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## Association of sports drinks with weight gain among adolescents and young adults

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### Abstract

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#### Authors' roles:

Alison E. Field: Dr. Field designed the study, obtained funding, conducted the analysis, drafted the manuscript, and approved the final manuscript as submitted

Kendrin R. Sonneville: Dr. Sonneville assisted with the statistical analysis, provided revisions to drafts of the manuscripts, and approved the final manuscript as submitted.

Jennifer Falbe: Dr. Falbe assisted with the statistical analysis, provided revisions to drafts of the manuscripts, and approved the final manuscript as submitted.

Alan Flint: Dr. Flint provided input on the design of the study, provided critical feedback on drafts of the manuscript, and approved the final manuscript as submitted.

Jess Haines: Dr. Haines assisted with data collection, assisted in developing the analysis plan, provided critical feedback on drafts of the manuscript, and approved the final manuscript as submitted.

Bernard Rosner: Dr. Rosner assisted with development of the data analysis plan, provided critical feedback on drafts of the manuscript, and approved the final manuscript as submitted.

Carlos A. Camargo, Jr.: Dr. Camargo assisted with designing the study and developing the analysis plan, provided critical feedback on drafts of the manuscript, and approved the final manuscript as submitted.

**Objective**—Sales of regular soda are declining, but sales of other sweetened beverages, such as sports drinks, are increasing. Our objective was to determine the prospective associations between sports drinks and body mass index (BMI) gains among adolescents and young adults.

**Design and Methods**—We prospectively followed 4,121 females and 3,438 males in the Growing Up Today Study II, aged 9–16 in 2004, from across the United States. Data was collected by questionnaire in 2004, 2006, 2008, and 2011. Servings per day of various beverages were assessed with a food frequency questionnaire.

**Results**—Among the girls, each serving per day of sports drink predicted an increase of 0.3 BMI units (95% confidence interval (CI) CI 0.03–0.54) more than their peers over the next 2–3 years. Among the males, each serving of sports drinks predicted a 0.33 BMI (95% CI 0.09, 0.66) increase. In addition, boys who increased their intake over the 2–3 year interval gained significantly more than their peers during the same time interval.

**Conclusions**—Intake of sports drinks predicted larger increases in BMI among both females and males. Our results suggest that school policies focused on obesity prevention should be augmented to restrict sports drinks.

### Keywords

Sports drinks; sweetened beverages; weight gain; adolescents

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In both observational studies and clinical trials, intake of sugar-sweetened beverages (SSB) has been found to predict weight gain and the development of obesity.<sup>1,2</sup> Some studies have focused on regular (non-diet) soda, while others have included a wider range of SSBs, including sweetened ice teas and fruit drinks, in their investigations. Sports drinks are heavily marketed to young adults and portrayed as part of an active lifestyle. The association of sports drinks, which contain approximately 50 calories, 110 mg of sodium, and 41 grams of sugar per 8 ounce serving, but are primarily sold in 20–32 ounce bottles, with weight gain has not been studied.

Regular soda is the mostly commonly consumed SSB, but intake has been decreasing during the past decade.<sup>3,4</sup> The decline may be partially due to the negative attention that SSBs have received regarding their association with obesity and chronic disease risk. In addition, the agreement between the Alliance for a Healthier Generation and the American Beverage Association resulted in regular soda not being sold in elementary or middle schools. However, the voluntary agreement allowed beverages with 60 or fewer calories per 8 oz serving to be sold in high school during the school day. Thus, regular soda cannot be sold, but sports drinks and diet soda are allowed.

Although not as popular as regular soda, sports drinks, flavored waters, sweetened ice teas, and energy drinks have increased in sales recently. In a recent study of 11,029 adolescents, approximately 37% of SSB intake was regular soda and 26% was sports drinks. Among males and blacks and Hispanics, three groups of adolescents with an elevated prevalence of obesity, the percent of SSBs that were sports drinks were 29%, 27%, and 28%, respectively.<sup>5</sup> Despite their gaining popularity, studies are lacking on the association between sports drink intake and weight gain. The aim of our study was to investigate the

independent associations between intake of sports drinks with gains in body mass index (BMI) among adolescents and young adults.

## Methods

The ongoing Growing Up Today Study (GUTS) II cohort was established in 2004 to assess relations of diet and activity to height velocity and weight gain. Participants were recruited by sending letters to 20,700 women in the Nurses' Health Study II who had children aged 9–15 years. The letter explained the purpose of the study and asked the nurse for permission to invite her child(ren) to participate. Invitation letters and questionnaires were mailed to 8,826 girls and 8,454 boys whose mothers granted consent. A total of 6,002 girls and 4,917 boys returned completed questionnaires, thereby assenting to participate. Follow-up questionnaires were sent in the fall of 2006 and 2008 and winter 2011. Participants with data on BMI from 2 consecutive questionnaires were eligible for analysis. The study was approved by the Human Subjects Committee at Brigham and Women's Hospital, and the analyses presented in this article were approved by the institutional review boards at Brigham and Women's Hospital and Boston Children's Hospital.

## Outcome

Body mass index (BMI) [ $\text{kg}/\text{m}^2$ ] was calculated using self-reported weight and height assessed on all questionnaires. Children and adolescents younger than 18 years were classified as obese based on the International Obesity Task Force (IOTF) cut-offs.<sup>6</sup> Participants who were 18 years or older with a BMI between 25 and 29.9 were classified as overweight and those with a BMI  $\geq 30$  were classified as obese. The outcome in the analyses was change in BMI, which was modeled as BMI at the end of the time interval, controlling for BMI at the beginning of the time interval and time between assessments. BMI was calculated from self-reported height and weight, which has been found to be valid among preadolescent and adolescent populations.<sup>7–9</sup> Adolescents and young adults are consistent in under-reporting their weight, thus weight *change* calculated from serial self-reports is very accurate.<sup>10</sup> The small number of outliers detected with the extreme Studentized deviate (ESD) procedure<sup>11</sup> (98 females and 83 males) were censored from the relevant time period. Participants contributed information on BMI change during up to three time periods: 2004–2006, 2006–2008, and/or 2008–2011.

## Exposures

The primary exposures were servings per day of three types of beverages: regular soda, diet soda, and sports drinks. Intake was measured with the Youth/Adolescent Questionnaire.<sup>12</sup> The response options for regular and diet soda were “never/less than 1 per month”, “1–3 cans per month”, “1 can per week”, “2–6 cans per week”, “1 can per day”, “2–3 cans per day”, and “more than 3 cans per day”. The response options for sports drinks were “never/less than 1 per month”, “1–3 bottles per month”, “1–4 bottles per week”, “5–6 bottles per week”, and “1 or more bottles per day”. The categories of the categorical variables were reweighted to be number of cans/bottles per week. Beverages were modeled as intake at the beginning of the time period, change in consumption during the time period, or including terms for both baseline and change. Hours per day spent watching television was collected

on each questionnaire. Physical activity was assessed on all questionnaires by asking participants to recall the amount of time per week within each season over the past year they engaged in 18 specific activities. Activities with MET values of at least 7<sup>13</sup> were considered vigorous.

### Sample for analysis

The analysis was restricted to the 4224 females and 3539 males who provided weight and height information on at least two consecutive questionnaires. Participants were excluded if they were missing information on vigorous activity (n=6 females and 4 males) or reported more than 40 hours per week of vigorous activity and thus were considered outliers (n=1 female and 5 males). In addition, 41 females and 38 males were missing information or outliers (> 70 hours per week) on time spent watching television and 56 females and 54 males were missing information on sports drink or diet soda consumption. After excluding these individuals, there were 4,121 females and 3,438 males who remained for the analysis.

### Statistical Analysis

All analyses were stratified by gender. Descriptive statistics (mean and standard deviation and percentages) were used to describe univariate associations. Spearman correlations were used to assess cross-sectional associations at baseline. Generalized estimating equations (Proc Genmod), which can take into account the correlations between siblings, were used to model the association of beverage consumption and change in BMI. All models adjusted for age, time between questionnaires, and baseline BMI in each period. All three beverage types (sports drinks, regular soda, and diet soda) were included in the same model. Final models also adjusted baseline hours/week of vigorous physical activity and time spent watching television in each period. Three related approaches were taken to modeling the data. In the model 1, beverage consumption at the start of the period was used to predict changes in BMI over the next 2–3 years. In model 2, beverage consumption was modeled as change during the interval. In model 3, both baseline and change were included in the model. Model 1 address the clinical question of whether current intake predicts change. Model 2 mimics the analyses of clinical trials where the focus is on a change in an exposure. Model 3 adjust change for baseline since exposure is not randomized.

To examine whether recent weight gains or a propensity to gain confounded the associations, in secondary analyses we adjusted for BMI at the start of the time period, as well as weight change during the previous time period. To tease apart unhealthy weight gain from weight gain due to physical development, we considered Tanner stage of physical development as a possible confounder. Due to the fact girls mature earlier than boys, Tanner stage of pubic hair development was predictive of BMI change only among the males. Since it was not a confounder among the females, it was included in analysis of the males. Dieting to control weight has been found to predict weight gain in several observational studies,<sup>14–16</sup> thus in secondary analyses we explored whether dieting (assessed in 2008) in the past year (frequency or frequent vs. infrequent or never) was a confounder of the associations between beverage type and weight gain between 2008 and 2011. Analyses were conducted with SAS software (version 9.3 SAS Institute, Cary, NC, USA).

## Results

At baseline in 2004, approximately 16% of females and 24% of males were overweight or obese (Table 1). Regular soda and sports drink consumption were higher among males (Figure 1a) than females (Figure 1b). However, intake of regular soda decreased over time. Among the males between 2004 and 2006 there was almost a doubling in the percentage of youth who consumed one sports drink per day. Among the females, the percentage consuming > one regular soda per day decreased by 50% between 2004 and 2006. Thus, in 2006 and 2008, more females were daily consumers of diet soda than regular soda.

Body mass index (BMI) at baseline was positively associated with intake of diet soda ( $r=0.25$  (girls),  $r=0.21$  (boys)), but unrelated to intake of regular soda or sports drinks at baseline. Whereas, hours per week of vigorous activity was positively associated with intake of diet soda ( $r=0.06$  (girls)), and sports drinks ( $r=0.30$  (girls),  $r=0.37$  (boys)). Dieting for weight control, which was only measured in 2008 was positively associated with intake of diet soda ( $r=0.16$  (girls),  $r=0.10$  (boys)) and inversely associated with regular soda ( $r= -0.17$  (girls),  $r= -0.10$  (boys)).

In model 1, where intake at one time point predicting change in BMI between questionnaire cycles, intake of sports drinks predicted larger increases in BMI. Among girls (Table 2) each serving per day of sports drinks predicted an increase of approximately 0.2 BMI units. There was a suggestion of an association among the males (Table 3), but it was not significant. In model 2, with change in beverage intake as the predictors, increases in daily consumption of sports drinks predicted greater BMI gains among the boys (Table 3), but there was no association among the girls. However, in model 3, where both baseline intake and change in intake were included in the same model, intake of sports drinks predicted an increase of approximately 0.3 BMI units among both girls ( $\beta=0.29$ , 95% confidence interval (CI) 0.03, 0.54) and boys ( $\beta=0.33$ , 95% CI 0.09, 0.58). Among the girls, baseline intake at the beginning of the 2–3 year cycle predicted change in BMI between questionnaire cycles, but change in beverage intake was unrelated to BMI gains. Among the males, not only were both baseline and change in beverage consumption predictive of larger increases in BMI, the associations were strengthened when both sets of variables were included in the model. For every sports drinks consumed per day at baseline, a male gained approximately 0.3 BMI units more than his peers. If he increased his sports drink consumption, he gained an additional 0.4 BMI units.

In secondary analyses we examined whether level of activity modified the associations. We did not observe an interaction between high levels of vigorous activity and intake of sports drinks or diet soda (data not shown). We also evaluated whether dieting to control weight was a confounder. We found that dieting did not influence the associations between beverage type and weight gain between 2008 and 2001 (data not shown). In other secondary analyses where we used only data from the 2006, 2008, and 2011 cycles so that we could adjust not only for BMI at the start of the time period, but also weight change during the previous time period, we found that previous weight change was inversely predictive of subsequent BMI gain. After adjusting for previous BMI change we observed that the associations were slightly attenuated for change in intake of sports drinks ( $\beta=0.37$ , 95% CI

0.05, 0.69), while the association with change in diet soda became stronger ( $\beta=0.57$ , 95% CI 0.17, 0.97) among the males. In addition, the associations between baseline intake of diet soda and sports drinks remained significantly predictive of BMI gains among the males. Among the females, controlling for past weight change strengthened the associations of sports drinks ( $\beta=0.42$ , 95% CI  $-0.01$ , 0.86) and regular soda ( $\beta=0.24$ , 95% CI  $-0.02$ , 0.50) and attenuated the association with diet soda ( $\beta=0.14$ , 95% CI  $-0.07$ , 0.34), however, none of the associations were significant.

## Discussion

Mirroring national trends, we observed that consumption of regular soda decreased between 2004 and 2011. During the same time period consumption of sports drinks increased. Endorsements by sports celebrities are particularly effective at influencing young males,<sup>17</sup> which may partially explain the increase in sports drink consumption. Moreover, it is possible that youth are exchanging sports drinks for soda because they are perceived as healthier.<sup>18</sup> Our findings suggest that this substitution also will promote weight gain and obesity. Among adolescent and young adult girls and boys we observed that frequency of consumption of sports drinks predicted greater increases in BMI.

Under the 2006 agreement between the American Beverage Association and the Alliance for a Healthier Generation (a partnership between the American Heart Association and the William J. Clinton Foundation), PepsiCo, Coca Cola, and Cadbury Schweppes agreed to not sell regular soda in schools and to only sell sports drinks, diet beverages, and flavored waters in high schools. This voluntary agreement was a big step forward, but it is possible that the beverages allowed in high schools still may promote weight gain. Despite their growing popularity, no previous studies have investigated the association between sports drink consumption and weight change. Sports drinks were designed for endurance athletes and athletes participating in rigorous training for more than 60 minutes. Some studies have found benefit in these athletes,<sup>19</sup> particularly when their intense activity levels are associated with heavy sweating and the potential for dehydration,<sup>20</sup> while other studies have found no benefit.<sup>21-24</sup> Another study suggests that just swishing with sports drinks and spitting it out is enough to confer a benefit among.<sup>25</sup> However, there is no evidence to suggest that sports drinks are beneficial for people engaged in short bouts of activity or to prevent dehydration among non-athletes. Using accelerometers to measure activity, Troiano et al. found that only 8% of U.S. adolescents were engaging in at least 60 minutes of activity per day,<sup>26</sup> thus suggesting that vast majority of US youth are insufficiently active to potentially warrant use of sports drinks. Less talked about are the potential detrimental effects of sports drinks. First, although they are labeled as having 50 calories per 8 ounce serving, they are most often sold in 20 or 32 ounce bottles, thus it is likely that people consume far more than 50 calories. Second, they are a SSB containing added sodium. The average 32 ounce bottle could contain as much as 800 mg of sodium. At a time when the general public is being urged to reduce their sodium intake,<sup>27,28</sup> a beverage containing added sugar and sodium is particularly problematic.

There are several limitations to our study, including that the sample has few minority youth or individuals of low socioeconomic status. While this may limit generalizability, the

relative homogeneity also limits confounding by these two factors with strong associations to obesity. Second, we relied on self-reported beverage intake, thus there may be some measurement error, which likely biases our results towards the null. Nevertheless, our study makes an important contribution to the field. It is the first prospective cohort study to examine changes in beverage intake patterns over time and how sports drinks are related to weight gain in youth.

The Smart Snacks in School standards from the USDA are planned to be implemented in 2014. They reduce the allowable calories per 8 ounce serving from 60 to 40, thus eliminating many sports drinks. However, they will allow calorie free flavored water, carbonated beverages with 10 calories per 12 ounces, and beverages with 60 calories per 12 ounces. The Smart Snack initiative is another step forward in improving the health of school children in the United States. The proposed change by the U.S. Food and Drug Administration to have serving sizes on labels correspond to what people actually consume may also help to make people aware that sports drinks, which are usually sold in 20 or 32 ounce bottles, are not a healthy choice. In fact, a 32 ounce bottle of Gatorade and Powerade has 200 calories and 52.5 grams of sugar. Low calorie variations, such as G2, have approximately 75 calories per 32 ounce bottle, which is less than other varieties, but could still contribute to weight gain. Moreover, sports drinks contain approximately 400 mg of sodium per 32 ounce bottle. It is an established public health problem that Americans consume too much sugar and sodium. Therefore, decreasing intake of sports drinks should receive more attention from obesity prevention programs, clinicians, and parents.

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## Abbreviations

|                |                           |
|----------------|---------------------------|
| <b>BMI</b>     | body mass index           |
| <b>SSB</b>     | Sugar-sweetened beverages |
| <b>GUTS II</b> | Growing Up Today Study II |

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**What is known**

Observational studies and clinical trials have observed a positive association between intake of sugar sweetened beverages, primarily soda, and weight gain.

**What this study adds**

This is the first study to assess the independent association of sports drinks with weight gain. Although soda is still the most commonly consumed sugar-sweetened beverage, intake of soda has been declining and intake of sports drinks has been increasing.

Figure 1a

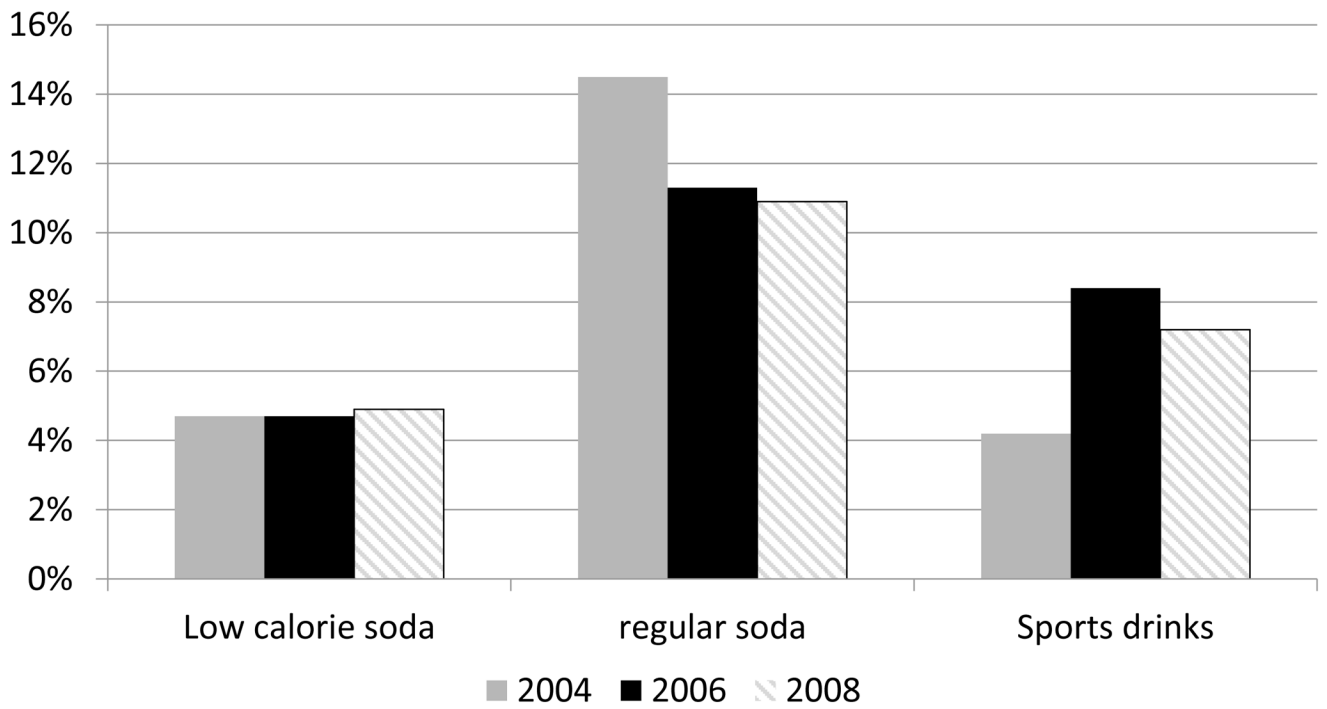
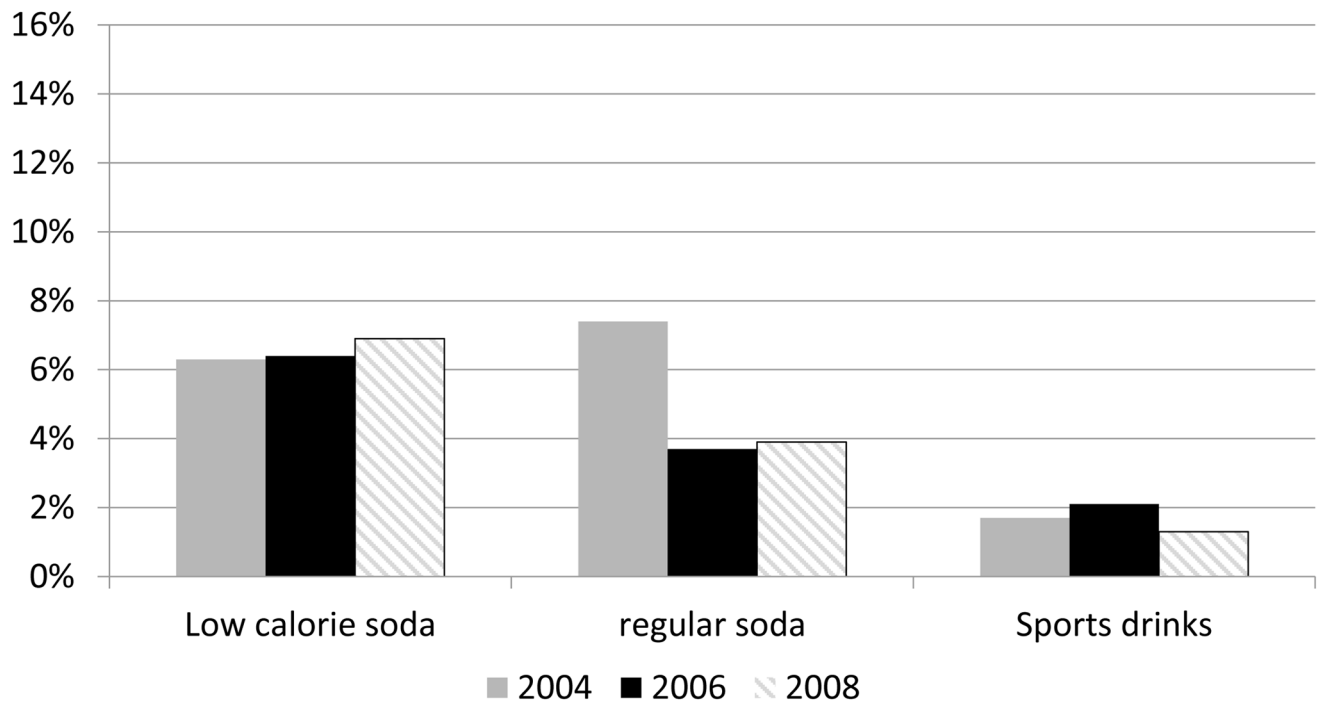


Figure 1b



**Figure 1.**

Figure 1a. Prevalence of consuming 1 beverage per day among boys in the Growing Up Today Study II

Figure 1b. Prevalence of consuming 1 beverage per day among girls in the Growing Up Today Study II

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**Table 1**

Baseline demographics (means (s.d.) and prevalence) of the 7559 adolescents in the Growing Up Today Study II

|                             | <b>Girls (n=4121)</b> | <b>Boys (n=3438)</b> |
|-----------------------------|-----------------------|----------------------|
| Age (years)                 | 13.0 (1.9)            | 12.9 (1.8)           |
| BMI (kg/m <sup>2</sup> )    | 20.0 (3.3)            | 20.2 (3.6)           |
| Overweight (%)              | 14.1%                 | 19.3%                |
| Obese (%)                   | 2.2%                  | 4.5%                 |
| Television viewing (hrs/wk) | 11.0 (8.7)            | 12.0 (8.9)           |
| Vigorous activity (hrs/wk)  | 6.2 (5.5)             | 7.8 (6.3)            |

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**Table 2**

Prospective associations ( $\beta$  and 95% CI) of servings per day of soda and sports drinks with changes in BMI among adolescent girls in the Growing Up Today Study II

|  | Model 1                    |                             | Model 2                    |                             | Model 3                    |                             |
|--|----------------------------|-----------------------------|----------------------------|-----------------------------|----------------------------|-----------------------------|
|  | Baseline Predictors        |                             | Change in Intake           |                             | Baseline & Change          |                             |
|  | Age- Adjusted <sup>¶</sup> | Fully Adjusted <sup>±</sup> | Age- Adjusted <sup>¶</sup> | Fully Adjusted <sup>±</sup> | Age- Adjusted <sup>¶</sup> | Fully Adjusted <sup>±</sup> |
| Regular soda (servings/day)                  | -0.20 (-0.12, 0.08)        | -0.00 (-0.10, 0.10)         |                            |                             | 0.01 (-0.16, 0.17)         | 0.02 (-0.14, 0.19)          |
| Change in soda intake (servings/day)         |                            |                             | 0.09 (-0.03, 0.21)         | 0.10 (-0.03, 0.22)          | 0.11 (-0.06, 0.27)         | 0.12 (-0.05, 0.29)          |
| Diet soda (servings/day)                     | 0.19 (0.08, 0.29)          | 0.19 (0.08, 0.29)           |                            |                             | 0.21 (0.08, 0.35)          | 0.21 (0.07, 0.35)           |
| Change in diet soda intake (servings/day)    |                            |                             | -0.04 (-0.19, 0.04)        | -0.06 (-0.20, 0.09)         | 0.06 (-0.10, 0.22)         | 0.04 (-0.12, 0.20)          |
| Sports drinks (servings/day)                 | 0.26 (0.09, 0.44)          | 0.23 (0.05, 0.41)           |                            |                             | 0.34 (0.10, 0.59)          | 0.29 (0.03, 0.54)           |
| Change in sports drink intake (servings/day) |                            |                             | -0.10 (-0.30, 0.10)        | -0.09 (-0.29, 0.11)         | 0.07 (-0.17, 0.30)         | 0.05 (-0.19, 0.29)          |

<sup>¶</sup> All beverages included in the same model, which also controlled for age, time between assessments, BMI at the start of the time period

<sup>±</sup> All beverages included in the same model, which also controlled for age, time between assessments, BMI at the start of the time period, hours per day of television viewing, and hours per week of vigorous activity.

**Table 3** Prospective associations ( $\beta$  and 95% CI) of soda and sports drinks with changes in BMI among adolescent boys in the Growing Up Today Study II

|  | Model 1                    |                             | Model 2                    |                             | Model 3                    |                             |
|--|----------------------------|-----------------------------|----------------------------|-----------------------------|----------------------------|-----------------------------|
|  | Baseline Predictors        |                             | Change in Intake           |                             | Baseline & Change          |                             |
|  | Age- Adjusted <sup>¶</sup> | Fully Adjusted <sup>±</sup> | Age- Adjusted <sup>¶</sup> | Fully Adjusted <sup>±</sup> | Age- Adjusted <sup>¶</sup> | Fully Adjusted <sup>±</sup> |
| Regular soda (servings/day)                  | 0.05 (-0.05, 0.15)         | 0.05 (-0.06, 0.16)          |                            |                             | 0.08 (-0.06, 0.32)         | 0.09 (-0.06, 0.24)          |
| Change in soda intake (servings/day)         |                            |                             | 0.09 (-0.04, 0.22)         | 0.08 (-0.06, 0.22)          | 0.15 (-0.00, 0.30)         | 0.14 (-0.02, 0.30)          |
| Diet soda (servings/day)                     | 0.19 (0.03, 0.35)          | 0.16 (-0.02, 0.34)          |                            |                             | 0.53 (0.30, 0.76)          | 0.56 (0.32, 0.80)           |
| Change in diet soda intake (servings/day)    |                            |                             | 0.17 (-0.04, 0.38)         | 0.20 (-0.02-0.42)           | 0.41 (0.18, 0.63)          | 0.45 (0.22, 0.69)           |
| Sports drinks (servings/day)                 | 0.28 (0.11, 0.45)          | 0.15 (-0.04,0.34)           |                            |                             | 0.47 (0.25, 0.69)          | 0.33 (0.09, 0.58)           |
| Change in sports drink intake (servings/day) |                            |                             | 0.23 (0.03, 0.43)          | 0.29 (0.07, 0.50)           | 0.42 (0.21, 0.64)          | 0.43 (0.19, 0.66)           |

<sup>¶</sup>All beverages included in the same model, which also controlled for age, time between assessments, BMI at the start of the time period

<sup>±</sup>All beverages included in the same model, which also controlled for age, time between assessments, BMI at the start of the time period, Tanner stage of development, hours per day of television viewing, and hours per week of vigorous activity.