Sugar-Sweetened Beverage Consumption Is Associated With Weight Gain and Incidence of Type 2 Diabetes

Reviewed by Jean Welsh, RN, MPH, and William Dietz, MD, PhD

STUDY

Schulze MB, Manson JE, Ludwig DS, Colditz GA, Stampfer MJ, Willett WC, Hu FB: Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. *JAMA* 292:927–934, 2004

SUMMARY

Objective. To examine the association between consumption of sugar-sweetened beverages, weight change, and risk for type 2 diabetes in women.

Design. A prospective cohort study.

Participants. Study participants were drawn from the 116,671 women aged 22–44 years enrolled in the Nurses' Health Study II. Women lacking dietary or physical activity data or with a history of diabetes, cancer, or cardiovascular disease were excluded. A total of 91,249 women were included in the diabetes analysis. Of these, 51,603 women for whom height and weight data were available were included in the analysis on weight change.

Methods. Information on weight and morbidity was collected every 2 years from 1991 through 1999 using a mailed questionnaire. Dietary data were collected through a food frequency questionnaire every 4 years. Women were asked how often, on average over the previous year, they consumed the following beverages: sugar-sweetened soft drinks ("Coke, Pepsi, or other cola with sugar," "caffeine-free Coke, Pepsi, or other cola with sugar," and "other carbonated beverages with sugar"); fruit juice ("apple juice," "orange juice," grapefruit juice," and "other juice"); fruit punch; and diet soft drinks ("low-calorie cola with caffeine," "low-calorie caffeine-free cola," and "other low-calorie beverages").

The impact of sugar-sweetened soft drink consumption on total calorie intake, weight gain, and incidence of type 2 diabetes was assessed. Similar comparisons were made for fruit punch, fruit juice, and diet soft drink consumption.

The mean weight change in groups of women, defined by their consumption pattern for each beverage type from 1991 to 1995 and from 1995 to 1999, was calculated. Consumption categories included: consistently low at ≤ 1/week; consistently high at ≥ 1/day, increased from ≤ 1/week to ≥ 1/day; decreased from ≥ 1/day to ≤ 1/week. The relative risks (RRs) of type 2 diabetes over the same time periods were estimated for each level of beverage intake, 1–4/month, 2–6/week, and ≥ 1/day compared with the lowest consumption category, <1/month.

Clinical measures were used to confirm cases of incident diabetes in accordance with guidelines established by the National Diabetes Data Group.[1]

Results. Consumption of sugar-sweetened soft drinks was positively associated with calorie intake, weight gain, and incidence of diabetes. Total calorie intake increased an average of 358 kcal/day for women whose sugar-sweetened soft drink consumption increased from ≤ 1/week to ≥ 1/day from 1991 to 1995. Mean weight gain for this group, adjusting for dietary and lifestyle confounders, was 4.69 kg. Among those whose consumption decreased from ≥ 1/day to ≤ 1/week, mean total calorie intake decreased by 319 kcal/day, and mean weight gain was 1.34 kg.

Similar results were obtained when the analyses were repeated using data collected from 1995 to 1999 and when the impact of fruit punch or fruit juice consumption was examined. Women who increased diet soft drink intake gained significantly less weight (1.59 kg) compared with those who decreased consumption (4.25 kg), controlling for the intake of other beverages.

The RR of type 2 diabetes, adjusted for dietary and lifestyle factors, was 1.83 (95% CI, 1.42– 2.36) for high consumers of sugar-sweetened soft drinks (≥ 1/day) compared with the lowest consumers (< 1/month) and remained significant even when controlling for BMI (RR 1.39, 95% CI 1.07–1.76). Similar results were observed with fruit punch but not fruit juice consumption. Frequent diet soft drink consumption did not increase the risk for type 2 diabetes significantly.

Conclusions. The results of this study suggest that the consumption of sugar-sweetened beverages is associated with increased weight gain and increased risk for development of type 2 diabetes in women. The authors suggest that the association may be the result of excessive calorie intake from sugar-sweetened beverages and increased availability of large amounts of rapidly absorbable sugars.

COMMENTARY

This study by Schulze et al. is the first long-term study to demonstrate an association between sugar-sweetened beverage consumption and weight gain among adults. It is also the first known study to demonstrate that the consumption of sugar-sweetened drinks is associated with an increased risk for diabetes independent of its association with BMI. The results of this study add to the body of evidence implicating the increasing consumption of sugar-sweetened beverages as a factor in the increased prevalence of overweight.[2–7] Previous experimental studies in adults[2,3] and long-term observational studies in school-aged[4–6] and preschool[7] children have also demonstrated a positive association between the consumption of sugar-sweetened beverages and weight.

In this study, women with increased consumption of diet soft drinks, controlling for other beverage consumption, gained significantly less weight. This observation supports previous short-term experimental studies in adults that showed that weight decreased or remained stable with increased diet soft drink consumption.[2,3] Because Schulze et al. found that increased diet soft drink consumption was associated with a decrease but not an elimination of weight gain, other unidentified factors also must have contributed to weight gain.

The mechanism that links sugar-sweetened drink consumption and weight gain remains unclear. Schulze et al. refer to previous research in humans that demonstrated that caloric compensation was less complete when liquid versus solid foods were consumed.[8–10] This effect is supported by animal research that shows that consumption of foods low in viscosity is associated with greater caloric intake (less compensation) and greater weight gain than the consumption of high-viscosity foods.[11]

High-fructose corn syrup, which has become the main caloric sweetener for beverages produced in the United States,[12] may also contribute to increased weight gain. Animal studies have demonstrated that high fructose consumption leads to increased energy intake, body weight, and adiposity.[13–15] Although less is known about its effect in humans, research suggests that fructose does not stimulate insulin secretion or enhance leptin production, two hormones important for long-term regulation of energy balance and body adiposity. In addition, fructose leads to markedly increased rates of de novo lipogenesis.[16,17] A review of these and other studies on the impact of fructose consumption concluded that the long-term consumption of diets high in fructose is likely to lead to increased energy intake, weight gain, and obesity.[18]

Strengths of the Schulze et al. study include its large sample size and ability to control for physical activity level and many other potential confounders related to diet and lifestyle. However, because the study was observational, cause and effect cannot be proven. Furthermore, food frequency questionnaires such as the one used in this study cannot precisely measure intake. Nevertheless, as noted by the authors, random error might account for a lack of association between sugar-sweetened soft drink consumption and weight but not the reverse.[19] Unreported dietary intake by obese individuals[20,21] could have produced a systematic error. However, in this case, underreported intake of sugar-sweetened drink consumption would likely underestimate its impact on weight.

Reduced consumption of sugar-sweetened beverages may be an important strategy for weight management among adults and children. This study also demonstrates that reduced sugar-sweetened beverage consumption may independently reduce incident diabetes. Therefore, health care providers involved in the prevention and treatment of diabetes are encouraged to inquire about beverage consumption patterns as part of routine patient screening. Frequent consumers of sugar-sweetened soft drinks should be encouraged to minimize their intake. Although further research is needed to identify the strategies most effective in reducing sugar-sweetened beverage consumption, replacing these beverages with calorie-free options, such as water or diet soft drinks, may significantly reduce caloric intake and weight gain.[1,2] Several school districts have already taken steps to replace sugar-sweetened beverages sold in schools with alternatives such as diet soft drinks, low-fat milk, water, and 100% juice. Evaluation of such initiatives is critical to determine their impact on reducing the risk for excess weight gain and diabetes.

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