American Journal of
Preventive Medicine

RESEARCH ARTICLE

Sugar-Sweetened Beverage and Water Intake in Relation to Diet Quality in U.S. Children

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Introduction: Sugar-sweetened beverages (SSBs) are a major contributor to children's added sugar consumption. This study examines whether children's SSB and water intakes are associated with diet quality and total energy intake.

Methods: Using data on children aged 2–18 years from the 2009–2014 National Health and Nutrition Examination Survey, linear regression models were used to analyze SSB and water intake in relation to Healthy Eating Index 2010 (HEI-2010) scores and total energy intake. Generalized linear models were used to analyze SSB and water intake in relation to the HEI-2010 scores. Analyses were conducted including and excluding caloric contributions from SSBs and were conducted in 2016–2017.

Results: SSB intake was inversely associated with the HEI-2010 total scores (9.5-point lower score comparing more than two servings/day with zero servings/day, p-trend < 0.0001) and positively associated with total energy intake (394 kcal higher comparing more than two servings/day with zero servings/day, p-trend < 0.0001). The associations between SSB and HEI-2010 total scores were similar when SSBs were excluded from HEI-2010 calculations. Water intake was positively associated with HEI-2010 total scores, but not associated with total energy intake. SSB intake was inversely associated with several HEI-2010 component scores, notably vegetables, total fruit, whole fruit, greens and beans, whole grains, dairy, seafood and plant proteins, and empty calories. Water intake was positively associated with most of the same HEI-2010 component scores.

Conclusions: Children who consume SSBs have poorer diet quality and higher total energy intake than children who do not consume SSBs. Interventions for obesity and chronic disease should focus on replacing SSBs with water and improving other aspects of diet quality that correlate with SSB consumption.

Am J Prev Med 2018;▮(▮):▮▮▮–▮▮▮.

INTRODUCTION

Sugar-sweetened beverages (SSBs) are the main source of added sugar in U.S. children's diets.[1–4] Although WHO recommends that children consume no more than 10% of total calories from sugar, data from the 2009–2010 National Health and Nutrition Examination Survey (NHANES), found that children consumed 8.0% of total calories from SSBs alone.[5,6] Water in its plain form contains no sugar or calories. According to the 2009–2012 NHANES, >60% of children and adolescents drink less than 2 cups of water daily, and 13% drink no water on a given day.[7] Given the low levels of water consumption, more attention to water intake is needed.

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0749-3797/$36.00
https://doi.org/10.1016/j.amepre.2017.11.005

SSB intake has been associated with increased energy intake[8,9] and higher risks of obesity, metabolic syndrome, type 2 diabetes, and heart disease.[10–14] Experimental studies have shown that interventions can be effective in reducing SSB consumption in children, translating into favorable impacts on BMI,[15,16] weight gain and fat accumulation,[17] and lean body mass.[18] However, SSB reduction may not be the only factor in childhood obesity prevention, as several observational studies have shown that SSBs are correlated with other unhealthy dietary behaviors. One national study found that higher consumption of SSBs in children was associated with lower intakes of calcium, folate, iron, and fiber, and higher intakes of saturated fat and added sugars.[19] Other studies have shown that children who consume SSBs also have higher intakes of fast food, savory snacks, and desserts.[8,20] These findings suggest that SSB reduction alone may not be enough to improve overall diet quality.

This study investigated water and SSB consumption in relation to overall diet quality and individual dietary components (e.g., total vegetables, total fruit) using the Healthy Eating Index 2010 (HEI-2010), as well as total energy intake (TEI) in a representative sample of U.S. children (aged 2–18 years). Associations were further examined by specific age groups: 2–5 years, 6–11 years, and 12–18 years, as beverage consumption and diet quality can vary across stages of childhood. It is hypothesized that SSB intake is inversely correlated with diet quality and positively correlated with energy intake, whereas water intake is positively correlated with indices of diet quality and not associated with energy intake. As SSB reduction has been increasingly promoted as public health policy, this study aims to understand whether interventions should focus on SSB reduction alone or whether SSB reduction combined with additional dietary guidance is warranted.

METHODS

Study Population

NHANES uses a multistaged probability design to derive a sample of participants that is representative of the U.S. civilian, noninstitutionalized population. The cross-sectional data are collected continuously. This study combined three waves (2009–2010, 2011–2012, and 2013–2014).

For this study, the data were limited to children aged 2–18 years. Participants were excluded if they had incomplete or missing dietary recall (only those with complete 2 days included), or had implausible energy intake (>2 SDs of reported energy intake from age- and sex-specific predicted energy requirements).[21] The resulting sample size was 7,757 children. The sample was further stratified into the following age groups: children aged 2–5 years (n=1,972), 6–11 years (n=2,890), and 12–18 years (n=2,895).

Measures

Dietary intake data were derived from the mean of two 24-hour dietary recalls per participant. Recalls for children aged <6 years were completed by a proxy (i.e., usually a parent). Recalls for children aged 6–8 years were done with a proxy and the child present, children aged 9–11 years conducted the recalls with the assistance of an adult familiar with the child's diet, and children aged 12–18 years completed the recalls without adult assistance.[22]

SSBs included soft drinks, fruit drinks with added sugar, sweetened coffee and tea drinks, sport drinks, and sweetened bottled water. Intake of 100% fruit juice, unsweetened milk, coffee, tea, and other similar unsweetened beverages were not categorized as SSBs, as they are not a source of added sugar. Flavored milk, which contains other nutrients in addition to added sugar, was not included as an SSB because the study intended to focus on beverages with little nutritional value that could be replaced with water. Plain water included all unsweetened water sources: tap water, bottled water, and unsweetened carbonated water. Both SSB and plain water intakes were converted to 8 fluid ounce servings and treated as categorical variables: zero servings (reference), more than zero to one serving, more than one to two servings, and more than two servings.

Diet quality was measured by the HEI-2010.[23] The HEI-2010 was developed by the U.S. Department of Agriculture to measure compliance with national dietary guidelines. The HEI-2010 total score has a maximum of 100, and comprises 12 component scores: total vegetables (maximum [max] score=5), total fruit (max score=5), whole fruit (max score=5), greens and beans (max score=5), whole grains (max score=10), dairy (max score=10), total protein foods (max score=5), seafood and plant proteins (max score=5), fatty acids (max score=10), refined grains (max score=10), sodium (max score=10), and empty calories (solid fats, alcohol, and added sugars) (max score=20). For refined grains, sodium, and empty calories, a higher score indicates a lower intake. HEI-2010 total and component scores were calculated according to the Simple HEI Scoring Algorithm using public SAS macros provided by National Cancer Institute. TEI was based on the type and amount of all caloric foods and beverages reported. As secondary outcomes, HEI-2010 scores and TEI were also estimated, excluding the contributions of SSBs. All dietary variables were estimated per day and then averaged across the 2 days.

Variables chosen a priori to control for potential confounding included: sex, age, race/ethnicity (white, Hispanic, black, other), household reference education (high school graduate and below, some college and above), family poverty to income ratio (<130%, 130% to <300%, ≥300%), household reference marital status (married/living with partner, single/divorced/widowed/separated), and child weight status. The household reference is the first person aged ≥18 years listed under household members who owns or rents the place of residence. Weight status was categorized using measured height and weight and converted into age- and sex-specific BMI percentiles (normal weight: <85th percentile, overweight: 85th to <95th percentile, obese: ≥95th percentile). Missing data for household reference education (n=211), marital status (n=183), family poverty to income ratio (n=551), and weight status (n=93) were handled using the missing indicator method.[24]

Statistical Analysis

All statistical analyses were performed using SAS, version 9.3 and Stata, version 12.1 SE. NHANES dietary survey weights and robust