The Role of Variety in Increasing the Consumption of Fruits and Vegetables Among Children

David R. Just, Jesse Lund, and Joseph Price

We use observational data from 22 elementary schools and over 48,000 child-day observations to examine the relationship between the number of fruit and vegetable items and the consumption patterns of children during school lunch. We find that each additional fruit or vegetable item that is offered increases the fraction of children who eat at least one serving of fruits and vegetables by 12 percent. We also use our observational data to provide practical information about which items are most likely to be eaten by children during lunch and compare this to the cost and nutritional quality of these items.

Key Words: variety, fruits and vegetables, school lunch, children

There has been considerable recent interest in increasing the amount of fruits and vegetables that children are consuming. Recent public programs to this end have included the USDA Fresh Fruit and Vegetable Program, the Gimme 5 program in Louisiana (Nicklas et al. 1998), the Pro Greens project in Europe, and the National Farm to School Network. The motivation for these programs stems from the importance of fruits and vegetables in preventing many diseases and the role they can play in preventing childhood obesity by increasing satiation and lowering overall caloric intake by crowding out high-caloric, less nutritious foods (Epstein et al. 2001). Unfortunately, most children do not eat the recommended amount of fruits and vegetables, and this deficiency is particularly notable among children in low-income families.

Schools have the ability to provide children access to fruits and vegetables as part of the school lunch program, which provides lunches to 31.3 million low-income elementary age children each day in the United States. In some school districts, children are able to receive breakfast, lunch, and dinner at school, and the Fresh Fruit and Vegetable Program provides children access to fruits and vegetables throughout the school day. However, schools may fall short of their potential to increase fruit and vegetable consumption in children if the children fail to take advantage of the opportunities at school.

One of the major barriers that children face in consuming fruits and vegetables at school is the often low quality of the items that are served. Children prefer fresh vegetables over the canned or overcooked ones school cafeterias often provide (Dalton 2004). At times the "bruised" condition of the fruits and the "nasty" appearance of the vegetables account for part of the reason adolescents seldom eat the produce available (Neumark-Sztainer et al. 1999). Furthermore, anecdotal evidence suggests that children don't eat new foods—including vegetables—because they are afraid the new food will make them sick (Glynn 2010).

We use observational data on what children eat during lunch to examine the role that the popu-

David R. Just is Associate Professor at the Charles H. Dyson School of Applied Economics and Management at Cornell University, in Ithaca, New York, as well as Co-Director of the Cornell Center for Behavioral Economics in Child Nutrition Programs. Jesse Lund is a doctoral student in the Department of Economics at the University of Texas, in Austin, Texas. Joseph Price is Assistant Professor in the Department of Economics at Brigham Young University, in Provo, Utah.

This paper was presented as a selected paper at the workshop "Economics of Food Assistance Programs," organized by the Northeastern Agricultural and Resource Economics Association (NAREA), in Pittsburgh, Pennsylvania, July 23, 2011. The workshop received financial support from the Cornell Center for Behavioral Economics in Child Nutrition Programs and the AAEA Foundation. The views expressed in this paper are the authors' and do not necessarily represent the policies or views of the sponsoring agencies.

This research was funded by the U.S. Department of Agriculture's Economic Research Service under the Food Assistance and Nutrition Research Program, Award No. 59-5000-0-0077.

larity and variety of items play in encouraging children to eat fruits and vegetables. Our sample involves data from 22 schools and nearly 50,000 child-day observations. For each observation, we know the fruits and vegetables that were being offered during lunch that day and which of those items each child decided to eat. Our data collection approach allows us to measure the consumption patterns of thousands of children in a non-invasive way that is less likely to influence the children's consumption patterns during the observation period.

For all of our analysis, we use variation in the items being offered based on lunch menus determined by the school district. The key variables that we focus on are the number of distinct fruit and vegetable items that were being offered and the popularity of the items being offered. We examine the degree to which each of these factors influences the amount of fruits and vegetables that children eat as part of their school-provided lunch.

Background

A diet rich in fruits and vegetables is important in preventing heart disease and many types of cancer. According to the World Health Organization (2002), "Up to 2.7 million lives could be saved annually with sufficient fruit and vegetable consumption," and "low fruit and vegetable intake is among the top 10 selected risk factors for global mortality." Consuming adequate amounts of fruits and vegetables has been shown to greatly reduce the risk of coronary heart disease (Rimm et al. 1996), hypertension (Rimm et al. 1996), a wide array of cancers (Block, Patterson, and Subar 1992, Serdula et al. 1996), and many other physical ailments. One mechanism of this protection is by physically crowding out fatty foods high in salt and cholesterol (Epstein et al. 2001). Fruits and vegetables high in antioxidants also protect on the cellular level by preventing oxidative DNA damage (Cheng et al. 1992).

Unfortunately, consumption rates of fruits and vegetables are low among children, particularly among those from lower-income families. This lower rate of fruit and vegetable consumption may be due in part to the relatively low cost of energy-dense foods (Darmon and Drewnowski 2008), though Dibsdall et al. (2003) claim that motivational and lifestyle factors have an even greater impact. Schools may be uniquely suited to help address these problems because a large fraction of children from low-income families receive a school-provided lunch each day. In addition, many districts now provide these children both breakfast and dinner during the school week (accounting for the majority of a child's meals during the school year). The real challenge, though, is ensuring that these children take advantage of the opportunities provided by school meals to consume fruits and vegetables.

There are two ways that increasing the variety of fruits and vegetables might increase the fraction of children who eat fruits and vegetables as part of their school-provided meals. First, providing variety might increase the chances that there is at least one item that each child would find appealing. This could operate by increasing the probability that there is at least one item that is popular among most children. In this study, we measure the popularity of specific items as the fraction of children who eat that item when it is offered during lunch and match the measure used in past research (Pollack 2001, Patterson 1990). It might also be the case that preferences for particular fruits and vegetables differ across children, and so providing additional options might increase the likelihood that the child has an option that they would chose. This channel might be especially important in schools with a large fraction of particular ethnic groups for which the items offered as part of the school lunch have little intersection with the fruits and vegetables offered at home.

Second, researchers have found that increased variety in a meal leads to higher rates of consumption. This is due to a phenomenon called "sensory-specific satiety," which means that the desirability of a food diminishes with each bite (Rolls et al. 1981a). For example, subjects offered three types of yogurts that differed in flavor and texture had higher levels of consumption than when only one flavor was offered, even when that single flavor was the subject's favorite (Rolls et al. 1981b). Thus, increased variety may increase a child's likelihood of consuming a serving of fruits and vegetables while eating less of each fruit and vegetable item served.

While there are likely to be benefits from increasing the variety of fruits and vegetables being offered during lunch, there are also natural constraints on the number of fruits and vegetables

that schools can provide. These constraints include the cost of the items, the time required to prepare additional items, and the space available to serve them. In the face of these costs and constraints, it is important to quantify the degree to which increased variety translates into increased consumption of fruits and vegetables so that this increase can be weighed against the costs of the increased variety. In the next section, we describe a dataset that provides this type of information.

Data

The data that we examine in this paper were collected as part of a field experiment designed to examine the role of incentives in increasing the fraction of children consuming fruits and vegetables as part of their school-provided lunch (Just and Price 2011). Prior to implementing any incentive programs, we collected a set of baseline observations for each school. Each of these schools provided a choice of entrées and sides as well as a variety of fruits and vegetables. Children are allowed to take as many servings of fruits and vegetables as they would like (though fewer than 1 percent of children take more than two servings).[1]

Research assistants stood near the area where students dumped their trays at the end of lunch and recorded the number of servings of fruits and vegetables that each child ate and how many they threw into the trash. The fruits and vegetables came in special cups or had a peel, core, or some other remnants that allowed us to measure based on a visual inspection. Our measures of the number of servings that were consumed and thrown away were recorded in half-serving increments (e.g. 0, 0.5, 1, 1.5, etc.). This is a coarser measure than used in past studies but allows us to collect information on a much larger sample of children. Also, our analysis is based on whether the child ate at least one serving of fruits and vegetables, which this approach captures very well. If asked by children what they were doing, the research assistants would reply that they were collecting data about school lunches (with no specific mention of fruits or vegetables).

The data from the original set of field experiments were based on a paper-based data collection tool that recorded information about the total number of servings of fruit and vegetables taken and consumed by each individual, rather than providing this information for each type of item. This specific focus was a conscious trade-off between the detail of data that could be collected and the number of observations that could be included in the sample.

While many past studies provide much more detailed data on what children are eating at lunch, the samples in these studies are often limited to fewer than 1,000 child-day observations (Davis et al. 2000, Wardle et al. 2003). The approach that Just and Price (2011) use, though less detailed, provides an enormous number of observations at a much lower cost than other approaches. In addition, for much of the analysis in this paper, the total number of servings of fruits or vegetables that each child consumes provides exactly the relevant measure for our analysis.

In order to look at the consumption of specific items, we developed a mobile device application that allows us to collect data in the same way as Just and Price's (2011) paper-based approach, but has the added advantage of recording the consumption of each specific fruit and vegetable item (rather than an overall measure that aggregates consumption over all of the fruit and vegetable items).[2] Rather than entering the information on a sheet of paper, our application includes fields where the observer can record the child's grade and gender, the entrée that they chose, and how many servings of each fruit and vegetable item they placed on their tray and how many they ate. All of this information is entered by simply tapping different spots on the screen of the mobile device, allowing the information to be quickly entered. This technology provides an even more cost effective method to collecting consumption data that does not require any additional time after lunch to enter data (as in the paper-based approach) or construct measures (as in approaches based on taking pictures of students' trays).

Altogether, our dataset includes 22 schools, with a total of 188 school-day observations and

[1] Throughout this paper, we use the term "take" to refer to children placing fruits or vegetables on their lunch tray, "consume" to refer to actually eating that serving, and "wastage" to indicate the number of servings of fruits or vegetables that were taken, but not consumed.

[2] The application, which is called "v-project," is available for free download at the Apple App Store and can be used by schools to conduct their own data collection and evaluate the efficacy of different approaches that they choose to implement.

48,533 child-day observations. Across the 188 school-day observations, we observe 40 different fruit and vegetable items being served, with all of the schools in each district serving the same items on a particular day. The demographic characteristics of the schools in our sample vary considerably. For example, the fraction of students who are Hispanic varies from 4 percent to 65 percent, and the fraction of students receiving a free or reduced-price lunch varies from 17 percent to 82 percent. We control for all of these differences across schools by including school fixed effects in all of our analyses, such that all of our results are based on variation in the variety offered at the same school.

In Table 1, we provide information for 24 of the items that were served by the schools in our sample during the observation period. For each of these items we provide measures of the popularity, nutritional value, and cost. These three measures reflect the different considerations that food service managers are likely to consider when choosing the types of items that they offer.

In the first column, we report the fraction of school-day observations in which each item appears using our full sample (188 school-day observations). Since schools generally serve more than one fruit or vegetable item (and in one case as many as eight), the percentages do not add up to one. The most common items that are served are salad (32.24 percent), carrots (29.10 percent), and oranges (25.40 percent), while some of the least frequently observed items include strawberries (3.17 percent), kiwi (1.59 percent), and grapefruit (1.06 percent). Some of the items that are served include a combination of individual items. For example, "finger salad" generally includes celery, carrots, and jicama sticks, and "mixed veggies" generally includes carrots, green beans, and corn.

In the second and third column we present two measures of the popularity of each item. Both of these measures are based on the days on which we collected the data using a mobile device rather than the paper-based approach (41 school-day observations) since both measures are based on the children's consumption and waste of specific items. Children are most likely to eat a serving of kiwi (15 percent), strawberries (11 percent), and oranges (11 percent). On the other hand, green beans, broccoli, and peas are the vegetables that children are most likely to take and then throw away, with about 70 percent of these items ending up in the trash. Generally, the more popular fruit items are richer in nutrients but also more expensive. The items most likely to end up in the trash—vegetables—also tend to be more expensive.

In the fourth column we provide a measure of the nutritional quality of each item. Since not all fruits contain the same nutrients, consuming a variety of fruit is the most nutritionally desirable (Foote et al. 2004). However, we provide a subjective ranking of fruits and vegetables. The first, used for fruit items, is compiled by the Center for Science in the Public Interest (CSPI). This measure gives fruits a score according to their calorie, carotenoid, vitamin C, folate, potassium, and fiber contents. According to this scoring system, the three highest ranked fruits that are served during the school-day observations are kiwi, strawberries, and oranges. Vegetable items are ranked according to the Aggregate Nutrient Density Index (ANDI), a multidimensional ranking system created by Joel Fuhrman (2008). The three highest scoring vegetable items according to this index are spinach, bell peppers, and romaine lettuce. Interestingly, in the case of both fruits and vegetables, the subsidized items rank the lowest, with the exception of apricot purée, which was served only once during our observations. This is mostly because the subsidized items tend to be canned items.

The final column provides a rough measure of the cost per serving of each item and is based on district calculations provided by the Nebo School District, one of the participating districts. The three most expensive vegetable items are cauliflower ($0.21), broccoli ($0.19), and green beans ($0.18); the most expensive fruit items are grapes ($0.21) and strawberries ($0.20). All fruits and vegetables are estimated to require 5 cents of labor per serving and 2 cents for each serving cup, if a serving cup is required. For example, bananas are typically served without a cup, costing a total of 10 cents.[3] The items that cost exactly 7 cents do not include the item price since these are provided by the USDA without any cost to the district.

[3] All of these cost measures are based on records from one of the school districts from which we collected the consumption data. In each case, we divided the price of the particular unit the item is measured by by the number of servings that come in that unit. Many prices vary considerably over the course of the year, and these numbers are meant to provide just a rough calculation.

Table 1. Information About the Fruits and Vegetables Being Served During School Lunch

	Serving Frequency	Ate at Least 1 Serving	Waste Rate	Nutritional Ranking	Price
Fruits				CSPI	
Oranges	25.68%	10.87%	33.28%	186	$0.17
Peaches	20.77%	9.69%	44.13%	26	$0.07
Apples	19.13%	3.04%	59.79%	43	$0.15
Applesauce	17.49%	6.84%	35.67%	14	$0.07
Fruit cocktail	14.75%	5.26%	35.49%	20	$0.07
Bananas	13.11%	2.68%	51.92%	54	$0.10
Mandarin oranges	10.38%	6.74%	38.45%	105	$0.17
Pears	8.74%	4.00%	33.76%	20	$0.07
Grapes	6.56%	10.26%	31.85%	46	$0.21
Pineapple	4.92%	5.16%	26.70%	35	$0.12
Strawberries	3.28%	11.36%	20.21%	173	$0.20
Kiwi	1.64%	15.04%	47.48%	233	$0.18
Grapefruit	1.09%	1.37%	44.44%	107	--
Vegetables				ANDI	
Salad	32.24%	3.05%	57.82%	--	$0.12
Carrots	28.42%	2.26%	61.10%	240	$0.17
Broccoli	14.74%	0.75%	67.33%	329	$0.19
Tomatoes	12.57%	0.59%	38.46%	164	$0.17
Cucumbers	11.48%	1.01%	66.54%	50	$0.17
Peas	9.84%	2.48%	67.19%	--	$0.07
Green beans	9.29%	5.48%	76.84%	240	$0.18
Finger salad	8.20%	1.33%	59.13%	285	$0.21
Cauliflower	5.82%	2.99%	50.00%	--	$0.07
Mixed veggies	4.92%	1.65%	62.30%	70	$0.07
Lettuce	3.37%	4.18%	40.23%	110	--

Notes: The serving frequency is the fraction of days that we observe this item being served. The second column provides the fraction of children who eat at least one serving of the item on the days that it is offered. The waste rate is the fraction of those items that students place on their trays that end up in the trash. The price is an estimate of the cost per serving of the item based on records from one of the school districts in our sample.

The USDA-subsidized items are part of the national school lunch program. School districts that participate receive a lump sum proportional to the number of students who participate in school lunches. This lump sum is drawn down as they order different food items. Certain fruit and vegetable items are further subsidized under the USDA commodity program. While schools may come up with estimates associated with these subsidies, the use of subsidies makes costs difficult to calculate. More generally, while districts may come up with their own way of thinking about the costs associated with serving fruits and vegetables, any cost estimates for fruit and vegetable items will suffer from the challenges associated with separating the cost of fruit and vegetable

preparation from the cost of preparing the whole meal.

The primary measure that we will be using in our analysis is the number of distinct fruit and vegetable items that are served during lunch on a particular day. One of the challenges associated with this measure is that schools may bring out additional options in the middle of the lunch hour. This can occur when the initial item being served is so popular that the school runs out of that particular item. If we were to use the actual number of items that are served each day, this would create a problem of reverse causality in which we would incorrectly infer that increased variety led to higher consumption rates, when, in fact, just the opposite is true, with high consumption rates leading to more options being offered.

To deal with this issue all of our measures of the number of items that are being offered are based on the school district records about the number of items that were supposed to be served each day. The top panel of Figure 1 provides a histogram of the number of options provided based on our set of 188 school-day observations. For the vast majority of our observations days, there are between one and four items offered. The bottom panel provides the same information separately for fruits and vegetables.

Results

Our first research question is whether increasing the number of fruit and vegetables that are offered increases the fraction of children who eat at least one serving of fruits or vegetables as part of their school-provided lunch. We estimate a linear probability model that includes controls for the child's grade and gender as well as school and day-of-the-week fixed effects. We cluster all of the standard errors at the school-day level.

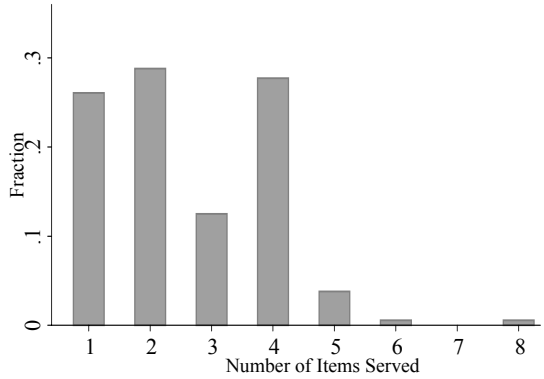
The results in the first column of Table 2 indicate that adding one additional fruit or vegetable item to the menu on a particular day increases the fraction of children who eat at least one serving of fruits and vegetables by 3.3 percentage points (or an 11.7 percent increase relative to the sample mean of 28.3 percent). This linear specification assumes that the effect of an additional item is the same whether we are starting with a small or large number of items. In order to estimate a nonlinear effect of adding additional items, we include a logged value of the number of items. The results in column 2, using the logged variable, indicate that doubling the number of items increases the fraction of children eating at least one serving of fruits and vegetables by 8.8 percentage points (a 31 percent increase).[4]

As mentioned earlier, there are two reasons why increasing the number of options increases the fraction of children who are eating fruits and vegetables. First, there might be a direct effect of variety on children's decisions. Second, increasing the number of options increases the chances that there is at least one popular item offered. To distinguish between these two effects we re-estimate the same models from columns 1 and 2 and include a control for the popularity of the most popular item being served that day. This measure is based on the item-specific data that we collected using the mobile device. The popularity variable is simply the fraction of children who chose that item on the days that it was served and corresponds to the list of values from column 2 in Table 1.

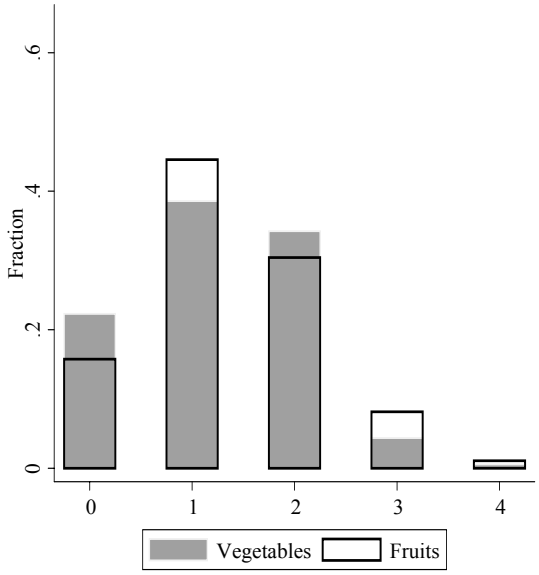
One weakness with this control for the whole dataset is the fact that we do not observe a popularity measure for every item served during the original field experiment. Among these unranked items are potentially popular items such as watermelon, cantaloupe, and blackberries (which were never offered during the 41 school-day observations that we used to construct our popularity measures). We remove any observations in which none of the items being offered that day have a measure of the popularity of the items. This restriction eliminates about 2 percent of the observations from our original data collection. We have applied this restriction to all of the analyses that we report in all of the tables and figures in the paper.

In columns 3 and 4 of Table 2, we find that controlling for the popularity of the items does not reduce the magnitude of the coefficients for

[4] These findings do not necessarily mean that increasing variety is always better. Our data show that only a small fraction of schools offer more than four options on any given day. This data limitation does not allow us to determine an optimal amount of variety in fruit and vegetable options. Further research (using data that have more observations with lots of options available) is needed to determine the effects of variety beyond four options. Some schools are beginning to implement salad bars, which may provide promising opportunities for further research into this question. However, our results are likely to be relevant for the many schools that are currently offering only a few fruit and vegetable options during lunch.



Total Number of Fruits and Vegetable Items That Are Served



Number of Fruit and Vegetable Items That Are Served

Figure 1. Amount of Variety of Fruits and Vegetables Served During Lunch

our measures of variety (and, if anything, it increases them slightly). This indicates that the direct effect of variety has a large and independent effect on consumption rates aside from any changes in the popularity of the items being offered.

We also find that the popularity of the most popular item is an important predictor of the fraction of children eating fruits and vegetables. We find that the fraction of children eating at least one serving of fruits and vegetables increases with the popularity of the most popular item. That is, increasing the popularity of the most popular item by 7 percentage points (which is equivalent to switching from bananas to peaches as the most popular item) would increase the fraction of children eating a serving of fruits or vegetables by about the same amount (a 30 percent increase). These results suggest that offering more popular items can have a large effect on consumption rates.

Past studies have documented a number of other factors that are likely to influence the consumption patterns at a school, including the size of the plates, the layout of the cafeteria, the amount of time allowed to eat, whether recess comes before or after lunch, or possibly even how nice the lunch staff is. Given that the data that we collected at each school occurred over a short period of time, all of these factors will be controlled for in our school fixed effects. There might also be other factors that vary by grade within a school, such as what time lunch starts or how close to the fruit or vegetable items the children sit. We find results nearly identical to those reported in Table 2 when we replace the school fixed effects with school-grade fixed effects that control for other factors that might differ by grade within a school.

Decisions about the optimal number of items to offer must weigh the benefits (increasing the fraction of children consuming fruits and vegetables) against the costs of providing the additional items. The most obvious costs of providing additional items are the labor costs of preparing additional items and the cost of providing additional space for the extra items. In Table 3, we look at one of the additional costs of increased variety and the number of additional servings of these items that are taken by children. We find that each additional item that is offered increases the number of fruits and vegetables that are served by 0.107 servings per child. Since these servings can cost up to about 20 cents per serving, providing an additional fruit or vegetable item to the menu can cost the school up to 2 cents per child.

From a cost-effectiveness perspective, the real question is whether these additional items that are being served end up being eaten or thrown away. The results in Table 3 indicate that providing additional items has no effect on the fraction of fruits and vegetables that end up in the trash (the

Table 2. Effect of Variety on Fraction of Children Eating at Least One Serving of Fruits or Vegetables

	(1)	(2)	(3)	(4)
Number of items	0.033**		0.037***	
	[0.013]		[0.013]	
Log # of items		0.088***		0.098***
		[0.031]		[0.027]
Rank of most popular item			1.192***	1.199***
			[0.254]	[0.254]
R-squared	0.042	0.043	0.048	0.048

Notes: N = 48,533. The sample mean for the dependent variable is 0.283. The regressions include school and day-of-week fixed effects as well as controls for grade and gender. Standard errors are clustered at the school-day level. ***, **, and * indicate statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Table 3. Effect of Variety on Other Consumption Outcomes

	Servings Taken	Waste Rate	Servings Wasted	---------- Ate Vegetable ----------	
Number of items	0.107***	0.002	0.052***	0.013	
	[0.027]	[0.010]	[0.016]	[0.015]	
Number of vegetables					0.020
					[0.013]
Number of fruits					-0.009
					[0.015]
Rank of most popular item	1.427***	-0.693***	0.113	0.273	0.293
	[0.492]	[0.246]	[0.320]	[0.357]	[0.350]
Observations	48,533	28,487	48,533	10,196	10,196
Sample mean	0.689	0.473	0.326	0.040	0.040

Notes: The regressions include school and day-of-week fixed effects as well as controls for grade and gender. Standard errors are clustered at the school-day level. ***, **, and * indicate statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

wastage rate). The number of observations for this regression is less than that of the previous column because it is restricted to just the children who placed at least one serving of fruits and vegetables on their tray. In addition, we weight the regression by the number of servings that each child took so that the coefficient represents, in fact, the fraction of items that are taken that end up being thrown away (which is about 47 percent of all items). However, when we look at the number of items that are thrown away per child, we find that this increases by 0.052 servings per child, which simply reflects the fact that children are placing more items on their tray when there are more options, but still throwing away about half of those items that they chose.

In addition to the extra costs of variety, there might also be some concern that while it may increase the overall fraction of children eating fruits or vegetables, it might actually decrease the fraction of children eating vegetables (if the increased variety allows these children to avoid vegetables by just eating more fruit). In Table 3, we re-estimate the same model as Table 2 but use as our dependent variable whether the child ate at least one serving of vegetables. For this analysis, we restrict our sample to just those observations collected using a mobile device in which we have

information about the consumption of specific items (this reduces our sample size from 48,533 to 11,656).

We find that for each additional item that is offered there is no statistically significant increase in the fraction of children who eat at least one serving of vegetables (the point estimate suggests a 1 percentage point increase but is very imprecise). We also separate our measure of the number of items being offered into a measure for the number of vegetables being offered and the number of fruits being offered. While neither of these coefficients are statistically significant, they are consistent with the pattern that offering more vegetable options increases the likelihood of eating a serving of vegetables, while additional fruit options reduces the likelihood of eating a serving of vegetables (suggesting some degree of cross-item crowd-out). This specific concern about cross-item crowd-out is something that could be examined in future research as more of this type of observational data is collected.

Conclusion

Schools are putting an increasing focus on ensuring that children are making healthy choices for their school lunch. Researchers have developed a number of interventions to help achieve this goal. In this paper, we use an innovative data collection approach that allows us to observe the consumption decisions that children make in a relatively cheap and unobtrusive way. We focus specifically on the fraction of children who eat at least one serving of fruits and vegetables, the consumption rates of specific items, and the amount of items that end up in the trash. The descriptive information that we provide can help school districts in balancing the different objectives of cost, nutritional quality, and the likelihood that children will actually eat the items.

We use this data to examine the effects of an intervention that would be very easy for most schools to implement: increasing the number of different fruit and vegetable items that are offered during lunch. We find that each additional item increases the fraction of children eating a fruit or vegetable by over 10 percent. This effect occurs because there is an increase in the number of fruits and vegetables that children place on their tray coupled with no change in the fraction of these items that end up in the trash. Our results also indicate that the increase in consumption is both an increase in the variety of the fruits and vegetables being offered as well as an increase in the likelihood that a more popular item is included as one of the choices.

Schools differ in their cafeteria structure, making it easier for some schools than others to expand the variety of fruits and vegetables that they offer at lunch. Our results suggest that investments and lay-out changes that allow schools to expand the variety of fruit and vegetable options each day should be considered among the set of interventions that schools can use to encourage healthy eating in children. While our results focused on offering additional fruits and vegetables, they might also apply to schools offering additional healthy entrée or beverage choices.

Finally, fruits and vegetables are part of a whole meal. The data collection approach that we use in this paper could also be used to examine the degree to which children may substitute away from fruits and vegetables when certain other items are provided. For example, providing large slices of pizza may reduce fruit and vegetable consumption even among those schoolchildren who otherwise would have at least one serving. Policymakers should consider both the quantity and quality of the foods being provided and how each may affect a child's decision to eat a desirable amount of fruits and vegetables.

References

Block, G., B. Patterson, and A. Subar. 1992. "Fruit, Vegetables, and Cancer Prevention: A Review of the Epidemiological Evidence." *Nutrition and Cancer* 18(1): 1–29.

Cheng, K.C., D.S. Cahill, H. Kasai, S. Nishimura, and L.A. Loeb. 1992. "8-Hydroxyguanine, an Abundant Form of Oxidative DNA Damage, Causes G-T and A-C Substitutions." *Journal of Biological Chemistry* 267: 166–172.

Dalton, S. 2004. "Schools and the Rising Rate of Overweight Children." *Topics in Clinical Nutrition* 19(1): 34–40.

Darmon, N., and A. Drewnowski. 2008. "Does Social Class Predict Diet Quality?" *American Journal of Clinical Nutrition* 87(5): 1107–1117.

Davis, M., T. Baranowski, K. Resnicow, J. Baranowski, C. Doyle, M. Smith, D.T. Wang, A. Yaroch, and D. Hebert. 2000. "Gimme 5 Fruit and Vegetables for Fun and Health: Process Evaluation." *Health Education & Behavior* 27(1): 167–176.

Dibsdall, L.A., N. Lambert, R.F. Bobbin, and L.J. Frewer. 2003. "Low-Income Consumers' Attitudes and Behaviour

Towards Access, Availability and Motivation to Eat Fruit and Vegetables." *Public Health Nutrition* 6(2): 159–168.

Epstein, L.H., C.C. Gordy, H.A. Raynor, M. Beddome, C.K. Kilanowski, and R. Paluch. 2001. "Increasing Fruit and Vegetable Intake and Decreasing Fat and Sugar Intake in Families at Risk for Childhood Obesity." *Obesity Research* 9(3): 171–178.

Foote, J.A., S.P. Murphy, L.R. Wilkens, P.P. Basiotis, and A. Carlson. 2004. "Dietary Variety Increases the Probability of Nutrient Adequacy Among Adults." *Journal of Nutrition* 134(7): 1779–1785.

Fuhrman, J. 2008. *Eat For Health: Lose Weight, Keep It Off, Look Younger, Live Longer*. Flemington, NJ: Gift of Health Press.

Glynn, L. 2010. "Healthy Waltham: Kids, Eat Your Veggies—With a Napkin." *Waltham News Tribune* (November 12, p. 9).

Just, D., and J. Price. 2011. "Using Incentives to Encourage Healthy Eating in Children." Working paper, Brigham Young University, Provo, UT.

Neumark-Sztainer, D., M. Story, C. Perry, and M.A. Casey. 1999. "Factors Influencing Food Choices of Adolescents: Finding from Focus Group Discussions with Adolescents." *Journal of the American Dietetic Association* 99(8): 929–937.

Nicklas, T.A., C.C. Johnson, L. Myers, R. Farris, and A. Cunningham. 1998. "Outcomes of a High School Program to Increase Fruit and Vegetable Consumption: Gimme 5—A Fresh Nutrition Concept for Students." *Journal of School Health* 68(6): 248–253.

Patterson, B.L. 1990. "Fruit and Vegetables in the American Diet: Data From the NHANES II Survey." *American Journal of Public Health* 80(12): 1443–1449.

Pollack, S. 2001. "Consumer Demand for Fruits and Vegetables: The U.S. Example." Report No. WRS01-1, Economic Research Service, U.S. Department of Agriculture, Washington, D.C.

Rimm, E.B., A. Ascherio, E. Giovannucci, D. Spiegelman, M.J. Stampfer, and W.C. Willett. 1996. "Vegetable, Fruit, and Cereal Fiber Intake and Risk of Coronary Heart Disease Among Men." *Journal of the American Medical Association* 275(6): 447–451.

Rolls, B.J., E.T. Rolls, E.A. Rowe, and K. Sweeney. 1981a. "Sensory Specific Satiety in Man." *Physiology & Behavior* 27(1): 137–142.

Rolls, B.J., E.A. Rowe, E.T. Rolls, B. Kingston, A. Megson, and G. Rachel. 1981b. "Variety in a Meal Enhances Food Intake in Man." *Physiology & Behavior* 26(2): 215–221.

Serdula, M.K., T. Byers, A.H. Mokdad, E. Simoes, J.M. Mendlein, and R.J. Coates. 1996. "The Association Between Fruit and Vegetable Intake and Chronic Disease Risk Factors." *Epidemiology* 7(2): 161–165.

Wardle, J., L.J. Cook, E.L. Gibson, M. Sapochnik, A. Sheiham, and L. Margaret. 2003. "Increasing Children's Acceptance of Vegetables; A Randomized Trial of Parent-Led Exposure." *Appetite* 40(2): 155–162.

World Health Organization. 2002. "The World Health Report 2002: Reducing Risks, Promoting Healthy Lifestyle." World Health Organization, Geneva, Switzerland.