Fruit Juice Intake Is Not Related to Children's Growth

Jean D. Skinner, PhD, RD*; Betty Ruth Carruth, PhD, RD*; James Moran III, PhD‡; Kelly Houck, MS*; and Frances Coletta, PhD, RD§

ABSTRACT. *Background.* **Excessive fruit juice intake (>12 ounces/day) has been reported to be associated with short stature and obesity in preschool children.**

Objective. **To confirm whether excess fruit juice intake was associated with short stature and obesity in preschool children, we assessed growth parameters and fruit juice intake in 105 white children, ages 24 to 36 months.**

Methodology. **Mothers were interviewed twice by a registered dietitian when children were age 24, 28, or 32 months (interview 1) and when children were age 28, 32, or 36 months (interview 2); interviews were assigned randomly. At each interview mothers provided 3 days of dietary data (one 24-hour recall and a 2-day food record) and the registered dietitian weighed the child and measured his/her height. Dietary data were analyzed using Nutritionist IV software. Each child's body mass index (wt/ht^2) and ponderal index (wt/ht^3) were calculated for each interview. Growth parameters of children consuming <12 ounces/day 100% fruit juice were compared with those consuming ≥12 ounces/day using the Student's *t* test, χ^2, Fisher's exact test, and mixed model repeated measures analyses (PROC MIXED).**

Results. **Results consistently indicated no statistically significant differences in children's height, body mass index, or ponderal index related to fruit juice intake. Intakes of soda pop were negatively related to intakes of milk and fruit juice although intakes of milk and fruit juice were not related.**

Conclusions. **The consistent lack of relationship between children's fruit juice intake and growth parameters in our study does not support previous recommendations to limit the intake of 100% fruit juice to <12 ounces/day.** ***Pediatrics*** **1999;103:58–64;** ***child, obesity, fruit juice, nutrition policy, children's growth.***

ABBREVIATIONS. SES, socioeconomic status; BMI, body mass index; PI, ponderal index; RDA, recommended dietary allowance.

Dennison and coworkers reported in 1996[1] and in 1997[2] that consumption of excess (≥12 fl ounces/day) fruit juice by 2- and 5-year-old children was associated with short stature and obesity. These results were cited in national media (eg, NBC's *Today Show*, and *Better Homes and Gardens* and *Parents* magazines) with advice to parents to control and moderate the amount of fruit juice consumed by young children. It was further suggested that fruit juice be diluted with water and/or fruit be offered in the solid form.[3] Although large amounts of fruit juices with the greatest amounts of nonabsorbable sorbital, such as apple and pear juices, may cause digestive disturbances in some children, 100% fruit juices generally are considered nutritious foods and suitable beverages for preschool children.[4] Fruit and fruit juices, particularly citrus fruits and juices, are major contributors to the ascorbic acid, folate, and potassium content of the American diet.[5] Dilution of juice with water decreases the nutritional value proportionally.

The major purpose of this study was to test the relationships between fruit juice consumption and growth parameters in 2-year-old children. Because findings from the Dennison study[2] were used to make global recommendations, it is important to confirm those findings in another group of children who are similar in age and race to those interviewed by Dennison et al.[2] As in the Dennison study the following questions were addressed: Are American preschool children drinking so much fruit juice that their linear growth is affected? Is fruit juice consumption related to obesity in young children? Additionally, we explored the following issues: Do children consume fruit juice in place of milk, which is an important dietary source of calcium and vitamin D, nutrients important for bone development? Does limiting fruit juice intake result in increased consumption of other less nutritious beverages, such as soda pop or fruit drinks (which may contain only a small percentage of juice)? Based on the Dennison et al[2] report, it seems that some children may consume very little fruit juice; ~22% of the 2-year-old children in that study had <2 ounces/day of fruit juice, and almost 40% had <4 ounces/day; thus, we investigated the nutritional implications of low juice consumption in our study.

METHODS

Study Population

The sample included 105 healthy, white children, 62 of whom were part of a longitudinal study about food habits of children 2 to 60 months of age.[6–8] The longitudinal study purposively included children from middle and upper socioeconomic status (SES) families, as measured by the Hollingshead Index[9] that uses education and occupation of the family wage earner(s) to assess SES. The scale ranges from 8 (low) to 66 (high). For the third year of the study only, a low SES component (Hollingshead Index

From the Departments of *Nutrition and ‡Child and Family Studies, University of Tennessee, Knoxville, Tennessee; and the §Gerber Products Company, Fremont, Michigan.

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Reprint requests to (J.D.S.) 229 JHB, Nutrition Department, University of Tennessee, Knoxville, TN 37996-1900.

≤33), which included 43 children, was added. Study participants were recruited from posters placed in clinics, day care centers, grocery stores, churches, and other places mothers might see them, personal referrals, and for the longitudinal sample, from newspaper birth announcements.

Interviews

For years 1, 2, and 3 of the study (children ages 2 to 36 months of age) a randomized, incomplete block research design was used; this means that not every subject was interviewed at each data point. This design reduced the cost of the study and also decreased the potential to annoy mothers by interviewing them too frequently. During the third year (24 to 36 months), each subject participated twice; the first interviews (interview 1) were conducted when children were 24, 28, or 32 months old and the second interviews (interview 2) when children were 28, 32, or 36 months old; interview times were assigned randomly and no child had both interviews at the same age. All interviews were conducted in the child's home by one of two registered dietitians who were trained on study protocol. Informed consent signatures for this phase of the study were obtained at the first interview during year 3 of the study.

The dietary data presented in this article were collected during 1994 to 1995, before the media reports from the Dennison et al[2] study. Three days of dietary data were collected at each interview (one 24-hour recall at the interview and 2 days of food records that had been kept before the interview). The registered dietitian reviewed food records with mothers for completeness and accuracy. All mothers had received previous instructions on keeping food records, either at an earlier interview (the longitudinal study participants) or in a short preinterview for the study participants who were recruited specifically for the third year. Daily beverage consumption including milk (all types), fruit juice (100% juice only), soda pop, and other drinks (ie, punch, lemonade, fruit drinks, but excluding water) was determined.

At each interview the child's height (without shoes) was measured with a steel tape to the nearest 0.1 cm using a wall or doorway in the child's home and a square (ie, two boards attached at a right angle). The child's weight was measured to the nearest 0.1 pound, using a standard scale (model 707; SECA, Columbia, MD), which was checked with standards of known weight. Demographic data were collected at the initial interview and updated regularly, as appropriate.

Statistical Analysis

Statistical procedures replicated the Dennison[2] study to the extent appropriate with our existing dataset. Although their study included children 2 and 5 years old, we compared our data only to their 2-year-olds. Our 60-month data had not been collected when the popular media began warning parents about the undesirable effects of excess fruit juice on children's growth, so these children's juice consumption at 60 months potentially could have been influenced by those reports.

Means plus/minus standard deviation were calculated, for demographic, beverage consumption, and anthropometric data. Differences in means between the two interviews and comparisons to the Dennison et al study[2] were tested with the Student's *t* test. Pearson's correlation analyses were used as the first step in testing the relationships between beverage intake and growth parameters and for the exploration of relationships among the four beverage categories.

Frequencies were obtained for categorical demographic variables and for the variables used in Dennison et al[2] to group study participants by anthropometric data and levels of daily beverage consumption. For fruit juice consumption, frequencies were calculated for three intake levels: <12 ounces versus ≥12 ounces, <2 ounces vs ≥2 ounces, and <4 ounces vs ≥4 ounces. Fisher's exact tests (2 × 2 tables) were used to test the association between dichotomous variables. The Cochran-Mantel-Haenszel test was used to test the association between stature and obesity while controlling for levels of fruit juice consumption.

For analyses involving child's height, gender specific height for age percentiles were determined from the National Center for Health Statistics growth charts.[10] We selected ≤10th and ≤25th percentiles for testing the effects of juice intake (<12 ounces vs ≥12 ounces) on height. Although Dennison et al[2] defined short stature as <20th percentile, this standard is not readily available, so we used the more typically available standards. For children interviewed at 24 and 36 months of age, we used the National Center for Health Statistic's standards for 2 and 3 years, respectively. For children interviewed at 28 and 32 months, we used values for 2.5 years from the growth charts.

Standards for obesity using body mass index (BMI) (wt/ht^2), as established by Hammer et al[11] and used by Dennison et al,[2] were ≥75th percentile as obese and ≥90th percentile as very obese. For the ponderal index (PI) (wt/ht^3), Dennison et al[2] used ≥90th percentile (PI ≥22 for 2-year-old children) as the standard for very obese. Thus, we used the same standards as Dennison et al[2] for comparing BMI and PI among children who had ≥12 ounces/day of fruit juice versus <12 ounces/day.

Mixed model repeated measures analyses (PROC MIXED) were used to test for mean differences in child height, child BMI, and child PI between the two juice consumption groups (≥12 ounces/day and <12 ounces/day). By using repeated measures analysis, measurements from both interview periods could be used to develop general linear models adjusted for maternal height, child age, child gender, and child age-gender interaction. Additional models were developed with this methodology using maternal BMI as a covariate in addition to maternal height, child age, child gender, and child age-gender interaction. Least squares means plus/minus the standard error of the least squares mean were used in reporting results of the mixed model repeated measures analyses.

All statistical analyses were conducted with the Statistical Analysis System[12] with the exception of Fisher's exact test of independence, which was calculated with the Statistical Packages for Social Sciences[13] exact test. The Statistical Packages for Social Sciences exact test calculates a significance level based on the exact distribution of the test statistic rather than using the asymptotic method to estimates *P* values. Estimation may produce unreliable results when the dataset is small, sparse, unbalanced, or poorly distributed. Consequently exact calculations were preferable for the contingency table analyses presented.

A probability level of $P \leq .01$ was established as a significance level for all Student's *t* tests. A probability level of $P \leq .05$ was used for all other statistical tests. All statistical tests were two-sided. Data from interview 2 were excluded from all analyses except those from the mixed models repeated measures models because there was lack of independence between interview 1 and 2, ie, the same study participants were interviewed twice. Averaging two sets of 3-day food records/recalls would eliminate the longitudinal aspect, which is a strength of this study. Two sets of dietary data, each averaged throughout 3 days, are a stronger estimate of an individual's usual food intake than more days from a single reporting period.[14] PROC MIXED analysis allows the use of longitudinal data in which the fixed effects can include both time-varying and nontime varying variables and in which the times between data collections can vary by subject.[14]

The Nutritionist IV (version 3.5) computer program was used to transform data and calculate beverage consumption in fluid ounces/day and to determine mean daily nutrient intakes. Differences in group mean intakes for children who had ≥12 ounces of juice per day versus those with <12 ounces/day, <2 ounces/day versus ≥2 ounces/day, and <4 ounces/day versus ≥4 ounces/day were tested with the Student's *t* test. The standard of adequacy used in this study was 100% of the Recommended Dietary Allowance (RDA)[15] for group means. Nutrients/food components selected for focus in this study were energy, protein, fat, saturated fat, carbohydrate, calcium, phosphorous, potassium, vitamin A, vitamin D, folate, ascorbic acid, sugar, and caffeine; beverages can make substantial contributions to intake of these nutrients/food components. Iron intake was also of interest because of the relationship between iron absorption and ascorbic acid intake[16] and because of the reported low iron intakes in many preschool children.[17]

RESULTS

Comparison of Samples

Characteristics of children and mothers in this study with those in the Dennison study[2] are presented in Tables 1 and 2. Both studies included white children (100% in ours versus 97% in Dennison's group), approximately the same ratio of males

TABLE 1. Characteristics of Children

	Our Study		Dennison et al*[2]
	Interview 1 (n = 105)	Interview 2 (n = 104)	(n = 94)
Age range (y)	2.0–2.7	2.3–3.0	2.0–2.9
Gender (% male)	52	54	53
Weight (kg)	13.0 ± 1.7*†[a]	13.9 ± 1.7[b]	13.3 ± 1.6[a]
Height (cm)	88.4 ± 4.0[a]	93.0 ± 4.1[b]	89.0 ± 4.6[a]
Body mass index (kg/m^2)	16.6 ± 1.4[a]	16.1 ± 1.4[b]	16.8 ± 1.4[a]
Ponderal index (kg/m^3)	18.8 ± 1.7[a]	17.3 ± 1.7[b]	18.9 ± 2.1[a]

* Mean ± standard deviation.
† Values with different letter superscripts are significantly different, $P \leq .05$, tested with Student's t test.

to females, and approximately the same number of 2-year-old children. At interview 1, children's mean height, weight, BMI, and PI did not differ statistically from the Dennison sample. Reflective of the slightly older ages of children by interview 2, heights and weights were higher and BMI and PI were lower than at interview 1 and similarly differed from the Dennison sample. Mothers in our study were slightly older and significantly more educated (P = .001) than those in the Dennison study. At interview 1, 12 families (11%) received Food Stamps as did 10 families (10%) at interview 2. Participation in the Women's, Infant's, and Children's Supplemental Food Program was reported by 17 (16%) and 12 (12%) of mothers at interview 1 and 2, respectively. By interview 2, slightly more mothers were employed outside the home (57%) than at interview 1 (50%), and the number of children in day care increased from 45 (43%) at interview 1 to 60 (58%) at interview 2.

Fruit Juice Intake

Mean beverage intakes of children are presented in Table 3. The distribution of fruit juice intakes by interview 1 and 2 is shown in Fig 1. Total juice intakes did not differ significantly by interview or between our study and Dennison's.[2] However, children in our study consumed more milk, soda pop, and other drinks than reported by Dennison et al.[2] These differences seem to follow regional differences reported in nationwide studies.[18] At interviews 1 and 2, 12 (11%) and 15 (14%) children, respectively, consumed ≥12 fluid ounces of juice per day; whereas ~30% had ≤2 fluid ounces of juice each day and ~40% had <4 ounces/day. Fruit juice intakes among children ranged from none to 23.8 fluid ounces/day. The mean percentages of children who consumed various juices at least once during the 3-day period

TABLE 2. Characteristics of Children's Mothers

	Our Study* (n = 105)	Dennison et al[2] (n = 94)
Age (mean, y)	32.2	29.9
Employed (%)	50	51
Education†		
High school (%)	22	42
Some college (%)	41	31
College degree (%)	37	28

* Data from interview 1 only.
† Mothers in our study had more education (P = .001) than those in the Dennison et al[2] study as tested by χ^2 analyses.

TABLE 3. Beverage Intakes of Children

Beverage	Our Study		Dennison et al[2] (n = 94)
	Interview 1 (n = 105)	Interview 2 (n = 104)	
Milk (ounces/day)	12.5 ± 7.6*†[a]	12.2 ± 8.5[a]	9.8 ± 6.1[b]
Fruit juice (ounces/day)‡	5.6 ± 4.9	6.0 ± 5.4	5.9 ± 4.7
Soda pop (ounces/day)	2.7 ± 3.5[a]	3.3 ± 4.2[a]	1.2 ± 1.5[b]
Other drinks (ounces/day)§	3.7 ± 6.4[a]	4.3 ± 5.8[a]	1.9 ± 2.8[b]
Total beverages (ounces/day)	24.5 ± 10.6[a]	25.7 ± 9.7[a]	18.7 ± 8.4[b]
Total beverages (mL/kg/d)	64.7 ± 28.3[a]	63.2 ± 24.0[a]	43.2 ± 20.9[b]

* Mean ± SD.
† Values with different letter superscripts are significantly different, $P \leq .05$, tested by Student's t test.
‡ 100% juice only.
§ Punch, lemonade, juice drinks, etc, excluding water.

were: 57% apple juice, 48% orange juice, and 22% grape juice.

Fruit Juice Intakes and Height

The number of children in each juice intake category at interview 1 (<12 ounces/day vs ≥12 ounces/day) by height percentiles (10th and 25th) are presented in Table 4. Percentages of children in both juice categories with heights <10th percentile at interview 1 were 24%; 43% were below the 25th percentile. No significant association was found between short stature and juice intake level. Additionally, the correlation between height and juice intake was not statistically significant (r = +0.17, P = .09). These analyses indicate that daily fruit juice intake is not related to children's height.

The effects of juice consumption on children's height were further examined using mixed model repeated measures analysis (Table 5). Data from interviews 1 and 2 were included in this analysis. Variables included child's juice category, interview, interview/juice category interaction, age, child's gender, age/gender interaction, and maternal height. There were no significant differences in children's height associated with fruit juice intake category (>12 ounces/day vs ≤12 ounces/day; F = 0.12, P = .73). Children's height was associated with their age (F = 46.03, P = .0001), gender (F = 4.67, P = .03), and their mother's self-reported height (F = 4.38, P = .04). Thus, these data also support the position that fruit juice intake (<12 ounces/day vs ≥12 ounces/day) does not interfere with children's linear growth. All the statistical tests on juice intake and child's stature (height) contradict the findings reported by Dennison et al.[2]

Children's Fruit Juice Intake and Measures of Obesity

The distribution of children by fruit juice intake levels and BMI and PI categories are included in Table 4. As tested by Fisher's exact test there were no significant associations between measures of obesity and the daily fruit juice consumption. Also, juice intake was not significantly correlated with children's weight, BMI, or PI (r = 0.16, 0.05, and −0.02,

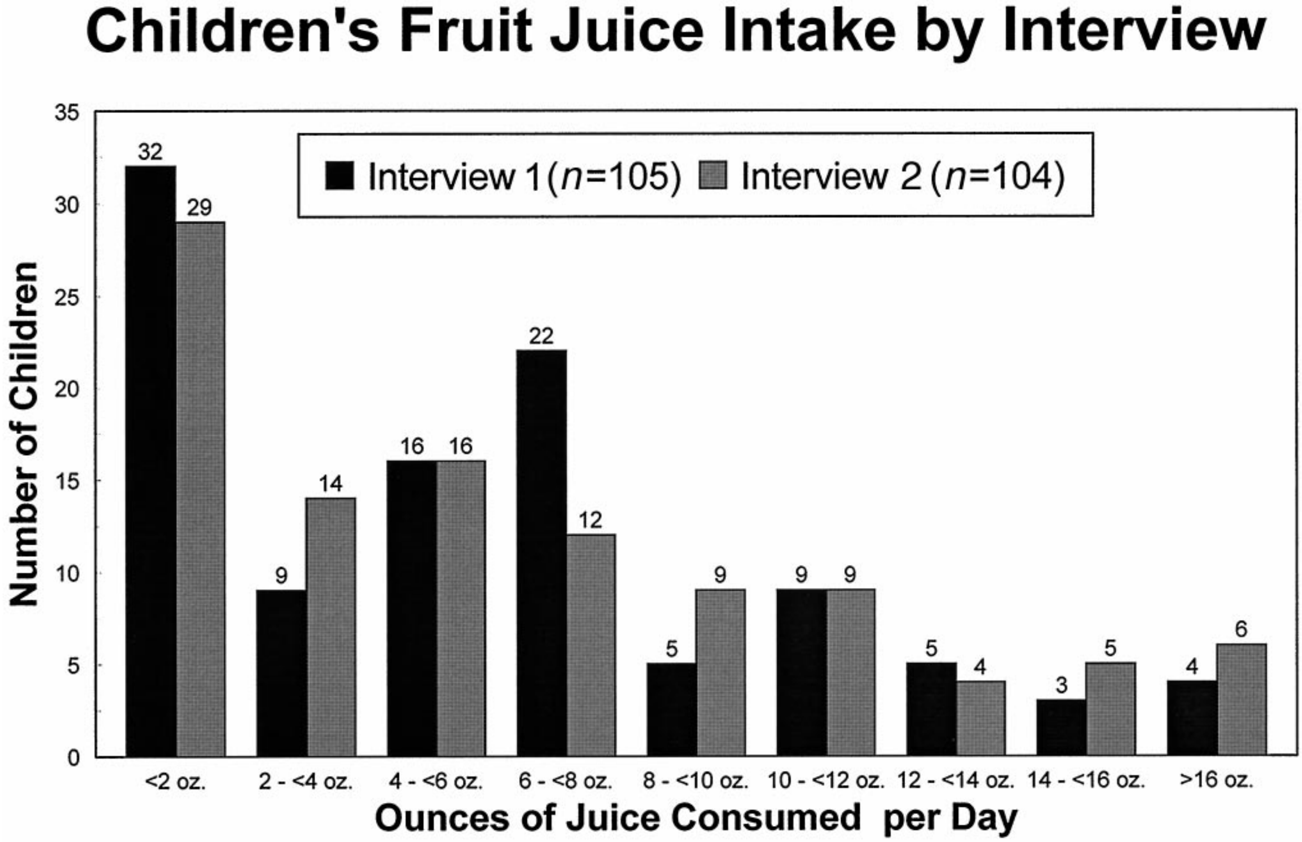

Fig 1. Distributions of children's fruit juice intake (3-day mean) by interviews when children were 24, 28, or 32 months of age (interview 1) and 28, 32, or 36 months of age (interview 2). The same children participated in both interviews.

respectively). There is no evidence that the prevalence of overweight children was higher among children consuming excessive amounts (≥12 ounces/day) of fruit juice.

The Cochran-Mantel-Haenszel test (data not shown) was used to compare children grouped as short versus not short (height <25th percentile) and obese versus not obese (BMI >75th percentile) while controlling for level of fruit juice consumption. No association was found between short stature and either measure of obesity (P = .80).

TABLE 4. Children's Fruit Juice Intakes by Height, Body Mass Index, and Ponderal Index Percentiles at Interview 1*

Growth Percentiles	Fruit Juice Intake		
	<12 Ounces/ day n (%)	≥12 Ounces/ day n (%)	P Value†
Height‡			
≥10	70 (75)	10 (83)	
<10	23 (25)	2 (17)	.73
≥25	52 (56)	8 (67)	
<25	41 (44)	4 (33)	.55
Body mass index§			
<75	66 (71)	7 (58)	
≥75	27 (29)	5 (42)	.51
<90	81 (87)	8 (67)	
≥90	12 (13)	4 (33)	.08
Ponderal index§			
<90	88 (95)	10 (83)	
≥90	5 (5)	2 (17)	.18

* n = 105; children 24 to 32 months of age and 100% juice only.
† Fisher's exact test was used to test for independence of juice intake and each growth percentile; there were no significant relationships, $P \leq .05$.
‡ Height percentiles derived from National Center for Health Statistics data, calculated for children by gender and age; 28 and 32 months, interpreted as 2.5 years, extrapolated from 2- and 3-year data.
§ Obesity percentiles from Hammer et al[13], BMI ≥75, obese; BMI and/or PI ≥90, very obese.

The effects of juice consumption on measures of obesity were further examined using mixed models repeated measures analysis (Table 5). Means for children's BMI and PI were tested for significant differences between juice intake categories (<12 ounces/day vs ≥12 ounces/day) while controlling for child's

TABLE 5. Children's Growth Parameters by Fruit Juice Intake

Parameter	Least Squares Means (±SEM) by Juice Intake		F	Pr > F
	<12 Ounces (n = 93)	≥12 Ounces (n = 12)		
Height (cm)*	90.71 ± 0.30	90.58 ± 0.45	0.12	0.73
Body mass index (kg/m^2)†	16.3 ± 0.13	16.4 ± 0.20	0.66	0.42
Ponderal index (kg/m^3)†	18.0 ± 0.16	18.2 ± 0.26	0.39	0.53

* Model also included interview, interview/juice category interaction, child's age, gender, age/gender interaction, and maternal height; child's age, gender, and maternal height were significant ($P \leq .05$) in predicting child's height.
† Models included interview, interview/juice category interaction, child's age, gender, age/gender interaction, and maternal height and body mass index. There were no significant variables in the models for body mass index; in the ponderal index model, only child's age was a significant variable ($P \leq .05$).

age, gender, age/gender interaction, and maternal BMI and height. There were no significant differences in children's BMI or PI by juice intake. There were no other variables in the BMI mixed model that were significant. Only children's age was related to PI ($F = 9.07$, $P = .003$). No analysis showed a significant association between measures of obesity and children's juice intake. These findings also contradict the report by Dennison et al.[2]

Children's Fruit Juice Intake and Nutrient Intakes

Children's mean nutrient intakes differed by fruit juice consumption for several nutrients, as shown in Table 6. At interview 1, children with ≥12 ounces/day of fruit juice had significantly higher intakes of potassium, folate, and ascorbic acid although both groups (<12 and >12 ounces juice/day) met the recommended intakes for these nutrients. Vitamin D, for which milk is a major dietary source, was higher for the children who had <12 ounces/day of fruit juice but less than the RDA[15] for both groups. Sugar intake was higher in children with ≥12 ounces of juice per day, and caffeine intake was higher in children with <12 ounces of juice per day. Thus, although children's diets were generally adequate compared with the RDA, children with higher juice intakes tended to have greater intakes of potassium, ascorbic acid, and folate, nutrients that are found in juices, and lower intakes of vitamin D for which milk is a major dietary source.

Total fat intake, which varied from 30% to 33% of kcal, and saturated fat intakes, which varied from 11% to 13% of kcal, did not differ by juice intake. These results about fat intake are not in agreement with those reported by Dennison et al.[2] However, mean fat intakes are appropriate for 2-year-old children.[19]

The dietary effects of fruit juice intakes ≥2 ounces/day and <2 ounces/day and ≥4 ounces/day and <4 ounces/day were compared. Of the 105 children, 41 (39%) had juice intake <4 ounces/day and 32 (30%) had <2 ounces/day. The percentage of children in this study with <4 ounces/day of fruit juice was similar to that reported by Dennison et al[2]; slightly more children in our study had <2 ounces/day (30% vs 22%). Potassium, ascorbic acid, and sugar intakes were significantly lower in children with <2 and <4 ounces/day of fruit juice, and caffeine was higher. Folate intake was less with juice intake <4 ounces/day. Mean potassium intake was <1800 mg for children consuming <2 and <4 ounces of fruit juice. The average intake of potassium for children in the United States is 1800 mg.[15] There were no differences in height, weight, BMI, or PI between children with ≥2 ounces or <2 ounces and ≥4 or <4 ounces of juice per day.

Fruit Juice and Milk Intakes

Relatively few children (32 of 105 at interview 1), consumed the recommended 2 cups (16 oz) of milk per day. This amount of milk would provide ~600 mg of calcium (75% RDA) and 5 μg of vitamin D (50% RDA). Although various foods that are popular with children provide additional calcium (eg, yogurt, cheese, ice cream) those foods rarely contribute to the vitamin D content of the diet because they are not produced from fortified milk. In our study, the correlation between juice and milk intake was $r = -0.06$, $P = .32$, indicating that juice did not substitute for milk in the diet. However, soda pop intake was negatively related to intakes of both milk and juice, $r = -0.23$, $P = .0008$ and $r = -0.28$, $P = .0001$, respectively. As tested by t tests, milk intake did not differ by fruit juice intakes of ≥12 ounces/day and <12 ounces/day. Milk intake ≥16 ounces/day was not related to differences in any growth parameter as tested by Fisher's exact test.

TABLE 6. Energy and Nutrient Intakes of Children by Fruit Juice Consumption at Interview 1*

Food Component	RDA†	Daily Fruit Juice Consumption (Mean ± SD)		
		<12 Ounces ($n = 92$)	≥12 Ounces ($n = 12$)	P Value ≤ .05‡
Energy (kcal)	1300	1414 ± 372	1473 ± 261	NS
Protein (g)	16	50 ± 15	52 ± 16	NS
Fat (g)	—	51 ± 17	51 ± 12	NS
(% of kcal)		(32.5%)	(31.2%)	
Saturated fat (g)	—	19 ± 8	18 ± 4	NS
(% of kcal)		(12.6%)	(11.0%)	
Carbohydrate (g)	—	194 ± 57	209 ± 32	NS
Calcium (mg)	800	856 ± 342	827 ± 421	NS
Phosphorus (mg)	800	987 ± 324	976 ± 261	NS
Potassium (mg)	1800§	1860 ± 613	2280 ± 471	.03
Iron (mg)	10	**9.7** ± 4.6	**9.5** ± 1.7	NS
Vitamin A (μg RE)	400	783 ± 522	707 ± 483	NS
Vitamin D (μg)	10	**5.0** ± 3.2	**3.4** ± 1.8	.02
Folate (μg)	50	142 ± 63	188 ± 69	.02
Ascorbic acid (mg)	40	81 ± 63	120 ± 75	.05
Sugar (g)‖	—	75 ± 31	93 ± 16	.006
Caffeine (mg)‖	—	8.3 ± 13.3	1.5 ± 2.9	.0001

* 100% juice only.
† Recommended Dietary Allowances for children, ages 1 to 3 years; bold values are below RDA.
‡ Probability level for significant differences based on juice intake.
§ Average intake for United States children, age 2 years, no RDA.
‖ Not a nutrient, but a food component present in many beverages.

Beverage Intake and Demographic Variables

Mother's education was related to intake of some beverages. At interview 1, other drink intake was 7.3 ± 11.9 ounces/day for children whose mothers had only a high school degree versus 2.6 ± 3.2 and 2.7 ± 3.4 ounces/day for children whose mothers had some college or a college degree ($P = .009$). There was a trend toward less soda pop as the mother's education increased ($P = .10$ at interview 1). Additionally, children's soda pop intake was negatively correlated ($r = -0.25$, $P = .01$) with the ages of both their mothers and fathers at interview 1, but not interview 2. Dennison et al[2] reported that milk and juice consumption did not differ by education of the primary caregiver. However, they also reported that soda pop intake decreased as the primary caregivers' education increased.

DISCUSSION

Results presented in this article contradict the major findings reported by Dennison,[2] which have received considerable attention in the mass media. We found no significant difference in growth parameters between children, 24 to 36 months of age, who were categorized as having excessive fruit juice intake, ie, ≥12 ounces/day and those who were grouped as nonexcessive, ie, <12 ounces/day as suggested by Dennison.[2] Following the statistical procedures used by Dennison et al, we also used Fisher's exact test to test for the independence of height (by 10th and 25th percentiles) and juice intake and the independence of BMI (by 75th and 90th percentiles) and PI (90th percentile) and juice intake. No significant associations were found between juice intake and any of the grouped growth parameters. Thus, we conclude that there is no prevalence of obesity and/or stunted stature in children who consume 12 ounces or more of fruit juice daily. This conclusion is supported by the Cochran-Mantel-Haenszel test reported.

Mixed models repeated measures analysis was used to test the effects of fruit juice intake on child's height and two measures of obesity, BMI and PI. Statistical adjustments were made for maternal height, child age, child sex, child age-sex interaction in one set of models. A second set of models added maternal BMI while retaining all the original adjustment factors. None of the models developed for these analyses found a significant difference in any of the growth parameters between the two juice intake groups. The results of these analyses are considerably more powerful than results reported for the nonparametric tests performed. However, conclusions drawn from the two methodologies are extremely consistent. Juice intake is not related to growth as measured by height nor to measures of obesity in these young children.

Neither our study nor Dennison's included paternal height or BMI measures in any analyses. Obviously, this is a weakness of both studies.

Fruit juice can contribute significantly to the intake of several important nutrients, such as ascorbic acid, folate, and potassium.[5] In this study, fruit juice did not seem to substitute for milk, which is important in the diets of young children for its calcium, protein, riboflavin, and vitamin D content. However, intakes of both fruit juice and milk were negatively related to soda pop intake, which is a questionable beverage choice for preschool children.

We do not believe that any 2-year-old child should be labeled obese or very obese because of psychological implications for the child and because young children's growth is highly variable. It is well known that children's growth, as well as childhood obesity, are affected by a myriad of genetic and environmental factors. Although ingestion of excessive amounts of any food may have negative results, intuitively it seems unlikely that amounts as small as 12 ounces/day of a nutritious, low-energy dense food such as 100% fruit juice would cause stunting and/or obesity in otherwise healthy children. Results of this study confirm that notion.

CONCLUSIONS

Health professionals are well aware of the dangers of making dietary recommendations for the general population based on a single study. The lack of agreement between two studies in groups of children with many similarities, ie, juice intake, race, age, and size of sample has broad implications. First, some professionals have recommended limiting fruit juices based only on the Dennison et al[2] study. Mothers will likely comply without questioning the appropriateness of such a recommendation for an individual child. Second, the popular media has echoed limiting fruit juice for children. Unfortunately, results presented in this article, which contradict the findings of the earlier article,[2] may not receive the same media attention because they do not suggest an easy, simple solution to childhood obesity and/or growth retardation. Obviously, additional studies on a broad spectrum of children are needed to resolve the controversies on children's fruit juice intake. Until that time no recommendations should be made to change or limit children's fruit juice intake. If other studies confirm the lack of association between growth parameters and fruit juice intake, how long will it take to convince the public that fruit juice intake is not related to obesity or short stature?

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THE GULF BETWEEN DOCTOR AND PATIENT

Practically every development in medicine in the post-World War II period distanced the physician and the hospital from the patient and the community, disrupting personal connections and severing bonds of trust. Whatever the index—whether ties of friendship, religion, ethnicity, or intellectual activity—the results highlight a sharp division between the lay world and the medical world. By the 1960s the two had moved so far apart that one could have asked a lay audience about the last time they spoke to a physician and had their clothes on, and they would have been unable to remember an occasion.

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Submitted by Student