De-Fizzing Schools: The Effect on Student Behavior of Having Vending Machines in Schools

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In recent years, many researchers have sought to measure the effects of adolescent soft drink consumption due to a suspected link with childhood obesity and other negative health outcomes. While most studies in the existing literature have focused on physical health outcomes, the current study seeks to analyze how providing soft drinks in vending machines affects adolescent in-school behavior and academics. The data for this analysis comes from a school district in which a subset of schools prohibited the sale of soft drinks in vending machines. Using this subset of schools as a treatment group, students at the treatment schools are compared with students at the schools that did not change their vending machine policies. A difference-in-differences estimation shows that the number of times a student was tardy to class decreased significantly at the treatment schools. Students also were less likely to be referred to the principal's office for behavior problems following the policy change. These results suggest that policies directed toward restrictions on soft drinks in school vending machines might improve behavioral outcomes for students.

Key Words: vending machines, student behavior

The way in which schools provide meals and snacks has recently come under scrutiny due to the increased prevalence of childhood obesity. Since 1980, childhood obesity has more than tripled. The prevalence of obesity in 12- to 19-year-olds went from 5 percent to 18 percent between 1980 and 2008, and more than one-third of adolescents are now considered overweight or obese (Centers for Disease Control and Prevention 2011). In response to the increased prevalence of adolescent obesity, the Child Nutrition and WIC Reauthorization Act of 2004 required schools participating in federal school meal programs to enact a wellness policy that was intended to (among other things) encourage schools to create nutritional guidelines for their food services. The American Academy of Pediatrics also addressed the availability of soft drink beverages in schools in 2004 by issuing a statement detailing the health risks associated with a high intake of sweetened drinks (American Academy of Pediatrics 2004). Their recommendations were straightforward: sweetened beverages should no longer be provided in schools, and in their place schools should offer real fruit and vegetable juices, water, and plain low-fat or flavored milks. As a result of these policies and recommendations, many schools began to create wellness programs targeted at the regulation of within-school vending machine soft drink sales.

For example, in 2004 the School District of Philadelphia prohibited the sale of soft drinks within its schools and required juice beverages to contain at least 25 percent real fruit juice. The New York City School District signed an exclusive deal to replace all soft drink beverages with Snapple beverages made from 100 percent fruit juice in all the schools in the district, and the Los

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Angeles Unified School District instituted a restriction on soda sales in elementary and middle schools. More recently, federal and state governments have enacted similar measures targeting within-school soft drink sales. The re-authorization of the Child Nutrition Act in 2010 gave the federal government the authority to establish nutritional guidelines for food and drinks sold on school grounds, including vending machines. In March 2011, Massachusetts passed a bill banning the sale of junk foods in schools, most notably soft drinks and chocolate milk. Other states, including Arkansas, California, Connecticut, and Texas, have also passed statewide laws restricting the sale of soft drinks in schools (Booth-Thomas 2004, National Conference of State Legislatures 2005, Burros and Warner 2006).

There are multiple studies in the existing literature analyzing the effects of soft drink consumption on adolescent physical health outcomes such as obesity (Levy, Friend, and Wang 2011, Fletcher, Frisvold, and Tefft 2010a, Fletcher, Frisvold, and Tefft 2010b, Powell, Chriqui, and Chaloupka 2009, Malik, Schulze, and Hu 2006). However, few studies to date have examined possible links between soft drink consumption and behavioral or academic outcomes. Those studies that have examined behavioral and academic outcomes have focused more on the effects of the school food environment in general rather than specifically on the availability of soft drinks. For example, Kleinman et al. (2002) found that increasing the availability of school-sponsored meals increased school attendance, decreased the number of times a student was tardy to school, and improved student behavior. Several studies have also examined the relationship between food environment and academic achievement. A two-year intervention—discussed in Hollar et al. (2010)—aimed at improving nutrition, curricula, and physical activity showed that students experienced a significant increase in math test scores. The results of Hollar et al. (2010) were supported by the findings of Kleinman et al. (2002), which suggests a positive relationship between availability of school meals and increases in math test scores. Finally, in an examination of high stake testing, Figlio and Winicki (2005) found a significant positive relationship between caloric intake at lunch and short-term cognitive performance.

One study to date—Lien et al. (2006)—has examined the association between soft drink consumption and student behavior. Using a "Strengths and Difficulties Questionnaire" to measure conduct problems among Norwegian youth, the authors found that adolescents who consumed more than 3 servings of soft drinks per day were more likely to have conduct problems. They claimed to find only an association between consumption of soft drinks and behavioral outcomes, and acknowledge the need to explore the causal relationship further.

The objective of the current study is to add to the existing literature by examining whether policy changes directed at prohibiting soft drinks from vending machines have an effect on in-school behavioral and academic outcomes for adolescents. In order to analyze this, the present study relies on a quasi-natural experiment from a suburban school district in the western United States. The school district allows its schools to contract individually with suppliers and determine which vending services to provide. After the 2006–2007 school year, administrators at two junior high schools decided to prohibit soft drink sales in vending machines and provide only sports drinks, juices, and flavored milk. The present study attempts to analyze the effect of students' behavior at these two schools as compared with the behavior of students at the twelve remaining junior high schools, where soft drinks could still be purchased. The present data contain two measures of student behavior: the number of times a student is tardy to class and the number of in-school behavioral referrals.

Results of this study indicate that the schools in which soft drinks were taken out of vending machines experienced a relative decrease in the number of times students were tardy to class compared with schools that continued to sell soft drinks. There was also a significant drop in the number of in-school behavioral referrals for both schools that removed soft drinks, indicating that the policy change had a positive impact on improving student behavior. The results of this study also support previous research suggesting a positive correlation between improvements in the school food environment and increases in test scores, as slight increases in math scores on standardized tests occurred following the removal of soft drinks from vending machines.

Data

The data for this study come from administrative records from junior high schools in a large suburban school district in the western United States. The data follow over 7,400 students who were in the seventh or eighth grade during the 2006–2007 school year into the 2007–2008 school year.[1] There are 17 junior high schools (seventh through ninth grades) in the district. The school district provided administrative data which contain student demographic characteristics such as race, gender, age, whether or not a student is identified as receiving special education, whether the student participates in an English as a Second Language (ESL) program, and whether the student receives free or reduced-price lunch. The data also contain measurements of in-school behavior such as the number of times a student was tardy to class. Tardies were reported by individual teachers to the school administrators and recorded as total number of times a student was tardy to class in each academic year. They do not report when each tardy occurred. The data also include the total number of in-school behavioral referrals during the 2006–2007 and 2007–2008 academic school years.

Supplemented with the administrative data from the school district are school characteristics that are reported in the Common Core of Data (CCD), including the number of students and the student-teacher ratio at each school. Additionally, each student in the school district takes a state-issued standardized test known as the Criterion-Referenced Test (CRT). This test is offered at the end of the academic year and is administered in three subjects: language arts, math, and science. Scores range from 130 to 200 and are standardized, with a state mean of 0 and a standard deviation of 1. Therefore, each student in the dataset has a CRT score in each academic subject for both 2007 and 2008.

Beginning with the 2007–2008 school year, administrators at two junior high schools in the district implemented a policy that prohibited the sale of soft drinks in vending machines. One school provided sports drinks, juices, and milk (including chocolate and strawberry flavored) after the change and the other school provided only juice and flavored milk. These two schools are labeled as the treatment schools, and the 12 junior high schools that continued to provide soft drinks in vending machines are labeled as the control group. Prior to the 2006–2007 school year, two schools in the district had already stopped providing soft drinks in vending machines, and they were dropped from the sample, as well as a small alternative junior high school with only 33 students enrolled.

There were noteworthy differences in observable characteristics between the 824 students attending the treatment schools and the 6,582 students attending the control schools in the period before soft drinks were removed from vending machines. As shown in Table 1, in the pre-period the treatment schools had significantly smaller student bodies than did the control schools. Treatment schools had a lower fraction of minority students than did the control schools, and control schools contained a greater number of Hispanic students. The racial composition of both the treatment and control schools in this study are not necessarily nationally representative. Compared with a nationally representative survey (Early Childhood Longitudinal Study, Kindergarten Cohort), minority groups seem to be underrepresented.

There were stark differences in the behavior and academic achievement between the treatment and control schools in the pre-treatment period. Students at treatment schools averaged 1.59 fewer tardies per student per year as compared with control schools. The average number of disciplinary referrals per student was slightly greater at treatment schools (1.28 compared to 1.14), though this difference is marginally significant at the 10 percent level. Students at treatment schools had significantly higher scores in language arts, math, and science standardized tests. Test scores at control schools were near the state mean (test scores are scaled at a state mean of 0), but scores at treatment schools were significantly higher than the state mean. Part of this difference could be explained by the resources available to each school, as the treatment schools have a student/teacher ratio significantly lower than the control schools.

In addition to the administrative data that was collected as part of the present study, a brief survey was also administered to principals to gauge their views regarding school vending machines.

[1] Students who did not re-enroll in the same school were dropped from the analysis, as were students enrolled only in the 2007–2008 school year.

Table 1. Summary Statistics

	Full Sample	Treatment	Control	
Variable	Mean	Mean	Mean	p-value
Male	0.515	0.504	0.517	0.479
White	0.860	0.882	0.857	0.049
Hispanic	0.077	0.055	0.080	0.011
Other	0.063	0.063	0.063	0.978
Special education	0.062	0.066	0.062	0.666
Free/reduced-cost lunch	0.199	0.199	0.199	0.992
ESL	0.040	0.045	0.040	0.470
Size of student body	1036.31	1072.32	748.69	0.000
Student/teacher ratio	20.1	19.8	22.8	0.000
Number of tardies	12.15 [17.15]	9.83 [13.66]	11.42 [16.93]	0.009
Referrals	1.23 [2.37]	1.28 [2.41]	1.14 [2.33]	0.096
Language arts score	0.016 [0.973]	0.126 [0.988]	0.007 [0.984]	0.001
Math score	0.008 [0.992]	0.220 [1.041]	-0.019 [0.985]	0.000
Science score	0.004 [0.980]	0.286 [1.001]	-0.021 [0.984]	0.000
N	7,406	824	6,582	

Note: Standard errors are in brackets.

Principals were asked to record the amount of revenue they receive from providing vending machines in schools. For those who completed the survey, revenue from contracts for vending services brings in almost $16,000 per year per school, indicating that this can be a substantial amount of money for some schools.

Method

To estimate the effect of the sale of soft drinks on student behavior and academic achievement, a difference-in-differences approach is implemented. The treatment group is defined as those students who attended one of the two junior high schools that prohibited soft drinks in vending machines. The post period is defined as the 2007–2008 academic year, which is the year that the policy restricting soft drinks in vending machines took effect in the treatment schools.

The empirical model is represented with the following equation:

$$Y = \beta_0 + \beta_1 \text{Treatment} + \beta_2 \text{Post} + \beta_3 \text{Treat} \times \text{Post} + X'B + \varepsilon,$$

where Y is one of the three outcomes of interest: number of tardies, number of referrals, and standardized scores on the CRT exams. The vector **X** contains observable characteristics of the individual student, including race, gender, free or reduced-priced lunch, and English as a second language.

The difference-in-differences identification strategy used in this study accounts for the differences between the treatment and control in the pre-

period, but relies on the identifying assumption that the trends in the pre-policy period of the control and treatment schools are similar. Since the data only goes back to one school year before the policy, it is assumed that the trends between the treatment and control schools were similar. Admittedly this is a strong assumption, but due to the limitation of the data it cannot be explicitly tested. With this assumption, the differences between the treatment and control schools would have continued to persist at the same rate after the treatment. Therefore, the coefficient on the interaction term between treatment and post (β_3) identifies the effect of removing soft drinks from vending machines on the outcomes of interest.

As noted in Table 1, students at treatment schools received fewer tardies on average than students at control schools, but they received slightly more behavior or disciplinary referrals. It is important to note that within a school there may be different policies regarding how tardies and behavior referrals are recorded. A limitation to the current data is that tardies and referrals are measures aggregated over the academic year, so it is not possible to know what time of day the referral was issued or which teacher reported it. However, this reporting will not introduce bias into the model as long as the policies of reporting did not change within a school over the short time period being observed in the data. Surveys of the principals did not reveal any policy changes directed at tardies or referrals, so it is not believed that this will introduce bias into the estimation.

Results

First, students at the treatment schools averaged 1.59 fewer tardies per year than students at the control schools during the 2006–2007 school year (see the first column of Table 2). The coefficient on the interaction between treatment and post provides the effect of the change in policy on the treatment schools and shows that the average number of tardies at treatment schools decreased by almost 2.5 per student per year. The point estimates are unchanged when including other observable characteristics of the individual students (see column 2 of Table 2). These results suggest that prohibiting the sale of soft drinks in vending machines significantly reduces the number of times students arrive tardy to class.

Anecdotally, on the survey that was administered to the principals, one principal mentioned that students often form a queue behind the vending machine and try to make purchases after the bell indicating the end of lunch has rung, thus causing them to show up late for their next class. Cullen et al. (2008) found that when sugar-sweetened beverages, including soft drinks, were removed from vending machines in schools, the sale of other vending machine items also decreased. Wiecha et al. (2006) also found that 70 percent of students who buy products out of vending machines purchase soft drinks. Therefore it can reasonably be assumed that removing soft drinks from vending machines might reduce the number of times students were tardy to class.

In addition to reducing tardies, results also indicate that removing soft drinks from vending machines reduced the number of behavioral referrals. Column 3 of Table 2 indicates that students received an average of 0.34 fewer behavioral referrals per year after soft drinks were taken out of vending machines. The point estimate is robust when accounting for student characteristics. While the point estimates are statistically significant, it is important to note that little of the variation of both measures of student behavior is explained with the included variables, as evidenced by the low R-squared statistic.

Based on consistent findings in previous research linking overall food environment to improvements in academic achievement, in this study principals were surveyed to gain insight into possible effects that vending machines might have on academic performance. One principal recorded in the survey, "Generally speaking we see positive gains." Another reported, "When we quit using vending machines, students became more focused on school & academics." Other principals responded, "not really," "no," and "no observable differences." Table 3 presents the results examining the effect of removing soft drinks from vending machines on standardized test scores in three subjects: language arts, math, and science. As noted, student scores at treatment schools in the pre-period are significantly higher than those at the control schools in all three subjects. Consistent with previous findings, the only significant change that occurred as a result of removing soft drinks from vending machines was that students at the treatment schools experienced an increase

Table 2. Regression Results on the Effect of Behavior

	Number of Tardies		Number of Referrals	
	(1)	(2)	(3)	(4)
Treatment	-1.593**	-1.350**	0.144	0.177**
	[0.632]	[0.616]	[0.088]	[0.084]
Post	2.289***	2.284***	0.197***	0.195***
	[0.315]	[0.308]	[0.044]	[0.042]
Treat*Post	-2.503***	-2.467***	-0.340**	-0.339***
	[0.961]	[0.937]	[0.133]	[0.128]
Male		1.547***		0.782***
		[0.290]		[0.040]
Hispanic		9.687***		1.035***
		[0.643]		[0.088]
Other		5.003***		0.674***
		[0.614]		[0.084]
Special education		4.735***		0.756***
		[0.578]		[0.079]
Free/reduced-cost lunch		3.518***		0.621***
		[0.374]		[0.051]
ESL		0.701		0.147
		[0.885]		[0.121]
Constant	11.424***	8.516***	1.139***	0.434***
	[0.211]	[0.269]	[0.029]	[0.037]
Observations	13339	13339	13339	13339
R-squared	0.01	0.06	0	0.08

Notes: Standard errors are in brackets. * indicates significant at 10 percent level, ** indicates significant at 5 percent level, and *** indicates significant at 1 percent level.

of 0.13 standard deviations in math test scores. There was no significant change in language arts or science scores. After including student-level characteristics, more of the variation in test scores is explained by the model. These results continue to suggest, as with previous studies, that the school food environment—in this case the access to soft drinks in vending machines—can impact academic performance.

Discussion

Much of the debate surrounding vending machines within schools has focused on the physical health effects on students. However, it is also important to understand other outcomes that having vending machines might effect, including problem behavior and academic performance. While other studies have examined the effect of the overall school food environment on these outcomes, the present study focuses on a specific important aspect of the food environment: the availability of soft drinks through vending machines. In the present study, students at schools that exchanged soft drinks for sports drinks, juices, and milk in their vending machines had fewer tardies and fewer in-school disciplinary referrals. Additionally, there was a significant increase in standardized math test scores at schools that instituted a change of contents in vending machines.

There are two limitations to this study that need to be addressed. First, there is an assumption that the only thing that changed at the treatment schools

Table 3. Regression Results on the Outcome of Academic Achievement

	CRT – Language Arts		CRT – Math		CRT – Science	
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.119***	0.116***	0.239***	0.237***	0.306***	0.306***
	[0.036]	[0.032]	[0.036]	[0.033]	[0.036]	[0.032]
Post	-0.015	0.004	-0.013	0.007	-0.015	0.003
	[0.018]	[0.016]	[0.018]	[0.017]	[0.018]	[0.016]
Treat*Post	0.082	0.068	0.147***	0.133***	-0.036	-0.051
	[0.055]	[0.048]	[0.056]	[0.050]	[0.055]	[0.049]
Male		-0.149***		0.077***		0.181***
		[0.015]		[0.016]		[0.015]
Hispanic		-0.365***		-0.398***		-0.400***
		[0.033]		[0.034]		[0.034]
Other		-0.239***		-0.224***		-0.276***
		[0.032]		[0.033]		[0.032]
Special education		-1.466***		-1.401***		-1.324***
		[0.030]		[0.031]		[0.030]
Free/reduced-cost lunch		-0.235***		-0.248***		-0.250***
		[0.019]		[0.020]		[0.020]
ESL		-0.421***		-0.195***		-0.407***
		[0.046]		[0.047]		[0.047]
Constant	0.007	0.281***	-0.019	0.131***	-0.021*	0.083***
	[0.012]	[0.014]	[0.012]	[0.014]	[0.012]	[0.014]
Observations	13339	13339	13339	13339	13339	13339
R-squared	0	0.22	0.01	0.19	0.01	0.2

Notes: Standard errors are in brackets. * indicates significant at 10 percent level, ** indicates significant at 5 percent level, and *** indicates significant at 1 percent level.

was the content of the vending machines. It may be the case that changing the content of the vending machines may have been only a part of a larger change that sought to improve multiple aspects of students' well-being. If this is the case, the true effect of vending machines would be much smaller than what was estimated in this study. Second, it is assumed that treatment and control schools experienced similar trends in behavioral and academic measurements in the preperiod. As stated earlier, this is a limitation to the data that cannot be explicitly tested.

In spite of these limitations, this study is the first to examine the effects of restricting access to soft drinks in school vending machines on in-school behavior and academic performance. This study suggests that removing soft drinks from vending machines improves in-school behavior in terms of disciplinary referrals and tardies. It also suggests that removing soft drinks may cause a small increase in student math scores. In light of the number of policies at the federal, state, and local levels currently being implemented to target the availability of soft drinks and vending services in schools, more research needs to be conducted to examine the potential impact that these policies might have on different outcomes for students.

References

American Academy of Pediatrics. 2004. "Soft Drinks in School." *Pediatrics* 113(1): 152–154.

Booth-Thomas, C. 2004. "The Cafeteria Crusader." *Time Magazine* (December 17). Abstract available at http://www.time.com/time/magazine/article/0,9171,1009706,00.html (accessed November 11, 2011).

Burros, M., and M. Warner. 2006. "Bottlers Agree to a School Ban on Sweet Drinks." *New York Times* (May 4). Abstract available at http://www.nytimes.com/2006/05/04/health/04soda.html (accessed November 11, 2011).

Centers for Disease Control and Prevention. 2011. "Childhood Obesity Facts." Abstract available at http://www.cdc.gov/healthyyouth/obesity/facts.htm (accessed November 28, 2011).

Cullen, K.W., K. Watson, I. Zakeri, and K. Ralston. 2008. "Improvements in Middle School Student Dietary Intake after Implementation of the Texas Public School Nutrition Policy." *American Journal of Public Health* 98(1): 111–117.

Figlio, D.N., and J. Winicki. 2005. "Food for Thought: The Effects of School Accountability Plans on School Nutrition." *Quarterly Journal of Economics* 89(2): 381–394.

Fletcher, J., D. Frisvold, and N. Tefft. 2010a. "Taxing Soft Drinks and Restricting Access to Vending Machines to Curb Child Obesity." *Health Affairs* 29(5): 1059–1066.

____. 2010b. "The Effects of Soft Drink Taxation on Soft Drink Consumption and Weight for Children and Adolescents." *Journal of Public Economics* 94(11/12): 967–974.

Hollar, D., S.E. Messiah, G. Lopez-Mitnik, L. Hollar, M. Almon, and A. Agatston. 2010. "Effect of a Two-Year Obesity Prevention on Percentile Changes in Body Mass Index and Academic Performance in Low-Income Elementary School Children." *American Journal of Public Health* 100(4): 646–653.

Kleinman, R.E., S. Hall, H. Green, D. Korzec-Ramirez, K. Patton, M.E. Pagano, and J.M. Murphy. 2002. "Diet, Breakfast, and Academic Performance in Children." *Annals of Nutrition and Metabolism* 46(1): 24–30.

Levy, D.T., K.B. Friend, and Y.C. Wang, 2011. "A Review of the Literature on Policies Directed at the Youth Consumption of Sugar Sweetened Beverages." *Advances in Nutrition* 2(2): 1825–2005.

Lien, L., N. Lien, S. Heyerdahl, M. Thoresen, and E. Bjertness. 2006. "Consumption of Soft Drinks and Hyperactivity, Mental Distress, and Conduct Problems Among Adolescents in Oslo, Norway." *American Journal of Public Health* 96(1): 1815–1820.

Malik, V.S., M.B. Schulze, and F.B. Hu. 2006. "Intake of Sugar-Sweetened Beverages and Weight Gain: A Systematic Review." *American Journal of Clinical Nutrition* 84(2): 274–288.

National Conference of State Legislatures. 2005. "Vending Machines in Schools." Abstract available at http://www.ncsl.org/default.aspx?tabid=14108 (accessed November 11, 2011).

Powell, L., J. Chriqui, and F.J. Chaloupka. 2009. "Associations Between State-Level Soda Taxes and Adolescent Body Mass Index." *Journal of Adolescent Health* 45(3): 57–63.

Wiecha, J.L., D. Finkelstein, P.J. Troped, M. Fragala, K.E. Peterson. 2006. "School Vending Machine Use and Fast-Food Restaurant Use Are Associated with Sugar-Sweetened Beverage Intake in Youth." *Journal of the American Dietetic Association* 106(10): 1624–1630.