Taxing Soft Drinks And Restricting Access To Vending Machines To Curb Child Obesity

ABSTRACT One of the largest drivers of the current obesity epidemic is thought to be excessive consumption of sugar-sweetened beverages. Some have proposed vending machine restrictions and taxing soft drinks to curb children’s consumption of soft drinks; to a large extent, these policies have not been evaluated empirically. We examine these policies using two nationally representative data sets and find no evidence that, as currently practiced, either is effective at reducing children’s weight. We conclude by outlining changes that may increase their effectiveness, such as implementing comprehensive restrictions on access to soft drinks in schools and imposing higher tax rates than are currently in place in many jurisdictions.

Childhood obesity has grown at an alarming rate. Between the late 1970s and 2003–2004, the prevalence of obesity approximately tripled for children ages 6–11 and adolescents ages 12–19.1–3

One factor that may contribute to rising obesity rates is the steep rise in soft drink consumption by children.4 Consumption has increased 500 percent in the past fifty years and is now the single largest category of caloric intake in children, surpassing milk a decade ago.5–7 Although most twelve-ounce servings of soft drinks contain only 140 calories, small changes in caloric intake can accumulate and lead to substantial changes in weight. One extra twelve-ounce serving of a sugar-sweetened soft drink per day can lead to a weight gain of fifteen pounds over a year, although the weight gain would not be expected to accumulate indefinitely.5,9

Recently, policies targeted to reduce soft drink consumption have been widely advocated as a critical step toward reducing obesity. The two most prominent have been school vending machine restrictions and taxing soft drinks. Although these policies are gaining popularity, little research has been done to evaluate their effectiveness.

In this paper we outline important concepts related to these policies. We present new empirical evidence of the likely effectiveness of school vending machine restrictions and increasing taxes on soft drinks on reducing obesity rates in children. We conclude by discussing how the effectiveness of these policies might be increased.

Efforts To Curb Soft Drink Consumption

SCHOOL VENDING MACHINE RESTRICTIONS Policies affecting consumption machine choices in schools have been an area of long-standing interest. There has been an increase in penetration of so-called competitive foods that compete with federally funded school meal programs in public schools—school stores, school vending machines, and à la carte options during meal-times. As a result, many school districts and several states have examined these food options and reassessed the potential health costs on the one hand and financial benefits on the other.

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diet soft drinks have no calories, they do not contain the nutritional advantages of fruit juice or milk.

A second issue with school vending machine bans is that they may simply change the avenue of access to soft drinks instead of reducing the amount of soft drinks that children consume. Therefore, a ban on vending machines could reduce soft drink consumption without reducing weight because of substitution patterns to different, similar-calorie alternatives. Alternatively, a ban could redirect the place of soft drink purchase without reducing consumption or weight. Indeed, the empirical results we report in this paper suggest that previous vending machine restrictions have been relatively ineffective in curbing soft drink consumption and weight for children, confirming recent research findings.16,17

Taxation of Soft Drinks A second policy that has received recent, widespread interest is increasing taxes on soft drinks or soda.18 Although soft drink taxes have existed for many decades, until recently they were implemented primarily as a way to increase state and local tax revenues rather than for potential health benefits, and many consumers seem to be unaware of their existence.

At the beginning of 2008, twenty states taxed soft drinks sold in stores at a higher rate than other types of food. The average rate, net of taxes on other food, was 2.08 percent. Twenty-two states and the District of Columbia have made minor changes to their soft drink taxes in the past two decades. However, there has been a dramatic increase of policy activity in recent years.19 This rise in policy activity has been driven in part by new interest in the potential for soft drink taxes to lead to improved health, in addition to raising revenue.20,21

In May 2008, Maine enacted legislation that would have taxed soft drinks at a rate of $0.42 per gallon of bottled or powder-based soft drinks and $4 per gallon of soft drink syrup.22,23 In December 2008 Gov. David Paterson of New York proposed an 18 percent “obesity tax” on sugared beverages. As its name suggests, this tax was intended to reduce soft drink consumption and subsequently reduce obesity rates by increasing the price of soft drinks.

Both of these proposals encountered political opposition, primarily from the beverage industry and antitax advocates.24 Maine’s beverage tax was repealed in a November 2008 referendum by a substantial majority vote. Although Governor Paterson’s proposal received national media attention, it failed to garner sufficient support in the New York legislature and was withdrawn. At the federal level, a tax on soft drinks was discussed as a possible source of funding for the

First, the issue of substitution patterns is relevant to most policies that seek to curb soft drink consumption. What, if anything, will children drink instead of soft drinks? Many potential substitutes, although presumably more nutritious, typically have a similar number of calories per serving as soft drinks. For example, twelve ounces of fruit juice or reduced-fat 2 percent milk contain a similar number of calories as a sugar-sweetened beverage. In contrast, although diet soft drinks have no calories, they do not
national health care reform initiative. It was not included in the legislation passed by the Senate or the House.25

In spite of these political defeats, as of April 2009 there were active legislative proposals involving soft drink taxes in at least eight states. For example, the Maryland Senate proposed a 6 percent tax on soft drinks.26 More recently, in November 2009 the governor of Colorado proposed a 2.9 percent tax.27

► S I N T A X E S: Although the public health case for increasing soft drink taxes appears strong on its face, there are several issues that have not received as much attention. Lately, soft drink taxes have been increasingly framed as “sin taxes” with an often explicit comparison to the success of cigarette taxes in reducing consumption and raising revenue. There are two aspects of framing soft drink taxes in this way that may require additional discussion.

First, unlike cigarettes, there is little evidence that modest levels of soft drink consumption, in the context of an overall healthy diet, directly lead to negative health consequences.28 It is only “excess” caloric intake without offsetting calorie expenditures—for example, exercise—that increases weight and reduces health over time. A potentially useful comparison with soft drinks might be alcohol, where only excessive use may pose health problems. If alcohol is a better comparator to soft drinks than cigarettes, then the policy of increasing taxes to curb use is not as straightforward because it is primarily excessive use that should be reduced, rather than modest use.

A second aspect of framing the taxation of soft drinks as a “sin tax” is the implicit trade-off between revenue generation that could be used to fund obesity prevention programs and consumption of the “sinful” product. In the extreme, if the tax is high enough to eliminate consumption, it will generate no revenue. In contrast, if the tax does not affect consumption behavior, it will generate considerable revenue but have no direct impact on obesity. It will be useful to consider these issues in formulating policies to tax soft drinks.

Along with the conceptual issues of treating soda as a “sinful” product, there are additional aspects of taxation that deserve discussion. First is the extent to which tax increases imposed on beverage producers translate into price increases experienced by consumers. If the government imposes a 10 percent tax on soft drink suppliers, does the retail price increase by 10 percent, more than 10 percent, or less than 10 percent—including, potentially, no increase? The best empirical evidence suggests that the answer is approximately 10 percent, but the evidence on this question is dated and somewhat limited.29

► LEVEL OF TAX: Additionally, the level of the tax could prove to be important in affecting changes in consumption patterns. Changes in taxes that are included in shelf prices have a greater effect on consumption than changes in taxes that are applied at the register.30 Under today’s more common method of soft drink taxation—the sales tax—the tax is applied at the register. If current soft drink taxes therefore have limited effects on behavior, the burden of reducing obesity will be placed on how the revenues of a soda tax are spent. The comparison to cigarette taxes in this case is potentially enlightening, as only 7 percent of state tobacco tax revenue and payments under the Master Settlement Agreements that settled states’ lawsuits against tobacco companies are used to reduce smoking or pay for smoking-related illnesses.31

► TAX BURDEN AND EQUITY: A third issue is the likelihood that soft drink taxes are “regressive,” with the burden of the tax falling disproportionately on low-income populations. This issue raises equity concerns, especially if low-income families have fewer consumption choices available. To counter this issue, some researchers suggest that the benefits of a soda tax may also be concentrated on low-income populations.25 However, it is currently unclear whether the benefits of soda taxation outweigh the costs for low-income populations.

► SUBSTITUTION PATTERNS: Finally, as with other policies such as vending machine restrictions, even if the taxes change behavior, it is important to know the relevant substitution patterns of consumption. If people offset their soft drink consumption by consuming other high-calorie beverages such as sports drinks, whole milk, or juice, there may be no direct effects on weight from the tax. In the extreme case of total substitution from taxed soft drinks to other high-calorie drinks that are untaxed, there would likely be no change in population weight as well as no tax revenues.

New Empirical Evidence

SCHOOL VENDING MACHINE RESTRICTIONS We began our analysis of the effects of policies aimed at reducing soft drink consumption and weight by using data on soft drink consumption and vending machine restrictions from the nationally representative Early Childhood Longitudinal Study–Kindergarten Cohort.32 We focused on the fifth grade (2004) and eighth grade (2007) survey waves, which were the only data waves that contained questions to measure soft drink consumption and access.
The children were asked, “During the last week that you were in school, how many times did you buy soda pop, sports drinks, or fruit drinks at school?” The children were also asked about total consumption, including at home, in school, and elsewhere: “During the past 7 days, how many times did you drink soda pop, sports drinks, or fruit drinks that are not 100 percent fruit juice?” In addition to the information from the students, the survey asked school administrators, “Can students purchase soda pop, either from vending machines, school store, canteen, snack bar or à la carte items from the cafeteria during school hours?”

To examine the potential effects of access to vending machines in elementary and middle schools, we present descriptive statistics from the sample of fifth graders in Exhibit 1 and eighth graders in Exhibit 2. Column 1 of each exhibit shows information for the full sample. The figures suggest that 84 percent of fifth and eighth graders reported some soft drink consumption in the past week, consuming approximately six drinks per week, on average. In addition, 13 percent of fifth graders and 25 percent of eighth graders reported buying soft drinks at school during the past week, consuming roughly one to two soft drinks every three weeks. School administrators reported that 27 percent of fifth graders and 60 percent of eighth graders had access to soft drinks in schools from a specific list of outlets.

To inform the potential success of future state and local policies that restrict vending machine access, we examined differences in weight and soft drink consumption from school-based restrictions on access to vending machines. To do this, columns 2 and 3 in each exhibit compare responses among those where the school administrator reported that students had access to soft drinks within schools, including from vending machines, with those whose administrators did not report such access.

The results show that there is less soft drink consumption based on purchases made at school for those students with limited access (8 percent versus 26 percent of fifth graders and 20 percent versus 28 percent of eighth graders reported any consumption from school-based sources; both results are significant at the 0.001 level). Yet the total amount of soft drinks consumed by students is remarkably similar between those who have access at school and those who have limited access. Specifically, for fifth graders, 86 percent of students in schools with access to soft drinks reported drinking any soft drink in the past week, compared to 84 percent of students in schools with limited access. The weekly consumption is nearly identical.

The results strongly suggest that limiting access to soft drinks at school might not reduce children’s soft drink consumption because of the many alternative outlets where they can obtain soft drinks, including homes, convenience stores, and other school outlets such as after-school events.

**The Taxation of Soft Drinks** Next, we examined the effects of soft drink taxes on soft drink consumption and weight among children and adolescents using data from the National Health and Nutrition Examination Survey (NHANES) III (1988–1994) and IV (1999–2006). The data include measured height and weight, as well as a twenty-four-hour dietary re-

### EXHIBIT 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full sample (N = 11,052)</th>
<th>Has school vending machine access (N = 2,871)</th>
<th>No school vending machine access (N = 7,664)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any soda consumption in past week</td>
<td>0.84</td>
<td>0.86</td>
<td>0.84</td>
<td>0.09</td>
</tr>
<tr>
<td>Total number of soft drinks consumed in past week</td>
<td>6.30 7.77</td>
<td>6.12</td>
<td>6.43</td>
<td>0.29</td>
</tr>
<tr>
<td>Any soda consumption in past week at school</td>
<td>0.13 0.26</td>
<td>0.26</td>
<td>0.08</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Number of soft drinks consumed in past week at school</td>
<td>0.32 1.42</td>
<td>0.59</td>
<td>0.22</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Body mass index</td>
<td>20.68 4.75</td>
<td>20.94</td>
<td>20.62</td>
<td>0.10</td>
</tr>
<tr>
<td>Overweight or obese</td>
<td>0.40</td>
<td>0.41</td>
<td>0.40</td>
<td>0.79</td>
</tr>
<tr>
<td>Obese</td>
<td>0.22</td>
<td>0.23</td>
<td>0.21</td>
<td>0.34</td>
</tr>
<tr>
<td>School vending machine access (school administrator)</td>
<td>0.27 1.00</td>
<td>1.00</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Authors’ analysis of data from the Early Childhood Longitudinal Study–Kindergarten Cohort. **Notes:** Means are weighted to be nationally representative of the population of fifth graders in 2004. Weighted sample sizes by column are 3,732,729; 931,641; 2,498,169; 565,958; and 3,020,109. The p value is based on the null hypothesis that the means in columns 3 and 4 are equal. SD is standard deviation.
Individual foods and beverages from the dietary recall were coded and classified using the U.S. Department of Agriculture’s Survey Nutrient Databases. From this information, we were able to determine whether youths consumed a soft drink, the total grams consumed, and the total calories consumed from soft drinks. We combined this information with the state soft drink sales and excise tax rates, net of taxes on other food. To analyze the influence of soft drink taxes, we combined the two surveys and restricted the sample to youths ages 3–18 whose height, weight, and soft drink consumption data were not missing. Further details of the data and our analysis are contained in the Technical Appendix.

Exhibit 3 presents the unadjusted means and proportions of the weight classifications and soft drink consumption. For the entire sample, 15 percent of children and adolescents were obese and 30 percent were overweight or obese, as determined by body mass index (BMI). Additionally, 57 percent of youths reported drinking a soda, and they consumed an average of 205 calories from soda per day.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full sample (N = 8,344)</th>
<th>Has school vending machine access (N = 4,719)</th>
<th>No school vending machine access (N = 3,073)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any soda consumption in past week</td>
<td>0.84 0.84</td>
<td>0.83 0.43</td>
<td>0.83 0.24</td>
<td>0.43</td>
</tr>
<tr>
<td>Total number of soft drinks consumed in past week</td>
<td>5.57 6.98</td>
<td>5.39 0.28</td>
<td>5.72 0.20</td>
<td>0.24</td>
</tr>
<tr>
<td>Any soda consumption in past week at school</td>
<td>0.25 0.84</td>
<td>0.28 0.20</td>
<td>0.20 &lt;.0001</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Number of soft drinks consumed in past week at school</td>
<td>0.68 1.42</td>
<td>0.71 1.64</td>
<td>0.64 0.16</td>
<td>0.16</td>
</tr>
<tr>
<td>Body mass index</td>
<td>23.22 6.07</td>
<td>23.04 6.07</td>
<td>23.23 6.07</td>
<td>0.39</td>
</tr>
<tr>
<td>Overweight or obese</td>
<td>0.38 0.36</td>
<td>0.36 0.37</td>
<td>0.37 0.54</td>
<td>0.54</td>
</tr>
<tr>
<td>Obese</td>
<td>0.20 0.20</td>
<td>0.20 0.20</td>
<td>0.20 0.65</td>
<td>0.65</td>
</tr>
<tr>
<td>School vending machine access (school administrator)</td>
<td>0.60 1.00</td>
<td>0.60 0.00</td>
<td>0.00 0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**Source:** Authors’ analysis of data from the Early Childhood Longitudinal Study—Kindergarten Cohort. **Notes:** Means are weighted to be nationally representative of the population of eighth graders in 2007. Weighted sample sizes by column are 3,071,309; 1,706,471; 1,111,461; 437,446; and 2,539,409. The p value is based on the null hypothesis that the means in columns 3 and 4 are equal. SD is standard deviation.
in states without a tax (the difference is not statistically significant at conventional levels). This finding of little consumer response to soft drink taxes in reducing consumption could be partially explained if consumers do not react to the small, and often hidden, tax rates typically applied to soft drinks.

Exhibits 4, 5, and 6 present additional estimates that are adjusted for age, sex, race/ethnicity, state of residence, quarter of year, and year. Exhibit 4 presents the predicted BMI z-score (a commonly used relative measure of BMI that allows for comparison of BMI levels across ages and sexes) for the average child in the data for three hypothetical soft drink tax levels: (1) no tax on soft drinks, (2) a tax equal to the current sample mean (the current scenario), and (3) a “large” tax rate of 6 percent, which is slightly more than double the sample mean. Exhibits 5 and 6 show predicted obesity prevalence and calories consumed from soft drinks, respectively, using the same technique.

The results show that a soft drink tax of 6 percent would not lead to a statistically significant change in BMI, obesity prevalence, or soft drink calorie consumption relative to the current tax scenario. Although not statistically significant, the differences in the predicted values suggest that soda consumption falls while obesity prevalence does not. One reason for this result could be that children substitute other high-calorie drinks for soda so that total calorie consumption is unaffected.34 This explanation highlights the importance of understanding substitution patterns when soda consumption is reduced through policy measures.

Discussion And Conclusions
This paper provides new evidence of the potential effectiveness of two policies to reduce soda consumption and weight in children: school soft drink restrictions and soft drink taxes.

Limitations
There are several limitations that should be considered when viewing the results. First, the results use cross-sectional data, which limits the ability to draw causal inference. Second, the Early Childhood Longitudinal Study–Kindergarten Cohort data do not contain information on high school–age children. Because there are large increases in soda consumption as children age, the results that focus on school soda restrictions might not apply to older children.

Weight Reduction
We conclude that as currently practiced, neither vending machine restrictions nor soft drink taxes will lead to noticeable weight reduction in children. In particular, our results suggest that typically imposed beverage taxes are neither large enough nor transparent enough to lead to meaningful behavioral change. Likewise, vending machine bans may redirect how children access soft drinks but not whether they access soft drinks. That is, we found that students in schools with vending machine restrictions consume as many soft drinks as students in schools with no restrictions.
**Policy Recommendations**

These results also suggest specific ways to revise future policies to better affect children’s weight outcomes. In particular, we make two recommendations based on our results. First, if states or schools implement policies aimed at reducing access to soft drinks, these restrictions must be comprehensive. Soft drinks should be completely removed from schools for this policy to have a greater chance of being effective—no vending machines, no cafeteria sales, no access anywhere. It is important to note, though, that continued access to soft drinks from homes, convenience stores, and other outlets may still serve to reduce the effects of completely removing soft drink sales from schools.

Second, our findings suggest that incremental changes in taxes on beverages will be largely ineffective. This finding does not preclude the effectiveness of very large increases in taxation on these products, as have been proposed in New York, for example. To date, we know of no evidence that could forecast the likely impacts of substantial changes in soft drink taxes with certainty, but we speculate that an environment of high taxes on soft drinks (as well as unhealthy substitutes), combined with informed consumers, may lead to weight reductions in children.

**Unanswered Questions**

Finally, the correct combination of the above policies and others depends crucially on questions yet to be answered conclusively. For example, if a state banned soft drinks in schools and imposed a high soft drink tax rate outside of schools, how great an effect would the presumed drop in soft drink consumption have on weight among children and adolescents? On the other hand, if consumption is not directly changed by a state’s policies but soft drink tax revenues are instead devoted to, say, education programs intended to reduce soft consumption and weight, by how much would weight outcomes change through this indirect method? Further research is needed to understand the behavioral responses of soft drink policies, which should be incorporated in a comprehensive policy framework.

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**Notes**

3 Obesity is defined as body mass index (BMI) greater than or equal to the ninety-fifth percentile of the sex-specific BMI-for-age distribution.
4 We use the terms “soft drink” and “soda” interchangeably throughout the text. A complete data definition of “soft drink” is included in the Technical Appendix, which is available by clicking the Technical Appendix link in the box to the right of the article online.
10 Centers for Disease Control and Prevention. Fact sheet: foods and beverages sold outside of the school meal programs [Internet]. Atlanta...


111. Authors’ calculations based on sources described in Note 18.


