Research Brief

Juice Displaces Milk and Fruit in High School Lunches

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ABSTRACT

Objective: To compare beverages and foods selected by high school students on days when juice was offered (juice days) and not offered (non-juice days) with the reimbursable school meal.

Methods: Lunch register data from 386 days across 3 low-income Northeast high schools were used to compare juice and non-juice days for average daily selections of meal components and *à la carte* water and 100% juice sales.

Results: On juice days, 9.9% fewer milks ($P < .01$) and 7.4% fewer fruits ($P < .01$) were selected with lunches. In addition, on juice days, 8.2% fewer bottles of water and 24.4% fewer bottles of 100% juice were sold *à la carte* ($P < .05$).

Conclusions and Implications: Reducing juice availability in the reimbursable school lunch may increase selection of milk and fruit. Future research is warranted to assess how juice availability influences selection of milk, fruit, and water across a range of student populations.

Key Words: 100% juice, fruit, high school, milk, *National School Lunch Program* (*J Nutr Educ Behav.* 2018;000:1−6.)

Accepted September 26, 2018.

INTRODUCTION

School food programs receive considerable attention as a setting to address obesity and improve diet quality among US children.[1] The *National School Lunch Program* (NSLP) reaches >30 million students, providing an unparalleled opportunity to improve diet quality among the nation's youth.[2] Because high school students consume inadequate levels of many nutrients,[3] including calcium, vitamin D,[4] and fiber,[5] foods rich in those nutrients (milk, fruit, and vegetables) warrant attention. Current school lunch standards require schools to offer at least 2 milk varieties daily;[6] students to select >1 fruit or vegetable serving with each reimbursable school meal; and schools to use 100% juice (hereafter referred to as juice) for no more than half of fruit offerings in the reimbursable meals each week.[7]

There is little doubt that fruits, vegetables, and dairy served in the school lunch are part of a healthy diet.[8] However, the appropriate role of juice in children's diets has generated debate. In 2017, the American Academy of Pediatrics published recommended limits on juice consumption, noting that children aged 7−18 years should consume ≤8 oz daily.[9] The rationale for limiting juice is its high levels of sugar, low fiber, and some evidence suggesting an association with adverse health outcomes.[5,10] Most nutrition researchers agree that whole fruit is nutritionally superior to juice because it contains more fiber and is less energy dense.[9,11] Proponents of juice argue that it helps children achieve fruit intake recommendations and warn that limiting it will reduce vitamin C, folate, and potassium intake.[12]

Proponents of juice also argue that it does not compromise whole-fruit intake;[12] however, this has not been tested in the school meal setting. A recent study[6] found that when juice was unavailable, elementary and middle school students were more likely to select and consume milk at lunch. It is unknown whether older children will respond the same way.

The primary research question of this study was whether high school students would select different meal components on days when juice was or was not available with the reimbursable school meal. The hypothesis was that students would select less fruit and milk when juice was available as part of the meal. A secondary research question was whether juice availability influenced *à la carte* juice and bottled water sales in the cafeteria at mealtime. The second hypothesis was that when schools offered juice, both *à la carte* juice and water sales would be lower.

The study focused on a low-income, ethnically diverse population because the highest rates of calorie consumption from beverages nationally (including sugar-sweetened beverages and juice) are found among minority populations.[13] In addition, low-income and minority children are at higher risk for obesity compared with higher-income and white children,[14] and calories from such beverages, including juice, have been associated with increased odds of obesity.[15,16]

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Conflict of Interest Disclosure: The authors have not stated any conflicts of interest.

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https://doi.org/10.1016/j.jneb.2018.09.013

METHODS

Sample/Setting

Three traditional high schools in an urban Northeast school district were recruited to participate in the study. These schools represented 81% of the total high school population in the city. Schools offered free meals to all enrolled students under the NSLP Community Eligibility Provision. School enrollment ranged from 1,177 to 2,140 students. All schools used the same electronic point-of-sale register system (3–5 registers/school) to track reimbursable meal components selected and *à la carte* items purchased. Students in these schools had limited access to foods and beverages available outside the school meal program. None of the schools had vending machines during the study and students could not obtain lunch off-campus. Daily itemized transaction data were collected from September, 2013 to June, 2014. The Yale University Institutional Review Board approved procedures and data collection.

Procedure

Posted lunch menus were used to classify days as juice and non-juice days. Cupped or chilled whole fruit was offered every day and juice was offered in addition to the fruit on 3 d/wk. Days when only fruit was offered (typically Mondays and Fridays) were considered non-juice days. Days when both fruit and juice were offered (typically Tuesdays, Wednesdays, and Thursdays) were considered juice days.

During data cleaning, a small number of juices appeared on some registers on non-juice days. In 1 school, juice appeared on 1 register on 12 non-juice days (<65 served/d). School food service managers confirmed that this register was used only for special event sales, special needs students, and extended serving times. Data collected from this register were excluded from all analyses. A small number of juices (<20 served/d) were recorded on days classified as non-juice days on other registers (47 days at school 1, 20 days at school 2, and 28 days at school 3). These may have been juices served out of compliance or register errors for *à la carte* juices sold to students or teachers. These days were retained in the analyses and classified as non-juice days. A Pearson chi-square test for independence confirmed no association between school and the number of non-juice days on which a small quantity of juices was served ($\chi^2 = 2.89$; $P = .24$).

Outcome Measures

Outcome measures included daily milk and fruit servings selected with the school meal and daily *à la carte* sales of bottled water and juice. The number of entrées and vegetable sides served daily was assessed to ensure that meal participation did not differ between juice and non-juice days. Meal component servings were compliant with the Final Rule on Nutrition Standards for the US Department of Agriculture NSLP for grades 9–12.[17] A fruit serving was 1 cup (8 oz) of fruit or juice, and 1 milk serving was 1 cup. An entrée was a combination food containing 2-oz equivalents of meat/meat alternates and 2-oz equivalents of grain; a combination food containing 2 oz of meat/meat alternate and 1 cup fruit or 1 cup vegetable; or a meat/meat alternate alone, excluding yogurt, low-fat or reduced-fat cheese, nuts, seeds, or nut or seed butters.[18] *À la carte* bottled water was sold in 16.9-oz bottles, and *à la carte* juice in 10-oz containers.

Data analysis

The difference in the proportion of students by race/ethnicity across the 3 schools was assessed using a Pearson chi-square test for independence. Average daily juice, milk, and fruit servings and *à la carte* sales of juice and bottled water were compared using unpaired *t* tests accounting for an unequal number of days between juice and non-juice days. Average daily entrées and vegetable sides served were compared in the same way. Multiple linear regression was used to compare juice and non-juice days for the following outcomes (the dependent variable in each model): average daily fruit servings, average daily milk servings, sales of *à la carte* juice, and sales of *à la carte* bottled water. The explanatory variable of interest in the regression model was a binary variable indicating whether the day was a juice day (= 1 if juice day; = 0 otherwise). The multiple linear regression model included school fixed-effects, which accounted for characteristics unique to each school that might bias regression results. Fixed-effects are a standard econometric approach in multiple linear regression analysis to capture and control for variability owing to otherwise uncontrolled characteristics of an entity.[19] The regression models also contained covariates, including a continuous variable indicating total daily entrées served and a continuous variable indicating total daily vegetable sides served. A categorical variable indicating the type of entrée served each day (37 distinct entrée types coded across all 3 schools) was also included as a covariate. Data analysis was completed in Stata (version 15.1/SE, StataCorp LP, College Station, TX, 2017).

RESULTS

The final analysis sample included 386 days (241 juice days and 145 non-juice days) across the 3 schools. There was no statistical difference in the number of days included per school ($\chi^2 = 3.03$; $P = .22$). Table 1 reports the percentage of students by racial/ethnic group and eligibility for free or reduced-priced school meals by school. There were no significant differences in the proportion of students from minority ethnicities or the share of students eligible for free or reduced-priced school meals across schools.

There was no difference in entrées served on juice and non-juice days (difference in mean, 4.4; 95% confidence interval (CI), −46.0 to 54.9; $t = 0.174$; $P = .86$). Average

Table 1. Total Student Enrollment, Racial/Ethnic Composition, and Eligibility for Free School Meals at 3 Traditional Urban Northeast High Schools

	School 1	School 2	School 3	Pearson χ^2 (*P*)
Total student enrollment, n	1,177	2,140	1,297	–
Racial/ethnic composition of students (%)				
Black or African American	44.6	44.5	41.5	5.89[a] (.44)
Other race[b]	0.8	1.3	0.4	
Hispanic	44.9	39.4	51.7	
Asian	3.8	3.4	0.5	
White	5.9	11.4	5.9	
Students eligible for free meals (%)[c]	100	100	100	–

[a]Pearson chi-square test for independence was used to determine whether the percentage of students by racial/ethnic groups was significantly different across the 3 schools in the study; [b]Other race includes American Indian or Pacific Islander students and students who reported being ≥2 races; [c]The school district for these 3 schools was eligible for universal free school meals under the US Department of Agriculture Community Eligibility Provision, making all students at these schools eligible for free school meals.

daily vegetable sides served on juice and non-juice days were not significantly different (difference in mean, 14.6, 95% CI, −3.4 to 32.6; $t = 1.594$; $P = .11$).

Table 2 reports unadjusted average daily fruit and milk servings and *à la carte* sales of juices and bottled waters on juice and non-juice days. On average, 8.6% fewer milk servings were served on juice days compared with non-juice days ($P = .03$). Likewise, on average, 8.8% fewer fruit servings were served on juice days compared with non-juice days ($P = .05$). Average *à la carte* sales of bottled water and juice were lower on juice days compared with non-juice days ($P = .01$).

Multiple linear regression results comparing outcome measures on juice and non-juice days, adjusted for school unobservable characteristics, number of entrées offered per day, and entrée type offered, are reported in Table 3. Unadjusted results in Table 2 comparing non-juice and juice days were robust to control variables included in the multiple linear regression model. On average, 9.9% fewer reimbursable milks and 7.4% fewer fruit servings were served on juice days compared with non-juice days ($P < .05$). *À la carte* sales of bottled water and juice were significantly lower ($P < .05$) on juice days compared with non-juice days.

DISCUSSION

This was a novel study showing the relationship between juice availability in the school meal program and student selection of milk and fruit, and *à la carte* sales of bottled water and juice. Study findings indicated that when juice was available as part of the reimbursable school meal, a significant number of high school students readily substituted it for fruit and milk. This is consistent with a prior study among elementary and middle school students; when juice was not available, students were more likely to select and consume milk at lunch.[6] The nutritional impact of this substitution pattern is important. An 8-oz serving of low-fat (1%) milk has 102 cal, 12.7 g sugar, 2.9 μg vitamin D, 305 mg calcium, and 366 mg potassium.[20] By comparison, an 8-oz serving of 100% apple juice has 114 cal, 24 g sugar, no vitamin D, 20 mg calcium, and 250 mg potassium.[20] Furthermore, 1 cup of fruit has 1.1−5.1 g of fiber[21] whereas juice contains no fiber. In light of the nutritional deficiencies documented for US adolescents, on balance, milk and fruit are more nutrient-dense choices than juice.[22]

The finding that *à la carte* bottled water sales were higher on non-juice days suggests that some students will choose to buy water when juice is not available with the school meal. Increasing water intake is a positive dietary outcome in light of concerns that most US youth do not reach the recommended daily intake of water,[23] and the 2015−2020 Dietary Guidelines for Americans clearly recommend water as a primary beverage.[8] On the other hand, it is curious that students are spending money on bottled water when the 2010 Healthy Hunger Free Kids Act requires it to be available for free in the cafeteria.[24]

Although this study provides important new evidence about how juice availability is associated with food and beverage choices among low-income, ethnically diverse high school- aged children, it had limitations. The data were limited to daily register data and the specific components selected with each reimbursable school lunch were not known. In addition, the findings were based on foods purchased or provided, not food consumption. Notably, plate waste has been a concern in the NSLP.[25] Although the average effect size of juice availability on servings of milk, fruit, and water was only 7% to 10%, these changes could be substantial if multiplied across the country every school day. Despite these limitations, this study provides evidence regarding how juice availability in school influences food and beverage choices among high school children participating in NSLP.

Table 2. Comparison of Average Daily Milk, Juice, and Fruit Servings, and *à la Carte* Sales of 100% Juice and Bottled Water on Juice and Non-juice Days at 3 Traditional Urban Northeast High Schools

	Non-juice Days (n = 145) (mean [SE])	Juice Days (n = 241) (mean [SE])	Difference: Juice – Non-juice Days (95% Confidence Interval)	t[a]	P[a]
Daily reimbursable juice servings offered	2.4 (0.3)	376.0 (9.1)	373.6 (355.7 to 391.5)	41.15	< .001
Daily reimbursable milk servings offered	636.8 (18.3)	586.2 (14.9)	−50.6 (−97.0 to −4.3)	2.15	.03
Daily reimbursable fruit servings offered	702.2 (21.5)	645.5 (18.1)	-56.7 (−111.9 to −1.4)	2.02	.05
Daily bottled waters sold	27.9 (1.1)	24.6 (0.8)	-3.4 (−6.0 to −0.7)	2.50	.01
Daily *à la carte* juices sold	80.7 (2.5)	67.6 (2.0)	-13.1 (−19.4 to −6.8)	4.10	.001

[a] *t* statistics and *P* reported for 2-sample *t* test with unequal variance used to compare average daily milk and fruit servings and *à la carte* juice and bottled water sales juice and non-juice days.

Notes: Data from cafeteria register transactions during school year 2013–2014 were used to calculate daily means.

IMPLICATIONS FOR RESEARCH AND PRACTICE

As noted earlier, the American Academy of Pediatrics recently created recommendations for daily juice consumption.[9] Ensuring that US children consume no more than the recommended juice amounts while promoting adequate intake of milk and fruit requires a comprehensive examination of juice access both in and out of schools. Future research can examine dietary intake from school lunches (mainly sugar, calcium, and fiber) on juice and non-juice days and assess the financial implications of a policy to remove or further limit juice availability in school meals and as a competitive food. The approach used in this study could be replicated in schools with different socioeconomic and demographic profiles. Moreover, future research is warranted to examine how cafeterias have implemented the 2010 HHFKA requirement to provide free water for students.

If further research confirms that juice displaces milk and fruit in the school meal, the role of juice in the program may warrant reevaluation. A policy to further limit juice availability frequency or serving sizes, or to remove it from schools entirely, may help children stay below the American Academy of Pediatrics juice consumption limit. Simultaneously, this could increase milk and fruit consumption among US children when they eat lunch at school. Behavioral economics interventions such as *Smarter Lunchroom Movement*[26] strategies could be used to promote milk, fruit, and water over juice without removing juice from school meals altogether.

ACKNOWLEDGMENTS

This research was funded by the *Healthy Eating Research Program* of the Robert Wood Johnson Foundation (No. 70740). The Robert Wood Johnson Foundation had no role in the design, analysis, or writing of this article. The authors thank Kathryn Henderson, Henderson Consulting.

Table 3. Average Difference in Daily Milk and Fruit Servings, and Daily Bottled Water and *à la Carte* Sales on Juice and Non-juice Days Multivariate linear regression used to control for school characteristics, entrée type, and total number of entrees served.

Parameter	Daily Milk Servings Coefficient	Daily Milk Servings (95% CI)	Daily Fruit Servings Coefficient	Daily Fruit Servings (95% CI)	Daily Water Bottles Sold Coefficient	Daily Water Bottles Sold (95% CI)	Daily *à la Carte* Juices Sold Coefficient	Daily *à la Carte* Juices Sold (95% CI)
Intercept	25.86	(−75.73 to 127.45)	73.43*	(−5.07 to 151.93)	32.72**	(21.92 to 43.52)	56.51**	(36.09 to 76.92)
Juice day (reference is non-juice day)	−58.20**	(−82.55 to −33.85)	−47.45**	(−69.86 to −25.04)	−2.67*	(−5.15 to −0.20)	−13.77**	(−19.31 to −8.23)
Control variables								
School 1 fixed effect[a]	−9.39	(−80.31 to 61.53)	−108.02***	(−182.09 to −33.94)	−17.71***	(−29.94 to −5.48)	−38.05***	(−51.04 to −25.07)
School 2 fixed effect[a]	16.20	(−35.73 to 68.12)	−55.04**	(−97.50 to −12.58)	−16.18***	(−21.23 to −11.12)	−15.59***	(−26.15 to −5.03)
Number of entrees served	0.84***	(0.73, 0.94)	0.90***	(0.83, 0.98)	0.01	(−0.00, 0.02)	0.05***	(0.03, 0.07)
Entrée type dummy variables included[b]	Yes		Yes		Yes		Yes	
Model R^2	0.87		0.92		0.59		0.63	
Model R	0.93		0.96		0.76		0.79	
Observations	386		386		386		386	

CI indicates confidence interval.

[a]School 3 is the reference school; [b]Entrée type dummies are binary covariates (0 or 1) indicating the type of entrée served each school day. Across the 3 schools in the study, 37 distinct entrée types were identified; 36 entrée dummy variables were entered into each model. Coefficients and their 95% CIs for the 36 dummy variables are omitted from tables for clarity; $^{*}P < 0.10$; $^{**}P < .05$; $^{***}P < .01$.

Notes: Data were obtained from cafeteria registers in 3 traditional urban Northeast high schools during school year 2013–2014. Multiple linear regression analysis was used to control for school characteristics, entree type, and total number of entrees served. Robust SEs were used to account for heteroscedasticity in all models. Coefficients and their 95% CIs are reported for all model variables.

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