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Teresia M. O'Connor, Su-Jau Yang and Theresa A. Nicklas

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ARTICLE

# Beverage Intake Among Preschool Children and Its Effect on Weight Status

**Teresia M. O'Connor, MD[a], Su-Jau Yang, MS[b], Theresa A. Nicklas, DrPH[b]**

[a]Department of Pediatrics and [b]Children's Nutrition Research Center, Department of Pediatrics, Baylor College of Medicine, Houston, Texas

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## ABSTRACT

OBJECTIVE. The obesity epidemic in the United States continues to increase. Because obesity tends to track over time, the increase in overweight among young children is of significant concern. A number of eating patterns have been associated with overweight among preschool-aged children. Recently, 100% fruit juice and sweetened fruit drinks have received considerable attention as potential sources of high-energy beverages that could be related to the prevalence of obesity among young children. Our aim was to evaluate the beverage intake among preschool children who participated in the National Health and Nutrition Examination Survey 1999–2002 and investigate associations between types and amounts of beverages consumed and weight status in preschool-aged children.

METHODS. We performed a secondary analysis of the data from the National Health and Nutrition Examination Survey 1999–2002, which is a continuous, cross-sectional survey of a nationally representative sample of the noninstitutionalized population of the United State. It included the collection of parent reported demographic descriptors, a 24-hour dietary recall, a measure of physical activity, and a standardized physical examination. The 24-hour dietary recall was obtained in person by a trained interviewer and reflected the foods and beverages that were consumed by the participant the previous day. The National Health and Nutrition Examination Survey food groups were classified on the basis of the US Department of Agriculture's Food and Nutrient Database for Dietary Studies. We reviewed the main food descriptors used and classified all beverages listed. One hundred percent fruit juice was classified as only beverages that contained 100% fruit juice, without sweetener. Fruit drinks included any sweetened fruit juice, fruit-flavored drink (natural or artificial), or drink that contained fruit juice in part. Milk included any type of cow milk and then was subcategorized by percentage of milk fat. Any sweetened soft drink, caffeinated or uncaffeinated, was categorized as soda. Diet drinks included any fruit drink, tea, or soda that was sweetened by low-calorie sweetener. Several beverages were removed from the analysis because of low frequency of consumption among the sample. Water was not included in the

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**Key Words**
obesity, overweight, beverages, young children, NHANES

**Abbreviations**
NHANES—National Health and Nutrition Examination Survey
AAP—American Academy of Pediatrics
ADA—American Dietetic Association
USDA—US Department of Agriculture
CI— confidence interval

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Address correspondence to Teresia M. O'Connor, MD, Department of Pediatrics, Baylor College of Medicine, 6621 Fannin St, CCC1540.00, Houston, TX 77030. E-mail: teresiao@bcm.edu

analysis because it is not part of the US Department of Agriculture's Food and Nutrient Database categories. For the purposes of this analysis, the beverages were converted and reported as ounces, rather than grams, as reported by the National Health and Nutrition Examination Survey, to make it more clinically relevant. The child's BMI percentile for age and gender were calculated on the basis of Centers for Disease Control and Prevention criteria and used to identify children's weight status as underweight (<5%), normal weight (5% to <85%), at risk for overweight (85% to <95%), or overweight (≥95%). Because of the small number of children in the underweight category, they were included in the normal-weight category for this analysis. Data were analyzed using SUDAAN 9.0.1 statistical software programs. SUDAAN allows for improved accuracy and validity of results by calculating test statistics for the stratified, multistage probability design of the National Health and Nutrition Examination Survey. Sample weights were applied to all analyses to account for unequal probability of selection from oversampling low-income children and black and Mexican American children. Descriptive and $\chi^2$ analyses and analysis of covariance, adjusting for age, gender, ethnicity, household income, energy intake, and physical activity, were conducted.

RESULTS. All children who were aged 2 to 5 years were identified ($N$ = 1572). Those with missing data were removed from additional analysis, resulting in a final sample of 1160 preschool children. Of the 1160 children analyzed, 579 (49.9%) were male. White children represented 35%, black children represented 28.3%, and Hispanic children represented 36.7% of the sample. Twenty-four percent of the children were overweight or at risk for overweight (BMI ≥85%), and 10.7% were overweight (BMI ≥95%). There were no statistically significant differences in BMI between boys and girls or among the ethnicities. Overweight children tended to be older (mean age: 3.83 years) compared with the normal-weight children (mean age: 3.48 years). Eighty-three percent of children drank milk, 48% drank 100% fruit juice, 44% drank fruit drink, and 39% drank soda. Whole milk was consumed by 46.5% of the children, and 3.1% and 5.5% of the children consumed skim milk and 1% milk, respectively. Preschool children consumed a mean total beverage volume of 26.93 oz/day, which included 12.32 oz of milk, 4.70 oz of 100% fruit juice, 4.98 oz of fruit drinks, and 3.25 oz of soda. Weight status of the child had no association with the amount of total beverages, milk, 100% fruit juice, fruit drink, or soda consumed. There was no clinically significant association between the types of milk (percentage of fat) consumed and weight status. In analysis of covariance, daily total energy intake increased with increased consumption of milk, 100% fruit juice, fruit drinks, and soda. However, there was not a statistically significant increase in BMI on the basis of quantity of milk, 100% fruit juice, fruit drink, or soda consumed.

CONCLUSIONS. On average, preschool children drank less milk than the 2005 Dietary Guidelines for Americans recommendation of 16 oz/day. Only 8.6% drank low-fat or skim milk, as recommended for children who are older than 2 years. On average, preschool children drank <6 oz/day 100% fruit juice. Increased beverage consumption was associated with an increase in the total energy intake of the children but not with their BMI. Prospectively studying preschool children beyond 2 to 5 years of age, through their adiposity rebound (~5.5–6 years) to determine whether there is a trajectory increase in their BMI, may help to clarify the role of beverage consumption in total energy intake and weight status.

THE OBESITY EPIDEMIC in the United States continues to increase.[1] US children are significantly affected by the obesity epidemic, with an increasing prevalence of both overweight and at risk for overweight among all ages and ethnic groups.[2–4] Because obesity tends to track over time,[5] the increase in overweight among young children is of significant concern. Twenty-three percent of 2- to 5-year-olds were overweight or at risk for overweight with a BMI ≥85%, and 10.3% were overweight (BMI ≥95%) according to National Health and Nutrition Examination Survey (NHANES) 1999–2002 data.[2] This percentage of overweight had increased compared with data from NHANES III (1988–1994), which showed that only 7.2% of 2- to 5-year-old children were overweight.[6] Preschool-aged children, 2 to 5 years of age, are of special interest because eating and exercise habits may become established at this young age.

Many have speculated as to the reasons for the increase in overweight among various age groups. Recently, 100% fruit juice and sweetened fruit drinks have been discussed as a potential source of high-energy, low-nutrient-dense beverages that could be a culprit in the prevalence of obesity among young children. Dennison et al[7] first brought up the concern of 100% fruit juice when they showed that preschool-aged children in their study who consumed ≥12 oz/day 100% fruit juice had greater prevalence of overweight (defined as BMI ≥90% for age and gender) than those who consumed <12 oz/day (32% vs 9%). They also found that the high 100% fruit juice consumers had a higher rate of short stature. Since that time, a few other small, regional studies have investigated the association between 100% fruit juice consumption and overweight in preschool-aged children, without finding an association.[8–10]

Several studies have investigated the association of overweight and the intake of sweetened beverages among older children and adolescents, with varying results.[11–19] Few studies have examined the association of sweetened beverage consumption and development of overweight among preschool children. Welsh et al[20] examined the association of sweet-drink consumption, defined as 100% fruit juice, fruit drinks, and sodas, with BMI during a 1-year period. They found no statistically significant association between sweet-drink consumption and development of overweight during a 1-year period in previously normal-weight preschool children who were enrolled in a Special Supplemental Nutrition Program for Women, Infants, and Children. Children who were overweight or at risk for overweight at the beginning of the study did have a statistically significant higher odds of staying overweight or becoming overweight when they drank >1 sweet drink per day. They then isolated fruit juice in the analysis and again found no association to change in weight status of children who were normal weight or at risk for overweight at baseline, whereas the children who were overweight at baseline did have a borderline significant persistence of overweight. Another prospective, longitudinal study of preschool-aged children who attended a regional Special Supplemental Nutrition Program for Women, Infants, and Children found no statistically significant correlation between weight change and the consumption of 100% fruit juice, fruit drinks, milk, soda, or diet soda.[21]

Even fewer studies have investigated the association of milk consumption with BMI in preschool-aged children. In a large cross-sectional school-based study from Italy, Barba et al[22] evaluated children 3- to 11-year-olds and found a statistically significant inverse relationship with milk consumption and BMI ($P = .003$), with the higher consumers of milk having the lowest mean BMI. In a study with an alternative approach, Skinner et al[23] followed a small sample of children from the age of 2 months to 8 years and found an inverse association of the child's body fat and calcium intake. Another cross-sectional study that evaluated older children's and adolescents' dairy calcium intake also found an inverse association with body fat indexes and calcium intake.[24]

In 2001, the American Academy of Pediatrics (AAP) published its recommendations for 100% fruit juice consumption in children[25] and concluded that 100% fruit juice had no nutritional benefit over whole fruit for infants who are older than 6 months or children. They recommended that 100% fruit juice be limited to 4 to 6 oz/day for children 1 to 6 years of age and not be given to infants who are younger than 6 months. For older children, 7 to 18 years of age, 100% fruit juice intake should be limited to 8 to 12 oz/day. They further recommended that in the evaluation of overnutrition in children, the health care provider should determine the amount of 100% fruit juice that children are consuming,[25] suggesting that 100% fruit juice consumption may be contributing to the child's overnutrition. The AAP's recommendations on milk intake can be inferred from their recommendations of calcium requirements for children. A child requires 800 mg/day dietary calcium for optimal bone mineralization and to help prevent osteoporosis in adulthood. This is equivalent to ~3 cups of milk per day (300 mg calcium per cup of milk).[26] The American Dietetic Association's (ADA's) recommendations of 2 to 3 servings per day of milk or other dairy products are consistent with the AAP's recommendations.[27] In addition, the ADA recommends that children consume primarily nonfat milk after the age of 2. The ADA does not make specific recommendations regarding 100% fruit juice or sweetened beverages for children, other than stating that added sugar should be consumed sparingly, including sweetened beverages.[27]

The new US Department of Agriculture (USDA) 2005 Dietary Guidelines also are consistent in regard to their recommendations of milk intake in preschool-aged children. It recommends that children 2 to 8 years of age consume 2 cups of low-fat milk per day.[28] In addition, the 2005 Dietary Guidelines agree with the AAP to limit 100% fruit juice to 4 to 6 oz among this age group.[28] The USDA conducted a special analysis for the 2005 Dietary Guidelines Advisory Committee to examine the impact of removing fruit juice and substituting the portion of the composite with whole fruit. Replacing 100% fruit juice with fruit did not result in nutrient shortfalls except for small differences in potassium and magnesium, nutrients that are already in shortfall in most diets. It is for this reason that the 2005 Dietary Guidelines Advisory Committee Report recommended that no more than one third of fruit servings be 100% fruit juice and at least two thirds be whole fruit.[29]

As described above, studies that have investigated the association between various types of beverages and the development of overweight in preschool-aged children have been in regional populations, and most of them have had small sample sizes. The purpose of this study was to evaluate the association of various beverages with weight status among a large, nationally representative sample of 2- to 5-year-old children who participated in the NHANES 1999–2002.[30] Specifically, our aims were to (1) evaluate beverage intake among preschool-aged children and investigate associations among types of beverages and weight status in preschool-aged children, (2) assess whether overweight or at risk for overweight preschool-aged children drank more 100% fruit juice, milk, fruit drink, or soda than their normal-weight counterparts, and (3) evaluate whether preschool-aged children who consumed larger quantities of 100% fruit juice, milk, fruit drinks, or soda had higher rates of being overweight than those who drank little to no 100% fruit juice, milk, fruit drink, or soda.

## METHODS

### NHANES Data

We performed a secondary analysis of the data from NHANES 1999–2002,[30] which is a continuous, cross-sectional survey of a nationally representative sample of the noninstitutionalized population of the United States and was conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention.[6] It includes a collection of demographic descriptors, physical activity, and a 24-hour dietary recall that was obtained in person by a trained interviewer and reflected the foods and beverages that were consumed by the participant the previous day.[30] Physical activity was self-reported by parents, who responded to the question, "How many times per week does your child play or exercise enough to make him/her sweat or breathe hard?" All participants also took part in a standardized physical examination, including weight and recumbent length or height.[6] Detailed description of these methods are available elsewhere.[30]

We selected the reported data on preschool-aged children, 2 to 5 years of age ($N = 1572$), for our analysis.[30] Ethnicity was self-reported by participants as Mexican American, other Hispanic, non-Hispanic white, non-Hispanic black, or other (including multiracial). NHANES oversamples low-income individuals, adolescents who are 12 to 19 years of age, individuals who are 60 years and older, black individuals, and Mexican American individuals.[30] For the purposes of this analysis, Mexican American and other Hispanic children were combined into 1 group called Hispanic. The category of "other" was too small ($N = 63$ [4%]) to include as a meaningful analysis. An additional 349 individuals were deleted from the analysis: 116 individuals had missing BMI data; 5 individuals reported "don't know," refused to answer, or had missing data on questions regarding physical activity of the child; 190 reported "don't know," refused to answer, or had missing data on questions regarding household income; and 38 individuals had data missing on >1 variable. The resulting sample size, 1160 children who were 2 to 5 years of age, were used in the analysis. A comparison was made between the BMI of the children who were included in the analysis and those who were excluded for reasons other than missing BMI, with no difference in BMI found.

### Beverage Classification

The NHANES food groups are classified on the basis of the USDA Food and Nutrient Database for Dietary Studies.[31] We reviewed the main food descriptors used and classified all beverages listed. One hundred percent fruit juice was classified as only those beverages that contain 100% fruit juice, without sweetener. Fruit drinks included any sweetened fruit juice, fruit-flavored drink (natural or artificial), or drink that contained fruit juice in part. Milk included any type of cow milk and then was subcategorized by percentage of milk fat (skim, 1%, 2%, and whole milk), including chocolate and flavored milk as separate categories. Any sweetened soft drink, caffeinated or uncaffeinated, was categorized as soda, and diet drinks included any fruit drink, tea, or soda that was sweetened by low-calorie sweetener. Several beverages were removed from analysis because of low frequency of consumption among our sample. These included energy drinks and rehydration beverages (0% frequency), carbonated water (0.3%), instant breakfast (0.1%), fruit smoothies (0.3%), malted milk (0.78%), coffee (1.1%), nonalcoholic beverages made from grains (0.1%), and meal supplement beverages (0.1%). Water was not included in the analysis because it is not part of the USDA Food and Nutrient Database categories.

For the purposes of this analysis, the beverages were converted and reported as ounces, rather than grams as reported by NHANES, to make it more clinically relevant. Milk quantity was subcategorized as none, >0 to 8 oz, >8 to 16 oz, >16 to 24 oz, and >24 oz on the basis of current recommended servings of milk.[27] One hundred percent fruit juice and fruit drinks were reported as none, >0 to 6 oz, >6 to 12 oz, and >12 oz on the basis of the current AAP recommendations for 100% fruit juice serving sizes.[25]

### Statistical Analysis

Data were analyzed using SUDAAN 9.0.1 (Research Triangle Institute, Research Triangle Park, NC) statistical software programs. SUDAAN allows for improved accuracy and validity of results by calculating test statistics for the stratified, multistage probability design of NHANES. Sample weights were applied to all analyses to account for unequal probability of selection from oversampling low-income children and black and Mexican American children. Descriptive statistics summarized the data. $\chi^2$ analysis was used to evaluate the association of categorical variables on BMI categories. Beverage consumption was presented as means with SE among BMI categories. Analysis of covariance was used to test the association of serving size of a beverage to energy intake and BMI.

## RESULTS

Table 1 describes the demographic descriptors, and Table 2 provides the demographic descriptors on the basis of weight status (BMI <85% [normal weight]; ≥85% to <95% [at risk for overweight]; ≥95% [overweight]). Of the 1160 preschool children in our sample, 579 (49.9%) were male; white children represented 35%, black children 28.3%, and Hispanic children 36.7% of the sample (Table 1). Seventy-five percent had a BMI of <85%, considered normal or underweight, 24.1% were at risk for overweight or were overweight (BMI ≥85%), and 10.7% were overweight (BMI ≥95%). There were no statistically significant differences in BMI between boys

TABLE 1 **Demographic Descriptors of Population**

| Descriptor | *n* (%) |
|---|---|
| Gender | |
| Male | 579 (49.9) |
| Female | 581 (50.1) |
| Ethnicity | |
| White | 406 (35) |
| Black | 328 (28.3) |
| Hispanic | 426 (36.7) |
| BMI | |
| <85% | 881 (75.9) |
| 85% to <95% | 155 (13.4) |
| ≥95% | 124 (10.7) |
| Age, y | |
| 2 | 361 (31) |
| 3 | 279 (24) |
| 4 | 280 (24) |
| 5 | 240 (21) |
| Household income | |
| $20 000 or less | 368 (32) |
| $20 000 to $24 999 | 125 (11) |
| $25 000 to $34 999 | 144 (12) |
| $35 000 to $54 999 | 217 (19) |
| $55 000 or more | 306 (26) |

TABLE 3 **Prevalence of Types of Beverages Consumed by Preschool Children**

| Type of Beverage | Prevalence of Children Who Consumed Beverage, % |
|---|---|
| 100% fruit juice | 47.9 |
| Fruit drink | 44.2 |
| Soda | 39.2 |
| Total milk | 82.6 |
| Whole milk | 46.5 |
| 2% milk | 25.3 |
| 1% milk | 5.5 |
| Skim milk | 3.1 |
| Chocolate milk | 14.6 |
| Other flavored milk | 2.2 |

and girls or among the ethnicities (data not shown). There was a statistically significant difference in age of the various weight categories (Table 2), with the overweight children being older (mean age: 3.83) compared with the normal-weight children (mean age: 3.48; $P = .03$). Almost 82.6% of children who were included in the analysis drank milk, 48% drank 100% fruit juice, 44.2% drank fruit drink, and 39.2% drank soda. Whole milk was consumed by 46.5% of the preschool children. Skim milk and 1% milk were consumed by 3.1% and 5.5% of the children, respectively (Table 3).

The mean volume of total beverages, excluding water, that was consumed by the preschool children was 26.93 oz (95% confidence interval [CI]: 25.75–28.12; SE: 0.57 oz; Fig 1). There was no significant difference in total beverages consumed by weight status of the children (Fig 1). Mean milk intake represented 12.32 oz of beverages consumed (95% CI: 11.03–13.62; SE: 0.63). Weight status had no association with total milk consumed after adjustment for age, gender, ethnicity, income, energy intake, and physical activity. There was no clinically significant association between the type of milk (percentage of fat) consumed and weight status (data not shown). Mean 100% fruit juice consumed among all of the children was 4.70 oz (95% CI: 4.04–5.36; SE: 0.32); there was no significant difference in 100% fruit juice consumption among the weight categories. Mean fruit drinks and soda consumed were 4.98 oz (95% CI: 4.20–5.76 oz; SE: 0.38) and 3.25 oz (95% CI: 2.78–3.71; SE: 0.23), respectively. None of the other drinks that were evaluated in this study, including fruit drinks, soda, teas, or diet drinks, was significantly associated with weight status of the child.

In analysis by covariance, children who drank more servings of milk consumed greater total energy than children who drank less milk. This association held true after adjustment for gender, ethnicity, age, income, physical activity, and energy intake ($P < .01$; Fig 2). However, there was no statistically significant difference in BMI on the basis of quantity of milk consumed (Fig 2). Increased consumption of 100% fruit juice, fruit drinks, and soda also had an increased total energy intake association, but they had no association with BMI (Figs 3–5).

## DISCUSSION

The prevalence of obesity in this analysis is comparable to previously reported prevalence by Hedley et al[2] on 2- to 5-year-old children from another subselection of the

TABLE 2 **Mean Descriptive Characteristics of the Preschool Children According to Weight Status**

| Characteristic | All Children | Normal Weight (BMI <85%) | At Risk for Overweight (BMI 85% to <95%) | Overweight (BMI ≥95%) |
|---|---|---|---|---|
| BMI, mean (SE)[a] | 16.32 (0.09) | 15.49 (0.05) | 17.54 (0.03) | 20.28 (0.28) |
| Age, mean (SE), y[b] | 3.52 (0.03) | 3.48 (0.04) | 3.53 (0.10) | 3.82 (0.12) |
| Annual household income, median | $25 000–$34 999 | $25 000–$34 999 | $25 000–$34 999 | $25 000–$34 999 |
| Physical activity, mean (SE), times per wk | 6.42 (0.16) | 6.23 (0.17) | 7.07 (0.76) | 7.13 (0.49) |
| Energy consumed, mean (SE), kJ/d[c] | 6766.2 (98.57) | 6661.2 (111.72) | 7187.67 (233.02) | 7091.78 (323.95) |
| Total beverages, mean (SE), oz/d | 26.93 (0.58) | 26.35 (0.75) | 29.49 (1.11) | 24.34 (2.09) |

[a] $P < .001$.
[b] $P = .03$.
[c] 1 kcal = 4.2 kJ.

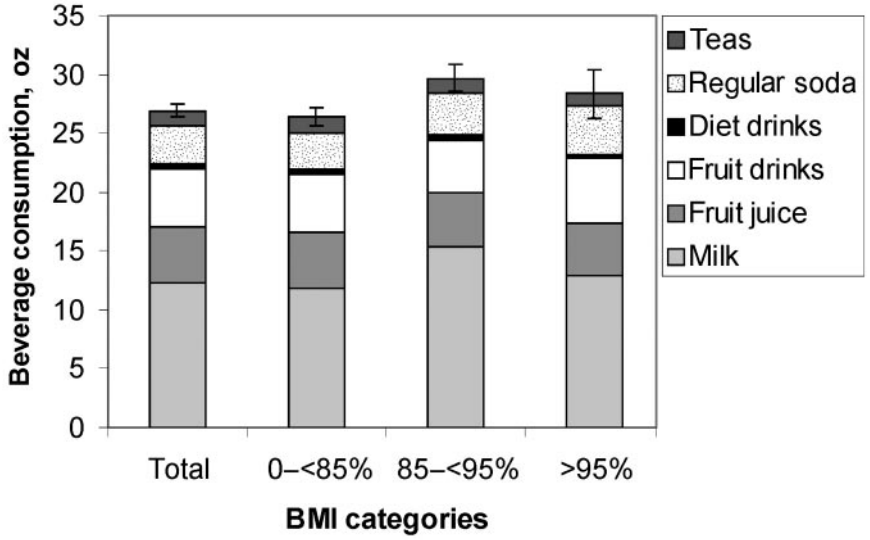


FIGURE 1
Mean quantity and type of beverages consumed by weight status of preschool children, with standard errors indicated. Weight status of preschool children had no statistically significant difference in beverage amounts or types after adjusted for age, ethnicity, gender, income, energy consumed, and physical activity.

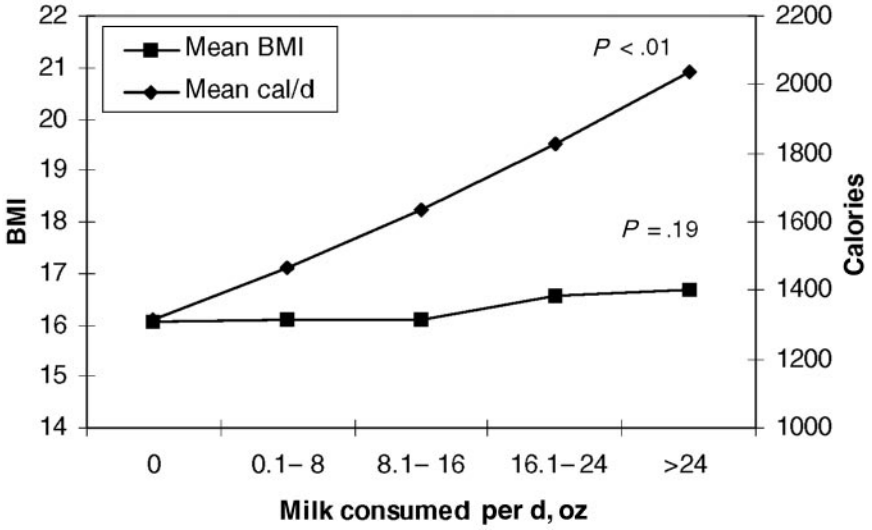


FIGURE 2
The association of energy intake and mean BMI, based on daily milk consumption. Adjusted for age, gender, ethnicity, income, calories and physical activity. ■, mean BMI; ◆, mean energy intake per day (1 cal = 4.184 J).

NHANES 1999–2002 data. They previously reported that 10.3% of preschool children had BMI ≥95% and 22.6% of preschool-aged children had BMI ≥85% from a sample size of 1522 2- to 5-year old children. Similar to the results found in this study, Hedley et al[2] did not find any statistically significant difference in BMI among the ethnicities of 2- to 5-year-old children. They did report significant differences in BMI by ethnicity in older children. The preschool-age cohort of children might be too young and have less prevalence of overweight to reveal clear differences in BMI status among the ethnic groups.

Our analysis suggests that although almost 83% of preschool children sampled in NHANES 1999–2002 consumed some milk, the average milk consumed was less than the recommended amount per day. The mean amount of milk consumed by the children in this analysis was 12.32 oz/day, or 1.5 servings per day. This is less than the 2 servings per day recommended for 2- to 5-year-old children by the 2005 Dietary Guidelines for Americans.[28] In addition, only 8.6% of children drank skim or 1% milk. This is concerning because the Dietary Guidelines recommend that everyone who is older than of 2 years should consume low- or nonfat milk.[28] As found by others,[21] milk still represents the beverage that is consumed in greatest quantity by preschool-aged children in our analysis. Our analysis also suggests that the preschool children are consuming, on average, appropriate amounts of 100% fruit juice. The preschool children in our analysis consumed a mean amount of 4.7 oz of 100% fruit juice per day, which is within the recommended <4 to 6 oz/day.[25] Of note is that the preschool children are consuming slightly greater quantities of fruit drinks than 100% fruit juice, a concern because these drinks usually are energy dense and provide little nutritional benefit compared with 100% fruit juice.[32]

The quantity of milk, 100% fruit juice, fruit drinks,

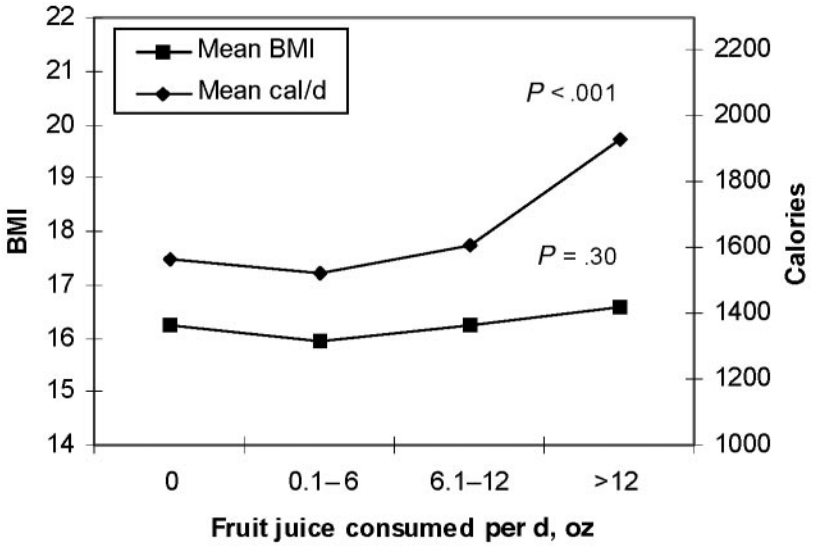


FIGURE 3
The association of energy intake and mean BMI, based on daily 100% fruit juice consumption. Adjusted for age, gender, ethnicity, income, calories and physical activity. ■, mean BMI; ◆, mean energy intake per day (1 cal = 4.184 J).

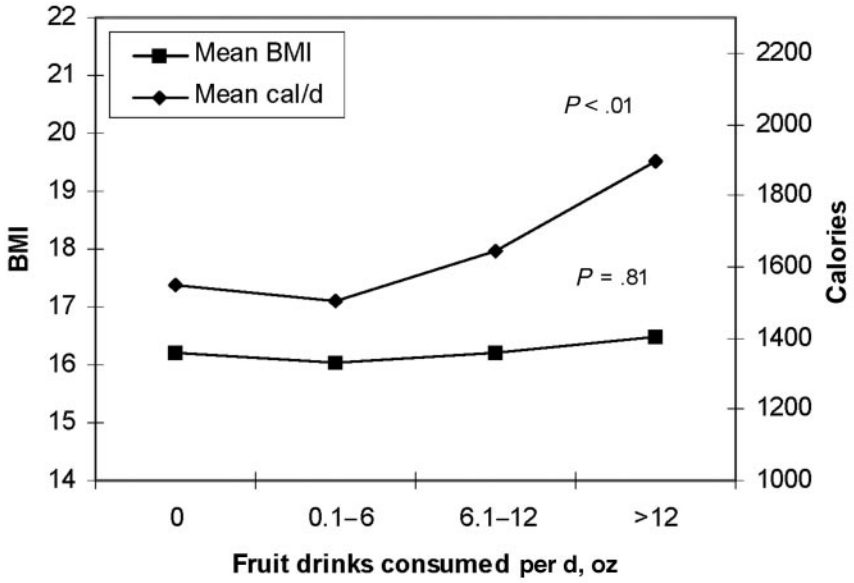


FIGURE 4
The association of energy intake and mean BMI, based on daily fruit drink consumption. Adjusted for age, gender, ethnicity, income, calories and physical activity. ■, mean BMI; ◆, mean energy intake per day (1 cal = 4.184 J).

and soda consumed was associated with increased total energy intake; however, the increased energy intake was not associated with an increase in BMI. This noted difference between total energy intake and mean BMI might have multiple explanations. First, the prevalence of overweight in this age group ($N$ = 124; 10.7%) may be too low to detect an association between increased energy intake and increased BMI. Second, we may be capturing children who are too young to see an effect of increased total energy intake on BMI. Because mean adiposity rebound occurs at ~5.5 to 6 years,[33,34] it is possible that if we were to follow the preschool children through their adiposity rebound, we may find that the increased energy intake may translate into an increase in BMI after age 6. As such, a secondary analysis poses some innate limitations. Because NHANES is a cross-sectional study, it does not provide longitudinal data to evaluate whether the high consumers of milk, 100% fruit juice, fruit drinks, or soda become overweight over time. Third, we attempted to control for physical activity in this analysis. However, the physical activity data that were available for 2- to 5-year-olds in NHANES is not specific. It asks only how many times per week the child plays or exercises until he or she sweats or breathes hard. This does not provide any information on the amount of time the children are physically active, which may be a more important variable. Fourth, a single 24-hour dietary recall may not be a fair representation of the typical dietary consumption of the participants because it can have problems with under- or overreporting.[35] In addition, a proportion of these children spend part of the day away from their parents in child care or

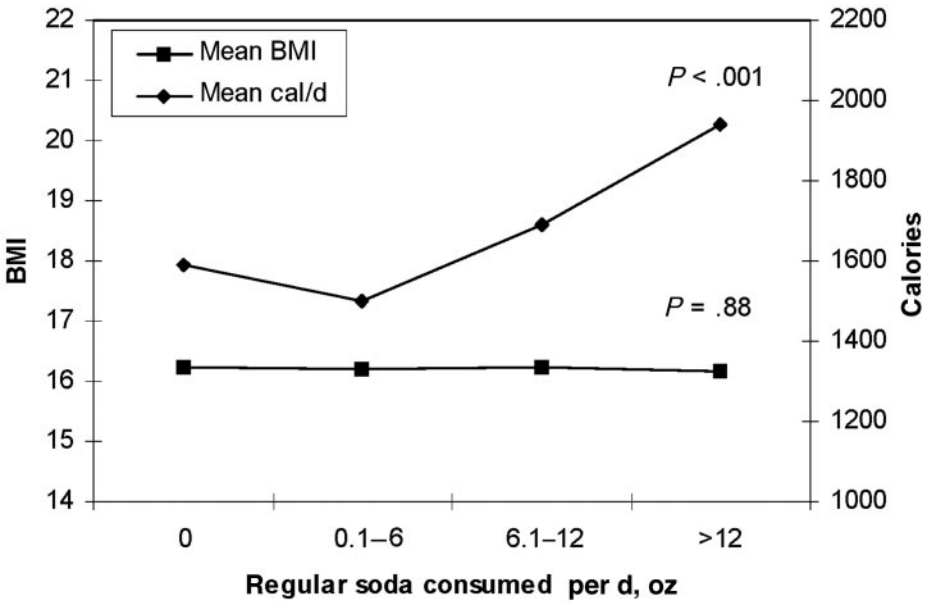


FIGURE 5
The association of energy intake and mean BMI, based on daily regular soda consumption. Adjusted for age, gender, ethnicity, income, calories and physical activity. ■, mean BMI; ◆, mean energy intake per day (1 cal = 4.184 J).

preschool. This makes it difficult for the parents truly to be aware of everything that the child consumed the day before. Last, the relationship between energy intake and BMI in this age group may be more complicated than previously thought.

The findings of this analysis support previous studies by Skinner et al[9,10] and Alexy et al[8] that 100% fruit juice consumption is not associated with overweight status in preschool-aged children. It also is consistent with the findings of Newby et al[21] that showed no significant correlation between weight change and the consumption of 100% fruit juice, fruit drinks, milk, soda, or diet soda in preschool-aged children. Unlike the previous studies, this analysis was performed on national data, representing a large and diverse population of preschool children. Given this, the results are more representative of the US population and therefore can be generalized more easily. Despite the limitations of our analysis, the association between increased consumption of milk, 100% fruit juice, fruit drinks, and soda to total energy intake but not to increasing BMI may warrant additional investigation. New studies to investigate the relationship among beverage consumption, total energy intake, and development of overweight should be performed. Ideally, these studies should include various age and ethnic groups and should follow the children longitudinally during critical periods of excessive weight gain.

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