Arch Intern Med. Author manuscript; available in PMC 2009 July 28.

Published in final edited form as:
Arch Intern Med. 2008 July 28; 168(14): 1487–1492. doi:10.1001/archinte.168.14.1487.

Sugar-Sweetened Beverages and Incidence of Type 2 Diabetes Mellitus in African American Women

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Abstract

Background—Type 2 diabetes mellitus is an increasingly serious health problem among African American women. Consumption of sugar-sweetened drinks was associated with an increased risk of diabetes in 2 studies but not in a third; however, to our knowledge, no data are available on African Americans regarding this issue. Our objective was to examine the association between consumption of sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes mellitus in African American women.

Methods—A prospective follow-up study of 59 000 African American women has been in progress since 1995. Participants reported on food and beverage consumption in 1995 and 2001. Biennial follow-up questionnaires ascertained new diagnoses of type 2 diabetes. The present analyses included 43 960 women who gave complete dietary and weight information and were free from diabetes at baseline. We identified 2713 incident cases of type 2 diabetes mellitus during 338 884 person-years of follow-up. The main outcome measure was the incidence of type 2 diabetes mellitus.

Results—The incidence of type 2 diabetes mellitus was higher with higher intake of both sugar-sweetened soft drinks and fruit drinks. After adjustment for confounding variables including other dietary factors, the incidence rate ratio for 2 or more soft drinks per day was 1.24 (95% confidence interval, 1.06–1.45). For fruit drinks, the comparable incidence rate ratio was 1.31 (95% confidence interval, 1.13–1.52). The association of diabetes with soft drink consumption was almost entirely mediated by body mass index, whereas the association with fruit drink consumption was independent of body mass index.

Conclusions—Regular consumption of sugar-sweetened soft drinks and fruit drinks is associated with an increased risk of type 2 diabetes mellitus in African American women. While there has been

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Author Contributions: Dr Palmer had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Palmer and Hu. *Acquisition of data:* Palmer and Rosenberg. *Analysis and interpretation of data:* Palmer, Boggs, Krishnan, Hu, Singer, and Rosenberg. *Drafting of the manuscript:* Palmer. *Critical revision of the manuscript for important intellectual content:* Palmer, Boggs, Krishnan, Hu, Singer, and Rosenberg. *Statistical analysis:* Boggs, Krishnan, and Hu. *Obtained funding:* Palmer and Rosenberg. *Administrative, technical, and material support:* Singer and Rosenberg. *Study supervision:* Palmer.

Financial Disclosure: Dr Rosenberg received industry support from McNeil Consumer Healthcare and Boehringer Ingelheim.

increasing public awareness of the adverse health effects of soft drinks, little attention has been given to fruit drinks, which are often marketed as a healthier alternative to soft drinks.

Type 2 Diabetes Mellitus, A leading cause of morbidity and mortality in the United States, has increased in incidence in recent years, and the mean age at diagnosis has dropped.[1] Type 2 diabetes is a particular problem among African American women, among whom the incidence rate is twice that of US white women.[2] Obesity is the strongest modifiable risk factor for type 2 diabetes,[2,3] and much of the excess incidence in African American women is due to their high levels of overweight and obesity.[4] It is important to identify modifiable factors that will lead to weight loss or that will reduce risk of type 2 diabetes regardless of whether weight loss occurs.

Three previous studies have examined the effects of soft drink consumption on risk of type 2 diabetes.[5–7] In 2 studies, consumption of soft drinks was associated with increased risk of diabetes,[5,7] and in the other, it was not.[6] We assessed the relation of sugar-sweetened soft drink consumption to risk of type 2 diabetes using data from the Black Women's Health Study (BWHS), an ongoing follow-up study of 59 000 African American women. We also assessed the consumption of "fruit drinks," a category that includes fruit juices other than orange or grapefruit, powdered Kool-Aid–type drinks, and fortified fruit drinks.

METHODS

The study protocol was approved by the institutional review boards of Boston University, Boston, Massachusetts, and Howard University, Washington, DC. The BWHS is an ongoing prospective cohort study of African American women from all regions of the United States.[8] The study was begun in 1995, when women enrolled by responding to questionnaires mailed to subscribers of *Essence* magazine (a popular magazine targeted to African American women), members of several African American professional organizations, and friends or relatives of early respondents. A cohort of 59 000 women aged 21 through 69 years at baseline (1995) was established and has been followed since then.

The baseline questionnaire obtained information on adult height, current weight, demographic characteristics, reproductive history, medical history, use of medications, use of cigarettes and alcohol, and usual diet. Follow-up questionnaires that update information on lifestyle factors and other exposures and identify new occurrences of serious illnesses, including diabetes, are mailed to participants every 2 years. Over the 5 cycles of follow-up, the average response rate is 80%.

The present analysis is based on data from the first 10 years of follow-up (1995 through 2005). We excluded women if they had reported diabetes (n=2920), gestational diabetes (n=638), myocardial infarction or stroke (n=806), or cancer (n=1146) at baseline; if they were pregnant at baseline (n=956); if they were younger than 30 years at the end of follow-up (n=1362); if data on height or weight were missing at baseline (n=474); if they did not complete the dietary questionnaire or left more than 10 dietary questions blank (n=2982); if they had implausible energy intake values (<500 or >3800 kcal; n=3050); or if they had missing data on soft drink consumption in 1995 (n=417). After exclusions, the final analysis cohort comprised 43 960 women.

CASE DEFINITION

Participants were classified as incident cases of type 2 diabetes if they reported diabetes on any of the follow-up questionnaires and had not previously reported a diagnosis of diabetes. The accuracy of self-reported diabetes was assessed among a random sample of participants who reported the diagnosis. A total of 656 women were asked to sign a release for their physicians to be contacted. Releases were returned by 293 women. Most of those who refused permission stated concerns about confidentiality as their reason. One-page questionnaires that asked about the diagnosis of diabetes, year of diagnosis, criteria for diagnosis, and medication prescribed were returned by 229 physicians. The diagnosis of type 2 diabetes was confirmed for 217 (94%) of the women. Of the 12 unconfirmed cases, 2 were classified as type 1 diabetes, 4 were classified as metabolic syndrome, 1 had steroid-induced diabetes, 2 had gestational diabetes only, and 3 did not have diabetes. The positive predictive value of self-report was high regardless of whether the participant had taken medications for the treatment of diabetes: among the 150 women who reported taking medications, the diagnosis was confirmed in 96% of cases, and among the 79 women who did not report taking medications for treatment of diabetes, the diagnosis was confirmed in 93% of cases.

DIETARY MEASUREMENT

Data on food and beverage intake were obtained through a modified, 68-item version of the short-form Block–National Cancer Institute food frequency questionnaire (FFQ).[9] The FFQ was completed by BWHS participants at baseline in 1995 and again in 2001 after 6 years of follow-up. A validation study carried out on the 1995 food frequency data indicated satisfactory agreement with responses from 3-day food diaries and 24-hour recalls for fat, protein, carbohydrate, dietary fiber, calcium, iron, vitamin C, folate, and beta carotene, with correlation coefficients ranging from 0.5 to 0.8.[10]

Three specific questions on beverage intake formed the basis for the present analyses. On the 1995 questionnaire, participants were asked how often they drank “regular soft drinks (not diet soda),” with frequency options ranging from never or less than 1 drink per month to 6 or more drinks per day. A medium serving was defined as a 12-oz (336-g) can or bottle, and participants could check medium, small (half of a medium serving), or large (1.5 times a medium serving). They were also asked how often they drank “orange juice or grapefruit juice,” with frequency options ranging from never or less than 1 drink per month to 2 or more drinks per day. A third question asked about consumption of “other fruit juices, fortified fruit drinks, Kool-Aid” with the same frequency options. Data from the Continuing Survey of Food Intakes by Individuals 1998 indicate that for US African American women aged 21 to 69 years, 80% of intake of such beverages is of sugar-sweetened fruit drinks and 20% is of unsweetened fruit juice.[11] For both juice questions, a medium serving was defined as a 6-oz (168-g) glass. The 2001 questionnaire included the same questions on juice consumption and regular soft drinks and added a separate item on diet soft drinks. For both sets of questionnaire data, the frequency and portion size information were combined to create a variable that represented the number of medium servings consumed per week.

COVARIATES

The baseline questionnaire asked about weight and adult height, and each subsequent biennial questionnaire also asked about current weight. A measure of body mass index (BMI) was computed as weight in kilograms divided by height in meters squared. The baseline questionnaire included questions on the highest level of education obtained, cigarette smoking, alcohol consumption, physical activity, hormone use, and other factors. Updated data on smoking and alcohol intake were obtained on each follow-up questionnaire.

STATISTICAL ANALYSIS

Person-years of follow-up were calculated as the number of years from enrollment in the study to first diagnosis of diabetes, death, loss to follow-up, or completion of the 2005 questionnaire. For participants who were younger than 30 years at the start of the study, follow-up began the year they turned 30 years old. Age-and time-stratified Cox proportional hazard models were used to calculate incidence rate ratios (IRRs) (hazard ratios) with 95% confidence intervals

(CIs). Departure from the proportional hazards assumption was tested by comparing models with and without cross-product terms for the exposure factor and age; the assumptions were met. Drink consumption was updated in 2001, and time-varying covariates were updated every 2 years. Multivariable models included terms for age; questionnaire cycle; family history of diabetes; cigarette smoking; physical activity; years of education; glycemic index of the diet; and intake of coffee, red meat, processed meat, and cereal fiber. Tests for linear trend across categories of drink consumption were carried out by adding an ordinal variable representing frequency of consumption to the multivariate models.

The main multivariate models were run without inclusion of terms for BMI or total energy intake because those factors could be in the causal pathway between consumption of sweetened drinks and diabetes risk. Additional models included terms for 1 or both of these factors to assess whether there was an association of soft drink and juice drink consumption over and above the effects of BMI and total caloric intake.

RESULTS

At baseline, 17% of participants drank at least 1 sugar-sweetened soft drink per day, 32% drank at least 1 sweetened fruit drink per day, and 22% had at least 1 glass of orange or grapefruit juice per day. Intake of sugar-sweetened soft drinks was inversely related to age, physical activity, years of education, and cereal fiber intake and positively related to BMI, cigarette smoking, energy intake, glycemic index, and intake of red meat and processed meat (Table 1). Intake of sugar-sweetened fruit drinks was also inversely associated with age and positively associated with total caloric intake and intake of processed meats. However, the pattern of consumption for fruit drinks differed from that of soft drinks with regard to other factors: consumption was unrelated to BMI or education but was positively correlated with physical activity, cereal fiber intake, and eating a low-glycemic index diet. To some extent, then, soft drink consumption was correlated with unhealthy behaviors and fruit drink consumption with healthy behaviors.

There were 2713 incident cases of type 2 diabetes identified during the 10 years of follow-up, from among a total of 338 884 person-years of follow-up. Diabetes risk increased with increasing intake of sugar-sweetened soft drinks (*P*=.002 for trend) and sweetened fruit drinks (*P*=.001 for trend, full multivariate model) (Table 2). For the highest category of intake of soft drinks (≥2 drinks per day), the IRR was 1.51 (95% CI, 1.31–1.75) in a multivariate model that did not include dietary factors and was reduced to 1.24 (95% CI, 1.06–1.45) after controlling for dietary factors. For fruit drinks, the comparable IRRs were 1.37 (95% CI, 1.18–1.58) and 1.31 (95% CI, 1.13–1.52). Consumption of orange and grapefruit juice was not associated with diabetes risk.

Adding terms for BMI, which might be in the causal pathway between consumption of sugar-sweetened soft drinks and risk of diabetes, reduced the IRR for 2 or more soft drinks per day to 1.05 (95% CI, 0.90–1.23). For fruit drinks, however, the IRRs were essentially unchanged after controlling for BMI; for 2 or more drinks per day, the IRR was 1.33 (95% CI, 1.15–1.54). Additional control for total energy intake did not further affect the estimates (IRRs of 1.04 for soft drinks and 1.32 for fruit drinks).

We repeated the analyses for sweetened drinks and diabetes risk stratified by age (<40 years and ≥40 years), BMI (<25, 25–29, and ≥30), and family history of diabetes (Table 3). A weak positive association of diabetes risk with the highest category of consumption was observed across subgroups of each factor, with the exception of BMI lower than 25 for fruit drinks, for which the IRR for 1 or more drinks per day relative to less than 1 drink per month was 0.84 (95% CI, 0.56–1.25).

Consumption of "diet" soft drinks was asked about on the 2001 questionnaire but not on the 1995 questionnaire. We assessed the relation of diet soft drink consumption to risk of type 2 diabetes for the follow-up period from 2001 through 2005, during which 906 new cases of type 2 diabetes were diagnosed. The IRR for 1 or more diet soft drink per day relative to less than 1 drink per month was 1.06 (95% CI, 0.83–1.36).

We used data from both the 1995 and 2001 questionnaires to assess the relation of changes in consumption patterns to changes in weight for the 6 years from 1995 to 2001. For each of sugar-sweetened soft drinks and fruit drinks, participants were classified into 5 mutually exclusive categories: those who consumed 1 drink or less per week in 1995 and had not changed their intake; those who consumed 1 drink or less per week in 1995 and increased to 1 or more drinks per day; those who consumed 1 drink or more per day in 1995 and did not change; those who consumed 1 or more drinks per day in 1995 and reduced their intake to 1 drink or less per week in 2001; and those who did not fit into any of the previous categories. The majority of participants gained weight during the 6-year interval. In multivariate models that included terms for change in other risk factors, the greatest weight gain was seen in those who increased their consumption of soft drinks (mean weight gain, 6.8 kg) (Table 4). The lowest mean weight gain (4.1 kg) occurred among those who decreased their consumption of soft drinks ($P<.001$ for the comparison of those with the greatest and lowest mean weight gains). Weight loss in the 6-year interval was most common (24%) among women who decreased their intake of sugar-sweetened soft drinks and least common (16%) among those who increased consumption or were already consuming 1 or more soft drinks per day and did not cut back. The association between changes in consumption and weight gain was weaker for sweetened fruit drinks (Table 4).

COMMENT

In this prospective study of African American women, consumption of sugar-sweetened soft drinks was positively associated with incidence of type 2 diabetes. Women who consumed 2 or more soft drinks per day had a 24% increase in incidence relative to women who drank less than 1 soft drink per month. A similar association was observed for sweetened fruit drinks, with a 31% increase observed for 2 or more drinks per day relative to less than 1 drink per month. Consumption of orange and grapefruit juice and of diet soft drinks was not associated with diabetes risk.

Several possible mechanisms may explain the observed associations between diabetes risk and consumption of sugar-sweetened drinks. The first, which probably accounts for most of the association, is through weight gain. A systematic review of the literature indicates a positive association between greater intakes of sugar-sweetened beverages and weight gain and obesity in both children and adults.[12] These beverages are dense in calories and are typically consumed as an addition to usual food intake. Several studies have shown that liquid foods have a low satiety and that when individuals increase consumption of liquid carbohydrates, they may not reduce consumption of solid food in response.[13–15] High-fructose corn syrup, which is now the sweetener used in all sugar-sweetened soft drinks consumed in the United States, appears to be particularly effective at promoting weight gain because of its adverse effects on insulin secretion and leptin release, leading to a reduction in the normal inhibitory effect on food intake.[16,17] In addition, fructose facilitates the biochemical formation of triacylglycerols more efficiently than does glucose.[17,18] Interestingly, orange and grapefruit juice consumption was not associated with an increased risk of diabetes in our study, perhaps because these beverages are typically consumed as part of a meal rather than between meals. The naturally occurring sugars in orange and grapefruit juices (glucose and fructose) may also have different metabolic effects than the high-fructose corn syrup that is added to soft drinks.

A second possible mechanism is through the glycemic effects of the beverages. Both sugar-sweetened soft drinks and fruit drinks contain large amounts of rapidly resorbed carbohydrates, the consumption of which leads to rapid increases in glucose and insulin concentrations.[19,20] Although the literature is not consistent, several large studies have found a positive association between glycemic load of the diet and risk of type 2 diabetes.[21,22] Sugar-sweetened beverages have a moderate glycemic index per se, but they contribute to a high glycemic load of the overall diet because of the large quantity consumed.[23]

When BMI was added to the multivariate model, the IRR for high soft drink consumption was reduced to 1.04, suggesting that the association with diabetes risk is mediated by the effects of soft drink consumption on BMI. Our data indicated that women who increased their intake of sugar-sweetened soft drinks had a considerably higher weight gain over a 6-year period than did women who reduced consumption. In contrast, adjustment for BMI had little effect on the association of fruit drinks with diabetes risk, and the relation between intake of these beverages and weight gain was not as strong as for soft drinks.

The consistency of the results observed within categories of age, family history of diabetes, and BMI do not support the hypothesis that adverse effects would be most severe among persons who are already insulin resistant.

The relation of sugar-sweetened beverage consumption to risk of type 2 diabetes was examined in data from the Nurses' Health Study II, a prospective follow-up of US nurses, almost all of whom are white.[5] Positive associations, somewhat stronger than in the present study, were found for both soft drinks and fruit drinks. The weaker associations observed in our study may be due to the higher baseline risk of diabetes experienced by African American women: relative risks associated with a given exposure will be smaller when the baseline risk is greater. In addition, the Nurses' Health Study II analysis did not adjust for meat intake, a variable that proved to be the strongest dietary confounder in our analysis. A small study of Finnish men and women also found an association of sweetened soft drinks and juice drinks with risk of type 2 diabetes.[7] On the other hand, in the Atherosclerosis Risk in Communities (ARIC) study, no association was observed for soft drink consumption and diabetes risk.[6] The authors speculated that the reason for the discrepancy may be the older age and higher baseline BMI in the ARIC population. Another study examined soft drink consumption in relation to metabolic syndrome and components of the metabolic syndrome in the Framingham Offspring cohort.[24] Of relevance to the present study, persons who consumed 2 or more soft drinks per day had a 32% increased risk of impaired fasting glucose relative to those who consumed less than 1 drink per day.[24]

Limitations of our study must be considered. The main analyses were based on beverage consumption data collected at baseline. Individuals who changed their drinking patterns may have been misclassified as to exposure, which would have tended to weaken the observed associations. Identification of incident cases of type 2 diabetes relied on the participant's self-report. A validation study of several hundred BWHS participants who reported incident type 2 diabetes demonstrated that the condition is reported with very few false-positive results. However, some participants may have been unaware of their diabetes and were erroneously misclassified as non-cases. Such misclassification of disease status would have biased results toward the null but would not have caused the association that was observed for soft drink consumption and diabetes risk.

Strengths of the study include the large size of the cohort, the large number of incident diabetes cases, the prospective data collection, and the focus on African American women, a population with particularly high rates of type 2 diabetes. Previous studies have not included enough African American participants for separate analyses. Because our study was based on 10 years of follow-up, it was possible to look at changes in soft drink consumption over time and assess those changes in relation to changes in weight. Physical activity and other potential confounders were taken into account.

Type 2 diabetes is an important public health problem in the United States and particularly so among African American women. Overweight and obesity have been identified as the most powerful risk factors for type 2 diabetes, but losing weight and maintaining a healthy weight have proven to be difficult for many people. Our study suggests that the mechanism for the increase in diabetes risk associated with soft drink consumption is primarily through increased weight. Reducing consumption of soft drinks or switching from sugar-sweetened soft drinks to diet soft drinks is a concrete step that women may find easier to achieve than other approaches to weight loss.

Finally, it should be noted that consumption of fruit drinks conveyed as high an increase in risk as did consumption of soft drinks. Fruit drinks typically contain as many or more calories compared with soft drinks and, like soft drinks, may not decrease satiety to the same extent as solid food. Fruit drinks were consumed more frequently than soft drinks in our study, and in the US population, the proportion of total energy intake from fruit drinks doubled from 1977 to 2001.[25] The public should be made aware that these drinks are not a healthy alternative to soft drinks with regard to risk of type 2 diabetes.

Acknowledgments

Funding/Support: This work was supported by grant CA58420 from the National Cancer Institute and grant 1R01DK068738 from the National Institute of Diabetes and Digestive and Kidney Diseases.

Additional Contributions: We acknowledge the dedication of Black Women's Health Study participants and staff.

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Table 1

Baseline Characteristics According to Sweetened Beverage Consumption

	Soft Drinks per Week			Fruit Drinks per Week		
Characteristic	**<1**	**2–6**	**≥1**	**<1**	**2–6**	**≥1**
No. of participants	25 971	10 521	7468	15 455	13 722	13 644
Age, mean (SD), y	39.2 (10.4)	37.5 (9.8)	37.1 (9.5)	40.6 (10.2)	38.0 (9.9)	36.1 (9.7)
Family history of diabetes, %	34.3	33.9	35.3	34.8	34.6	33.9
BMI, mean (SD)	27.1 (6.1)	28.0 (6.6)	28.9 (7.3)	27.7 (6.3)	27.5 (6.4)	27.8 (6.6)
Physical activity, ≥1 h/wk, %	55.5	45.6	38.6	49.7	51.6	49.4
Current smoker, %	13.0	18.5	22.4	16.6	15.4	15.8
Education ≤12 y, %	12.7	17.3	19.9	15.2	14.5	15.8
Alcohol, drinks/wk	1.4 (4.0)	1.4 (4.1)	1.5 (4.4)	1.6 (4.4)	1.3 (3.8)	1.3 (4.0)
Diet, mean (SD)						
Total energy, kcal/d	1424 (618)	1641 (656)	2055 (730)	1378 (622)	1538 (641)	1875 (708)
Glycemic index	49.4 (7.9)	49.7 (6.4)	51.6 (6.2)	50.1 (8.1)	50.4 (7.1)	48.9 (6.2)
Red meat, mean, servings/d	0.21 (0.24)	0.33 (0.29)	0.40 (0.33)	0.25 (0.26)	0.28 (0.28)	0.30 (0.31)
Processed meat, servings/d	0.27 (0.35)	0.41 (0.42)	0.47 (0.48)	0.29 (0.36)	0.35 (0.39)	0.38 (0.44)
Cereal fiber, g/d	4.0 (3.0)	3.8 (2.8)	3.7 (2.6)	3.6 (2.8)	3.9 (2.6)	4.4 (3.1)
Coffee, cups/d	0.6 (1.3)	0.6 (1.1)	0.8 (1.4)	0.8 (1.4)	0.6 (1.2)	0.6 (1.1)

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared).

Table 2

Beverage Consumption in Relation to Risk of Type 2 Diabetes Mellitus

Drink Type	Diabetes Cases, No.	Person-Years	Age-Adjusted IRR	Multivariate IRR (95% CI)[a]	Multivariate IRR (95% CI)[b]	*P* Value
Sugar-sweetened soft drinks						
<1 Drink/mo	733	96 266	1 [Reference]	1 [Reference]	1 [Reference]	
1–7 Drinks/mo	783	111 418	1.01	0.96 (0.87–1.06)	0.89 (0.80–0.99)	
2–6 Drinks/wk	656	78 319	1.24	1.14 (1.02–1.27)	1.00 (0.89–1.12)	
1 Drink/d	280	29 273	1.43	1.27 (1.12–1.47)	1.11 (0.96–1.28)	
≥2 Drinks/d	261	23 608	1.76	1.51 (1.31–1.75)	1.24 (1.06–1.45)	.002
Sweetened fruit drinks[c]						

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Drink Type	Diabetes Cases, No.	Person-Years	Age-Adjusted IRR	Multivariate IRR (95% CI)[a]	Multivariate IRR (95% CI)[b]	*P* Value
<1 Drink/mo	506	60 701	1 [Reference]	1 [Reference]	1 [Reference]	
1–7 Drinks/mo	637	79 119	1.11	1.11 (0.99–1.25)	1.08 (0.96–1.22)	
2–6 Drinks/wk	775	102 311	1.11	1.13 (1.00–1.26)	1.08 (0.96–1.21)	
1 Drink/d	421	53 154	1.20	1.21 (1.06–1.39)	1.17 (1.02–1.33)	
≥2 Drinks/d	315	36 782	1.37	1.37 (1.18–1.58)	1.31 (1.13–1.52)	.001
Orange or grapefruit juice						
<1 Drink/mo	441	50 871	1 [Reference]	1 [Reference]	1 [Reference]	
1–7 Drinks/mo	767	102 984	0.92	0.94 (0.84–1.06)	0.93 (0.83–1.05)	
2–6 Drinks/wk	891	111 975	0.96	1.00 (0.89–1.13)	0.99 (0.88–1.11)	
1 Drink/d	445	53 789	0.93	1.00 (0.88–1.15)	0.99 (0.87–1.14)	
≥2 Drinks/d	147	16 620	1.02	1.10 (0.91–1.33)	1.11 (0.92–1.35)	.28

Abbreviations: CI, confidence interval; IRR, incidence rate ratio.

[a] Adjusted for age, family history of diabetes, physical activity, cigarette smoking, years of education, and each of the 2 other types of drinks.

[b] Adjusted for same variables as in footnote a, plus intake of red meat, processed meats, cereal fiber, and coffee, and glycemic index.

[c]Includes fortified fruit drinks, Kool-Aid, and fruit juices other than orange or grapefruit juice.

Table 3

Beverage Consumption in Relation to Risk of Type 2 Diabetes Mellitus, According to Age, Family History, and BMI

		Frequency of Consumption, Multivariate IRR (95% CI)[a]			
Variable	**Diabetes Cases, No.**	**<1 Drink/mo**	**1–7 Drinks/mo**	**2–6 Drinks/wk**	**≥1 Drinks/d**
Sugar-sweetened soft drinks					
Age <40 y	904	1 [Reference]	0.92 (0.75–1.12)	1.11 (0.90–1.36)	1.28 (1.02–1.59)
Age ≥40 y	1809	1 [Reference]	0.88 (0.78–1.00)	0.95 (0.83–1.09)	1.11 (0.95–1.29)
BMI <25	278	1 [Reference]	0.72 (0.52–1.00)	0.95 (0.67–1.35)	1.07 (0.72–1.58)
BMI 25–29	813	1 [Reference]	0.98 (0.81–1.17)	0.92 (0.75–1.14)	1.08 (0.85–1.36)
BMI ≥30	1622	1 [Reference]	0.92 (0.80–1.06)	0.99 (0.85–1.14)	1.05 (0.90–1.23)
Family history of diabetes	1142	1 [Reference]	0.87 (0.76–1.00)	0.96 (0.83–1.12)	1.17 (0.99–1.37)
No family history	1518	1 [Reference]	0.89 (0.76–1.05)	1.03 (0.87–1.23)	1.16 (0.96–1.40)
Sweetened fruit drinks					
Age <40 y	893	1 [Reference]	0.94 (0.74–1.18)	0.94 (0.75–1.18)	1.13 (0.91–1.41)
Age ≥40 y	1761	1 [Reference]	1.14 (0.99–1.31)	1.13 (0.98–1.30)	1.25 (1.08–1.44)
BMI <25	273	1 [Reference]	1.15 (0.80–1.65)	1.17 (0.82–1.67)	0.84 (0.56–1.25)
BMI 25–29	791	1 [Reference]	1.29 (1.04–1.61)	1.29 (1.04–1.60)	1.28 (1.02–1.60)
BMI ≥30	1590	1 [Reference]	1.00 (0.86–1.17)	1.01 (0.86–1.18)	1.30 (1.11–1.52)
Family history of diabetes	1119	1 [Reference]	1.10 (0.94–1.28)	1.04 (0.89–1.22)	1.18 (1.00–1.38)
No family history	1484	1 [Reference]	1.07 (0.89–1.30)	1.15 (0.96–1.39)	1.29 (1.01–1.56)

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CI, confidence interval; IRR, incidence rate ratio.

[a] Adjusted for age; questionnaire cycle; education; physical activity; smoking status; family history of diabetes; intake of red meat, processed meat, cereal fiber, and coffee; glycemic index; and each of the other 2 types of drinks.

Table 4

Change in Intake of Soft Drinks and Fruit Drinks in Relation to Mean Weight Change, 1995 to 2001

Intake		Sugar-Sweetened Soft Drinks			Sweetened Fruit Drinks		
1995	**2001**	**No. of Participants**	**Weight Gain, Mean (SD), kg[a]**	**Subjects Who Lost Weight, %**	**No.**	**Weight Gain, Mean (SD), kg[a]**	**Subjects Who Lost Weight, %**
≤1 Drink/wk	≥1 Drinks/d	880	6.8 (0.28)	16	1069	5.4 (0.26)	17
≥1 Drinks/d	≥1 Drinks/d	2032	5.8 (0.19)	16	3426	5.5 (0.14)	15
≤1 Drink/wk	≤1 Drink/wk	14 246	4.9 (0.07)	20	7271	5.2 (0.10)	21
≥1 Drinks/d	≤1 Drink/wk	1472	4.1 (0.22)	24	3198	4.6 (0.15)	22
All others		11 057	5.5 (0.08)	17	14 448	5.3 (0.07)	18

[a] Adjusted for baseline age; cigarette smoking; years of education; physical activity; family history of diabetes; baseline body mass index; intake of red meat, processed meat, cereal fiber, and coffee; glycemic index; changes in physical activity; cigarette smoking; dietary factors from 1995 to 2001; and the other type of drink.