illustrated identical weight loss in the two groups; women who virtually eliminated aspartame from their diets lost the same amount of weight as women who significantly increased their aspartame intake, suggesting that artificial sweeteners are not specifically helpful at aiding weight loss. More recently, an interventional study in overweight adults examined daily consumers of SSB who were encouraged to replace the SSB with either diet soda or water; both groups demonstrated weight loss that was not different from that observed in an attentional control group given no specific advice about beverage intake (Tate et al., 2012). This again suggests that little effectiveness is specifically added by the use of artificial sweeteners. In other words, adults can lose weight over the short term by paying attention to what they eat and drink, but including artificial sweeteners does not appear to produce better outcomes than not including artificial sweeteners. Reviews of the results of studies examining artificial sweeteners and weight have also produced inconsistent conclusions (Blundell & Green, 1996; Mattes & Popkin, 2009). While a recent food-industry sponsored meta-analysis appears to suggest that artificial sweeteners may be beneficial for short-term weight loss (Miller & Perez, 2014), concerns regarding the selection strategy of trials included in this work have been raised (Pan & Hu, 2014). Further, within some of the trials that were included, only select groups were considered. For example, in the Tate et al. (2012) study, only the attentional control and artificial sweetener groups appear to have been considered, while results from the water group were excluded.

Outcomes of long-term prospective cohort studies that examine body weight effects also do not clearly support the utility of artificial sweeteners. For example, in a multi-ethnic prospective cohort study, consumption of artificially-sweetened beverages was associated with significantly increased risk of overweight after 7–8 year follow-up in people who were at a healthy weight at baseline, and significantly increased risk of obesity in those who were overweight at baseline (Fowler et al., 2008). In contrast, other cohort data have indicated that replacement of SSB with artificially-sweetened versions is associated with weight loss (Mozaffarian, Hao, Rimm, Willett, & Hu, 2011; Pan et al., 2013). As described above, some of these contradictory results may reflect differences in comparison groups, with artificially-sweetened beverages producing better outcomes than SSB, but worse outcomes compared to no sweetened beverages at all.

Thus, in adults evidence that artificial sweeteners are particularly useful for promoting weight loss is mixed at best. Despite this fact, their availability and consumption continues to increase, even in children (Ng, Slining, & Popkin, 2012; Sylvetsky, Welsh, Brown, & Vos, 2012). For example, approximately 15% of children in the U.S. aged 2–17 years old reported daily intake of artificially sweetened beverages in 2007–2008 (Sylvetsky et al., 2012). A positive impact of artificially-sweetened beverage intake on body weight outcomes is no more obvious in children than it is in adults, and again likely depends on whether the comparison group is one that is consuming SSB or not. One recent interventional study in overweight adolescents indicated that reduction of SSB intake among those who regularly consumed them did result in decreased body weight gain