Sugar-Sweetened Beverages Increase Risk for Type 2 Diabetes in African-American Women

Palmer JR, Boggs DA, Krishnan S, et al. Sugar-sweetened beverages and incidence of type 2 diabetes mellitus in African American women. Arch Intern Med 2008;168:1487–92.

Study Overview

Objective. To examine the association between sugar-sweetened beverage consumption, weight gain, and incidence of type 2 diabetes mellitus in African-American women.

Design. Prospective cohort study using data from the ongoing Black Women's Health Study.

Setting and participants. The Black Women's Health Study is comprised of 59,000 African-American women aged 21 to 69 years who have been followed since 1995. Questionnaires assessing diet, weight, height, lifestyle risk factors, new occurrence of serious illness, and other exposure information have been mailed to the cohort every 2 years since study inception. This analysis is based on data from 1995 to 2005. Women were excluded if they reported diabetes, gestational diabetes, pregnancy, cancer, myocardial infarction, and stroke at baseline; were aged < 30 years at the end of follow-up (2005); or had missing data. Food and beverage intake data were obtained through the short-form Block–National Cancer Institute food frequency questionnaire administered at baseline in 1995 and in 2001. This analysis focused on questions regarding consumption of regular soft drinks, orange or grapefruit juice, and "other fruit juices, fortified fruit drinks, Kool-Aid." The final analysis included 43,960 women.

Main outcome measures. Relationship between sugar-sweetened beverage consumption and incidence of type 2 diabetes. Incident cases of type 2 diabetes were identified by participants' reporting a new diagnosis of diabetes on any of the follow-up questionnaires. The accuracy of self-reported diabetes was verified through random sampling of participants' physicians. Age and time-stratified Cox proportional hazard models were used to calculate incident rate ratios (IRRs) with 95% confidence intervals (CIs). Multivariable models controlled for age, cycle of questionnaire, family history of diabetes, physical activity, years of education, smoking, diet glycemic index, coffee intake, processed meat intake, red meat intake, cereal fiber intake, and body mass index (BMI). Some multivariable models excluded BMI based on the premise that it could be a causal pathway between sweetened beverage consumption and diabetes.

Main results. 2713 incident cases of type 2 diabetes occurred during a total of 338,884 person-years of follow-up. During the baseline assessment, 17% of women drank ≥ 1 sugar-sweetened soft drink/day, 32% drank ≥ 1 sweetened fruit drink/day, and 22% drank ≥ 1 glass of orange or grapefruit juice/day. Compared with women who drank < 1 drink/month, women who consumed > 2 soft drinks/day had an IRR of 1.24 for developing diabetes (95% confidence interval [CI], 1.06–1.45]); however, when BMI was included in the multivariable model, the IRR decreased to 1.05 (95% CI, 0.90–1.23). The IRR was 1.31 (95% CI, 1.13–1.52) for > 2 sugar-sweetened fruit drinks, and this was essentially unchanged when controlling for BMI (IRR, 1.33 [95% CI, 1.15–1.54]). High consumption of unsweetened fruit juice was not associated with an increased risk of diabetes (IRR, 1.11 [95% CI, 0.92–1.35]). Stratified analyses by age, BMI, and family history of diabetes showed similar but generally weaker associations between women who consumed the highest amount of soft drinks or sweetened fruit beverages and incident risk of diabetes, except in women with low BMI (< 25 kg/m^2). In stratified analyses evaluating sugar-sweetened soft drink consumption, results were only statistically significant among younger women (age < 40 years), whereas stratified analyses evaluating sweetened fruit drink consumption were all statistically significant except in older women (age ≥ 40 years) and those with the lowest BMI. The majority of survey participants gained weight during the follow-up interval. In multivariable analyses that included changes in other risk factors, the greatest mean weight gain occurred in women who increased their soft drink consumption, while the lowest mean weight gain occurred in women who decreased their soft drink consumption (mean weight gain, 6.8 vs. 4.1 kg; $P < 0.001$ for comparison).

Conclusion. High consumption of sugar-sweetened soft drinks and fruit drinks increased the risk for diabetes in African-American women in this analysis. The relationship between soft drink intake and diabetes was mediated by BMI, whereas the reverse was true for sugar-sweetened fruit

drink intake. Women with highest intake of sugar-sweetened soft drinks had the largest mean weight gain. Increased consumption of unsweetened fruit juice was not associated with an increased risk of diabetes.

Commentary

Previous studies provide conflicting data on the relationship between consumption of sugar-sweetened beverages and risk for developing type 2 diabetes. The Nurses' Health Study [1] and a smaller Finnish study [2] both found a positive association between sugar-sweetened beverage consumption and diabetes risk, whereas the Atherosclerosis Risk in Communities study did not [3].

This study by Palmer et al evaluated whether a relationship exists between consumption of sugar-sweetened beverages and risk of type 2 diabetes in a large cohort of African-American women. The incidence of type 2 diabetes increased by 24% and 31% in women consuming more than 2 sugar-sweetened soft or fruit drinks per day as compared with women who drank less than 1 of these sugar-sweetened drinks per month. No relationship existed between high consumers of unsweetened fruit juices and risk of diabetes. The relationship between sweetened soft drink consumption and risk of diabetes disappeared after controlling for BMI in the multivariable model, while the relationship remained in the fruit drink model.

The study had a number of important strengths. The study's findings were demonstrated in a large prospective cohort of women at high risk for developing diabetes over a period of 10 years. The focus on African-American women is laudable given their high risk and the lack of previous large studies focusing on dietary risk factors for diabetes. Response rates to the survey were high (~ 80%), and diabetes diagnoses were verified in a subsample of women (217 of 229 [94%]). The authors accounted for important confounders such as other dietary risk factors, BMI, family history, and physical activity.

A few limitations deserve attention. The study utilized self-reported dietary data as opposed to directly measured food intake data. More importantly, much of the analyses relied on beverage consumption data derived from the survey at baseline. Thus, a misclassification bias is possible because participants who changed their consumption of sweetened beverages over the succeeding 10 years of follow-up may have been misclassified to the exposure group. A repeat set of beverage questions was asked in 2001, so women who had changed their patterns during the initial 6 years had an opportunity to update their information. Finally, the authors measured diabetes incidence by participant self-report. Although their subsample verification showed few false-positive diagnoses, women could have been undiagnosed or unaware of their condition.

What are the implications of this study? First, it is likely that the association between increased diabetes risk and consumption of sweetened drinks is mediated to a large extent by weight gain. Not only are sugar-sweetened beverages calorie-dense, but other studies have shown that these liquid carbohydrates do not promote satiety and do not reduce consumption of solid food [4]. BMI mediated the risk of diabetes among high consumers of sweetened soft drinks, and this group also had the highest weight gain over the course of the study. Furthermore, high fructose corn syrup (HFCS), the main sweetener used in all sweetened drinks, is particularly obesogenic due to its deleterious effects on insulin secretion, triglyceride metabolism, ghrelin secretion, and leptin regulation [5]. Because is it less expensive than natural sugar and has a better shelf life, use of HFCS is expanding rapidly, especially within beverages [6]. Some authors estimate that 20% of the daily carbohydrate intake and 10% of the daily energy intake in the United States is from HFCS [7]. Naturally occurring unsweetened fruit juice consumption was not associated with increased diabetes incidence in this study, possibly due to the lack of HFCS or to different metabolic properties of the naturally occurring sugars.

A second interesting implication of this study is that BMI did not mediate the relationship of sweetened fruit drinks and increased diabetes risk in African-American women. This is possible because women who had high sweetened fruit drink consumption also reported better "healthy" habits such as increased intake of fiber and increased physical activity. This finding suggests that HFCS may have the potential to increase diabetes risk independent of weight gain, given that some sugar-sweetened fruit drinks contain even higher levels of HFCS than certain sweetened soft drinks [3].

Applications for Clinical Practice

High daily consumption of sweetened soft drinks and fruit drinks is associated with increased incidence of diabetes in African-American women. This relationship is mediated by weight gain for soft drinks, but not sweetened fruit drinks. Clinicians should consider strongly counseling their patients at high risk for diabetes to reduce consumption of sugar- and HCFS-sweetened beverages both as a weight reduction strategy and as a diabetes risk reduction strategy.

—Review by Asaf Bitton, MD

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