Impact of Exposure to the Fresh Fruit and Vegetable Program on Children's Body Mass Index

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The Fresh Fruit and Vegetable Program (FFVP) is a supplemental nutrition program targeting low-income elementary schools in the United States. FFVP provides a fresh fruit or vegetable snack separate from normal school-meal times (school breakfast or school lunch). Goals of the program are to broaden childhood exposure to a variety of fresh fruits and vegetables, increase fruit and vegetable consumption, and promote health through improvements in children's diets (USDA Food and Nutrition Service (FNS) 2010). In 2002, FFVP began as a congressionally authorized pilot program in four states and one tribal organization. Additional states were added to the program in 2004 and 2006. The program was expanded to all states in 2008 and became permanently authorized in Section 19 of the 2008 Farm Bill.

FFVP is unique in that it targets low-income children, but the determination of "low-income" is made at the school level. Once an FFVP grant has been awarded to a school, free fresh fruit and vegetable snacks must be provided to all children attending the school, regardless of the child's own family's income. Thus, there should be no stigma attached to in-school FFVP participation as there could be with other school meal programs, which use a family-income test. To ensure that the program reaches lower-income students, FFVP grants are awarded to elementary schools with the highest percentage of students certified for free and reduced-price school-meal benefits. Schools must, nevertheless apply for the grants. States are required to conduct outreach to highest need schools to help ensure that these schools apply and meet the criteria to participate in the program (USDA-FNS 2010).

Schools receiving FFVP grants are funded at between $50 and $75 per student per academic year to use for fresh fruit and vegetable snacks. These snacks must be served at least twice per week and be served outside of normal school meal times (USDA-FNS 2010). The FFVP snack is often served in the classroom as part of a nutrition education lesson or in an effort to integrate nutrition education into other subject matter lessons. A companion nutrition education program is not a requirement of FFVP participation but is highly encouraged. The classroom teacher is also eligible to receive an FFVP snack because role modelling by the teacher can encourage children to try and consume the food being offered. FFVP schools are also required to advertise the availability of fresh fruits and vegetables within the school. A comprehensive overview of the program and its requirements can be found in a United States Department of Agriculture (USDA) handbook prepared to aid schools in applying and implementing FFVP program grants (see USDA-FNS 2010).

There is evidence that FFVP is popular among children (Lin and Fly 2016b) and that it is associated with increases in fruit and vegetable consumption (Lin and Fly 2016a). FFVP affects children's preferences, willingness to try, and ability to identify fruits and vegetables (Jamelske et al. 2008; Masis et al. 2017). Olsho et al. (2015) found that children in FFVP schools consumed significantly more fruits and vegetables, but that most of this increase was directly from foods provided by the program. However, there is evidence that FFVP is affecting broader changes beyond the immediate effects of fresh fruits and vegetables provided. For example, Ohri-Vachaspati et al. (2018) found that FFVP participation was associated with more requests for fruits and vegetables by children at home and on shopping trips. FFVP schools also tended to serve more fresh fruit during school meals in comparison to schools not participating in FFVP (Ohri-Vachaspati, Turner, and Chaloupka 2012). Finally, Qian et al. (2016) found that students in FFVP schools had lower BMI z-scores and BMI percentiles in comparison to comparable children in non FFVP schools.

The aim of this paper is to shed additional light on the association between FFVP exposure and weight outcomes among children in early elementary school. Like the earlier work of Qian et al. (2016), we use a unique dataset from a legislatively-mandated BMI screening program in Arkansas. We extend the work of Qian et al. (2016) in several ways. First, Qian et al. (2016) were only able to study the first two years of FFVP among Arkansas schools. While the evidence they presented is compelling, it was conducted early in the program's history and their sample size did not permit them to examine whether the association between program exposure and BMI differed by gender, race, ethnicity, or neighborhood income. The study was based on a limited number of schools that were early FFVP participants in Arkansas and that could, therefore, be more innovative or attentive to school health policies. Moreover, the children that comprised their sample were heterogenous with regard to age. In this study, we are able to draw on a much larger sample based on seven years of FFVP program history in Arkansas. This permits us to focus specifically on children in early elementary school, kindergarten through second grade. The children in our study fall primarily between ages 5 and 8 years and we examine the effect of continuous exposure to FFVP during kindergarten through second grade on the second grade BMI.

We focus on children in early grades of elementary school given that early provision of optimal nutrition have been linked to positive child development outcomes (Aboud and Yousafzai 2015; Hurley, Yousafzai, and Lopez-Boo 2016). Hence, prevention of nutrient deficiencies and promotion of healthy eating habits in early childhood can have longer-term and widespread benefits for children into adulthood. For example, studies have shown that the benefits of children's intake of fruit and vegetable can be traced into adolescence (Maynard et al. 2005, Pearson et al. 2011, Ambrosini et al. 2014) and that the food preferences established in early childhood tend to be maintained into adulthood (Mikkilä et al. 2004, Te Velde, Twisk and Brug 2007, Schneider et al. 2016). Data from the 2015-2016 period show that childhood obesity rates increased from 13.9 percent among children aged 2-5 years to 18.4 percent among children aged 6-11 years (Hales et al. 2018). This is another reason why early elementary grades are of importance. Our focus on Arkansas is also important given that it has one of the highest childhood obesity rates in the United States.

In what follows, we compare the BMI z-scores of children who were exposed to FFVP for three consecutive years to children who were never exposed to FFVP. We begin by comparing FFVP exposed to non-exposed students with controls of the child's family income, gender, race, ethnicity and neighborhood socioeconomic characteristics. Simple comparisons are problematic because FFVP specifically targets lower-income schools, where children are at greater risk of obesity. Consequently, we examine the association after homogenizing the sample to include only children from lower income neighborhoods and children from minority racial or ethnic groups. We find a negative association between BMI z-scores and FFVP exposure among African American children and children in lower-income neighborhoods. As a falsification test, we repeat the analysis using the children's kindergarten BMI z-score as the outcome variable. The logic here is that exposure to FFVP during kindergarten through second grade should have a much smaller or no impact on children's BMI during kindergarten since most of the exposure occurred after the kindergarten BMI measurement. Indeed, we find no evidence of a negative association between kindergarten BMI and three-years of continuous FFVP exposure.

Next, we use a machine-learning-based matching strategy to compute the average treatment effect on the treated (ATT) from a matched sample of exposed to non-exposed children.

This method places no restrictions on model complexity but penalizes overfitting to derive the ATTs (Athey, Tibshirani, and Wager 2018; Athey 2017; Wager and Athey 2017) and has an advantage over propensity-score matching in that it sidesteps the requirement of a researcher-supplied functional specification of the likelihood of being assigned to the exposed or non-exposed group. We compute the ATT of three-years of continuous FFVP exposure on 2nd grade BMI z-scores and find evidence of a negative association across all children, but again the largest effect is in subsamples of African American children and low-income boys. The falsification tests re-estimating the ATT of three-years of FFVP exposure on kindergarten z-scores from the same matched samples provide no evidence of a significant and negative association.

Data and Methods

Arkansas was the first US state to institute a statewide BMI screening program for public schoolchildren. The program was implemented to conform to Act 1220 of 2003, a state law designed to address high rates of childhood obesity. Children are screened biennially when they are in kindergarten, second, fourth, sixth, eighth, and tenth grades. Standardized protocols and equipment are used to measure children's heights and weights, which are collected by trained personnel in the public schools and are then converted to age-sex specific z-scores according to the Centers for Disease Control and Prevention (CDC) guidelines (CDC 2015). In addition to BMI, these data provide information on race, ethnicity, gender, age, grade in school, and school of attendance. Data from this ongoing screening program are maintained by the Arkansas Center for Health Improvement (ACHI), and the Center compiles annual reports of the screening program by academic year (e.g., ACHI 2017). ACHI facilitated the development of the dataset used in this research.

Staff at ACHI assisted in the assignment of children to their census block group of residence, which we used to match the BMI data to block-group-level neighborhood characteristics taken from the 2015 American Community Survey (ACS) five-year summary files. Specifically, we use the ACS data to characterize neighborhood racial composition, educational attainment, vehicle ownership, median income, property values, prevalence of poverty, and family structure.

Arkansas FFVP began in the 2008/2009 academic year. Our analysis is based on the BMI data covering the 2008/2009 through 2014/2015 academic years. Data on FFVP participation were provided by the Arkansas Department of Education Child Nutrition Unit and were matched to the BMI data by school. As noted above, FFVP snacks are available to all children who attend an FFVP elementary school. Thus, a child's FFVP exposure could be determined by his or her school of attendance. Even though BMI is measured in even-numbered grades, the dataset assembled for this research provided information on the child's grade and school of attendance in years when BMI was not measured. This allowed us to identify children who were fully exposed to FFVP by virtue of attending an FFVP school in kindergarten, first grade, and second grade. Similarly, we were able to identify children who were never exposed to FFVP during kindergarten through second grades. Our analysis reflects five cohorts comprised of children entering kindergarten in the 2008/2009 through 2012/2013 school years. Our outcome of interest is the BMI z-score in second grade, which is observed in the 2010/2011 through 2014/2015 school years for these cohorts, respectively. To ensure that FFVP exposure was measured consistently for all children, we excluded children who attended a FFVP school in one or two, but not all three academic years. We also excluded children that did not advance through the school system on schedule, those who skipped a grade or repeated a grade, as they would also not have a uniform, three-year exposure to FFVP by the second grade.

Finally, we restrict our sample to children with non-missing BMI z-scores in both kindergarten and second grade. While the second-grade z-score is the primary outcome of interest, the availability of the kindergarten BMI provides an opportunity to assess, through our falsification test, whether an observed association between FFVP exposure and BMI is spurious or meaningful. The logic is that if FFVP does actually prevent excess weight gain during early childhood, FFVP exposure, most of which occurs in the future, should not be having a meaningful impact on children's BMI at the present time. Thus, evidence of a negative association between FFVP exposure and second grade BMI coupled with much lower or no association between FFVP exposure and kindergarten BMI would suggest that FFVP exposure is playing a role in promoting healthy weight in early elementary school.

We first measure the association between FFVP exposure and second-grade z-scores within a regression framework that includes controls for the child's gender, race, ethnicity and income (as measured by eligibility for free school meals). We also control for the racial composition, mean level of educational attainment, and a number of other socioeconomic indicators within the child's census block-group of residence. Because FFVP specifically targets low income schools, we measure this association in subsamples homogenized by neighborhood income status, race, ethnicity, and gender.

Second, we estimate the ATT of FFVP exposure using matched samples obtained from a supervised machine learning approach called the "honest" random forest. The advantage of this approach is that unlike propensity matching, there is no need to specify a function between the likelihood of FFVP exposure observed covariates. In reality, this relationship can be complex and unknown. The approach is "honest" in that trees are grown using subsamples that differ from the subsamples used for predictions at the leaves of the trees (Wagner and Athey 2017). Therefore, the asymptotic properties of treatment effect estimates within the splits are the same as if the partition had been exogenously given (Athey, Tibshirani, and Wager 2018; Athey and Imbens 2016; Wager and Athey 2017). The method places no restrictions on model complexity (but penalizes over-fitting) to derive the ATTs (Athey, Tibshirani, and Wager 2018; Athey 2015; Wager and Athey 2017). Software to implement the method is available in R through the Generalized Random Forests (grf) package (Tibshirani et al. 2018). Specifically, we use the "causal_forest" command within the grf package to compute the ATT estimates of FFVP exposure.

Results

Table 1 presents the descriptive statistics for the FFVP exposed and FFVP non-exposed children. On average, children in the FFVP-exposed sample have second grade BMI z-scores that are 0.055 standard deviations higher and kindergarten BMI z-scores that are 0.044 standard deviations higher than children in the non-FFVP sample. This reflects the fact that FFVP targets lower-income children who are at increased risk of excess weight gain during childhood. The differences in income are apparent in table 1. On average, FFVP-exposed students qualified for free lunch 1.7 of the three years spent in kindergarten through second grade in comparison to 1.4 years for the non-exposed students. There are similarly marked differences in the median home value, level of educational attainment, poverty rate, and median household income in the neighborhoods where FFVP-exposed and non-FFVP exposed children live. The two samples are fairly comparable in terms of race and ethnicity with each comprising about 19.5 percent African American children. There are slightly more Hispanic children in the non-exposed sample. Asian children are a small proportion of each, but also have greater representation in the non-exposed sample.

Table 2 presents regression estimates of the association between FFVP exposure and BMI z-score for our full sample and for several subsets comprised of children from lower-income neighborhoods, Hispanic children, African American children, boys in lower income neighborhoods, and girls in lower-income neighborhoods. Lower income neighborhoods are defined as those where the majority of households in the census block fell below 185 percent of poverty. The 185 percent threshold is chosen because it is the cutoff for reduced-price school meals. Children at or below this threshold are targeted by FFVP. All models include controls for block group characteristics reported above in table 1 (estimates not reported).

With exception of the full sample, estimates of the association between FFVP exposure and second-grade BMI z-score are negative. Only two are significant at conventional levels, the estimate for children in lower-income neighborhoods and the estimate for African American children. The estimate from the full sample, while positive, is essentially zero for practical purposes. A comparison of this estimate to the mean difference in BMI z-score computed from table 1 among the FFVP-exposed and non-exposed samples suggests that controls are capturing much of the higher risk of excess weight gain faced by children from disadvantaged socioeconomic backgrounds. The association for lower-income boys ($p = 0.11$) is larger than for low-income girls but is not significant at conventional levels.

Table 3 presents the results of our falsification test; i.e., estimates of the association between FFVP exposure and kindergarten BMI. The specifications in table 3 are same as those reported in table 2, except there is no control for an earlier BMI measurement (models in table 2 included the child's kindergarten BMI z-score as a control). None of the reported associations between kindergarten BMI z-score and FFVP exposure are significant. Those estimated from the low-income sample and sample of African Americans continue to be negative but with estimates that are roughly 10 times smaller in magnitude in comparison to the estimates reported in table 2. In kindergarten, FFVP-exposed children would have been in the program for just a few months. The fact that there is no evidence of an association between FFVP exposure and kindergarten BMI provides evidence that the association found with second-grade BMI is meaningful as opposed to spurious.

Other estimates in tables 3 and 4 are generally as expected, but sign reversals on the free school-meals measure is noteworthy. Table 3 suggests that children eligible for free meals in kindergarten through second grade had higher BMI z-scores. Significant and positive estimates are reported for all but the subsample of African American children. Eligibility for free meals is based on income and it is likely that a family's unobserved income status prior to the child entering public schools is highly correlated with the family's income status during the child's time in early elementary school. Thus, the positive and significant association is consistent with earlier evidence that lower-income children are at greater risk of excess weight gain. Interestingly, this association is negative for all but the subsample of Hispanic children in table 2.

This sign reversal could be a reflection of recent findings by Smith (2017) that school meals represent an important improvement to the diets of disadvantaged children at risk for low-quality diets outside of school. In table 3, the free-school meal variable primarily reflects the child's income status because he or she would have been the recipient of school meals for only a few months when kindergarten BMI was measured. By the time BMI was measured in second grade (table 2), the child would have had access to meals at school for a much longer period of time, which may have led to dietary improvements that lowered energy intake. The fact that the magnitude of the estimate for free meals is larger among lower-income and minority students are also consistent with Smith's (2017) findings that school meals play an important role for disadvantaged children.

The top panel of table 4 presents the ATT estimates on the second-grade BMI z-score obtained from the causal forest algorithm in Tibshirani et al.'s (2018) grf package. In contrast to the estimate reported above, the ATT estimate from the sample of all children is negative and significant. The ATT from the low-income sample is larger in magnitude but is not statistically different from zero. Much of the main effect appears to be driven by African American children and boys in lower income neighborhoods. The ATT estimates from these groups are, respectively, -0.914 and -0.139 standard deviations. These estimates show a meaningful difference in second-grade BMI among FFVP-exposed and non-exposed children. In contrast to the ATT estimates on second-grade BMI z-scores, falsification ATTs computed with kindergarten BMI scores (bottom panel of table 4) show no evidence of a meaningful negative association between FFVP and kindergarten BMI.

Discussion

Findings presented above provide evidence of a meaningful negative association between FFVP exposure and BMI, but we are unable to address or assess the mechanisms by which FFVP exposure influences excess weight gain. One is that a healthy snack may help regulate appetite. An important feature of the program is that fresh fruits and vegetables are served outside of normal meal times. School lunch can be served as early as 10:30 am. A fresh fruit or vegetable snack later in the day could curb hunger pains and reduce the desire to snack after school or on other occasions. Second, FFVP may increase the frequency of children asking for fresh fruits and vegetables outside of school as found by Ohri-Vachaspati et al. (2018). Substitution of fruits and vegetables for other energy dense foods can reduce overall energy intake and prevent excess weight gain. Finally, to the extent that FFVP leads to greater acceptance of fresh fruits and vegetables among children, school meal plans may improve to accommodate this greater acceptance. Indeed, Ohri-Vachaspati, Turner, and Chaloupka (2012) provide evidence that FFVP schools are more likely to serve fresh fruit during school meals. An increased frequency of fresh fruits and vegetables in school meals may help moderate energy intake, which could help prevent excess weight gain.

We find that the largest association between FFVP-exposure and improvements in body weight were among African American children. This may be an especially important finding given that African American children are at an elevated risk for obesity (Caprio et al. 2008). However, it is somewhat difficult to place this finding within the extant literature because the literature on the influence of race/ethnicity on fruit and vegetable consumption contains mixed findings depending on which groups were compared, and there are often different patterns of consumption observed for fruit and vegetables Melnik et al. 1998,Cullen and Zakeri 2004, Rasmussen et al. 2006, Kim et al. 2014, and Drewnowski and Colin 2015).

We also find a large effect for boys in lower-income neighborhoods but not for girls. Girls tend to have a higher or more frequent intake of fruits and vegetables than boys (Cullen et al. 2000, Cullen et al. 2003, Rasmussen et al. 2006, Drewnowski and Colin 2015). Consequently, a program like FFVP may not be as important in changing the behaviors of girls. The fact that FFVP has a higher effect among boys indicates the program is a good intervention to help boys in lower-income neighborhoods who are unlikely to consume sufficient fruits and vegetables at home.

Policy Implications

The evidence presented here suggest that FFVP could be an important intervention to help address high rates of childhood obesity. While we only consider the impact of FFVP exposure through second grade, studies have shown that the benefits of children's intake of fruit and vegetable can be traced into adolescence (Maynard et al. 2005, Pearson et al. 2011, and Ambrosini et al. 2014) and that the food preferences established in early childhood tend to be maintained into adulthood (Mikkilä et al. 2004, Te Velde, Twisk and Brug 2007, and Schneider et al. 2016).

FFVP was funded at 40 million dollars in the 2008 Farm Bill with the potential to increase to 150 million dollars (USDA-FNS 2010). At present, FFVP does not reach all schools that would be technically eligible for the program. This is true in Arkansas where funding is insufficient to provide grants to all eligible schools that apply. The program costs of FFVP are modest relative to other nutrition programs. Given the growing body of evidence that FFVP is linked to improvements in fruit and vegetable consumption coupled with the findings presented here and earlier in Qian et al. (2016) showing an association between FFVP participation and improvements in BMI, expansion of FFVP to reach all eligible schools should be a high priority. Indeed, Qian et al. (2016) present a compelling case that FFVP is a cost-effective childhood health intervention.

Limitations and Future Areas of Research

Our data permit us to look only at the association between FFVP exposure and BMI. Fruit and vegetable consumption has been associated with a number of beneficial health outcomes in addition to healthier body weight (Shashirekha, Mallikarjuna and Rajarathnam 2015). Thus, our study is unable to capture the broader benefits of increases in fruit and vegetable consumption that could result from exposure to FFVP. Moreover, because the benefits of fruit and vegetable consumption are numerous and varied, our finding of no meaningful association among Hispanic children and lower-income girls should not be taken as evidence that FFVP is ineffective for these groups of children.

Another limitation is that we are unable to conclusively show that FFVP is a causal factor in lowering BMI. This is because we are unable to separate FFVP exposure from other school policies that could be conducive to a healthy weight status. It is possible, for example, that FFVP is especially attractive to schools that already emphasize nutrition education, engage in farm-to-school initiatives, or maintain strong physical activity programs. In such cases, FFVP exposure could be symptomatic of a positive school environment, and the causal factors behind improved weight outcomes could be other school policies that promote healthy weight.

Nevertheless, findings from Olsho et al. (2015) provide evidence of a causal link between FFVP and increased fruit and vegetable consumption. These researches used a regression discontinuity design and measured dietary intake from students in schools just above and below the funding cutoff in randomly selected states. We were unable to pursue a similar strategy here because we have BMI measurements linked to schools from only one state and attempts to replicate this study on BMI would be underpowered. Nevertheless, Olsho et al.'s (2015) findings suggest that it is plausible that FFVP is a meaningful factor driving the improvements in childhood BMI observed here. FFVP status is the one known commonality shared across all schools. Moreover, states have a requirement to engage in outreach to encourage FFVP applications from the most disadvantaged schools, which may limit the ability of healthier schools to self-select into the program.

Nutrition interventions have been found to benefit children's growth outcomes and children's development (Grantham-McGregor et al. 2014). Hence future studies should also assess if FFVP exposure can have longer term effects on other important outcomes such as cognitive development, academic achievement, and labor market outcomes. Moreover, a growing body of evidence documents the persistent effects of temporary interventions or policies on a range of individual or household behaviors (Costa and Gerard 2018). Hence, it is possible that the benefits of the FFVP program could persist even if it is no longer in place given the possible mechanisms discussed above (e.g., habit formation). It would then be important for future studies to check if hysteresis in children's behavior exists; i.e., if the effects of FFVP exposure in early elementary school can be maintained into later years even if it is no longer in place. Such studies can be informative for the welfare evaluation of not only the program's short-run but also long-run effects.

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Table 1. Descriptive Statistics

	FFVP-Exposed Children (N=4,870)		Non-FFVP Children (N=63,682)	
	Mean	Std. Dev.	Mean	Std. Dev.
Second Grade BMI z-score	0.660	1.088	0.605	1.072
Kindergarten BMI z-score	0.629	1.076	0.585	1.060
Female	0.497	0.500	0.498	0.500
Hispanic	0.102	0.302	0.128	0.334
Asian	0.009	0.092	0.025	0.156
African American	0.194	0.396	0.196	0.397
Other Races	0.017	0.129	0.017	0.129
Free School Meals (years)	1.710	1.334	1.415	1.364
Neighborhood Characteristics				
Asian Population [a]	0.005	0.015	0.015	0.034
African American Population [a]	0.166	0.240	0.166	0.253
Hawaiian or Pacific Islander Population [a]	0.000	0.003	0.005	0.023
Native American Population [a]	0.004	0.011	0.007	0.014
Population of Other Race [a]	0.035	0.047	0.053	0.080
College and Higher [a]	0.148	0.089	0.223	0.153
Some College [a]	0.276	0.082	0.289	0.081
High School [a]	0.386	0.094	0.333	0.108
Median Home Value ($1,000) [b]	89.385	32.290	124.771	61.694
Median Year Structures were Built	1979.970	9.557	1983.960	12.356
Households in Rental Units [a]	0.356	0.176	0.337	0.190
Vacant Housing Units [a]	0.144	0.086	0.123	0.089
No Vehicle [a]	0.071	0.072	0.059	0.069
Below 185 % Poverty [a]	0.461	0.156	0.384	0.187
Median HH Income ($1,000) [b]	37.116	11.346	48.575	21.907
Single Female HH with children [a]	0.300	0.219	0.263	0.231
Married HH with children [a]	0.625	0.227	0.667	0.245
Working Mother [a]	0.660	0.189	0.636	0.194
Spanish Language [a]	0.051	0.076	0.067	0.100
Asian or Pacific Language [a]	0.004	0.014	0.014	0.029
Other Language [a]	0.009	0.019	0.013	0.019

a. Proportion within the block-group of the child's residence based on the 2015 American Community Survey.

b. Monetary values are in 2015 dollars.

Table 2. Regression Estimates, the Dependent Variable is Second-Grade BMI z-score

	All Children (N= 68,552)	Low-Income (N=18,430)	Hispanic (N=8,667)	African American (N=13,429)	Low-Income Boys (N=9,131)	Low-Income Girls (N=9,299)
FFVP	0.004	-0.031*	-0.040	-0.046**	-0.040	-0.026
	(0.010)	(0.017)	(0.029)	(0.023)	(0.025)	(0.022)
Kindergarten BMI	0.825***	0.821***	0.816***	0.815***	0.785***	0.860***
	(0.003)	(0.005)	(0.008)	(0.006)	(0.008)	(0.007)
Female	0.001	0.016*	-0.061***	0.053***		
	(0.005)	(0.009)	(0.013)	(0.010)		
Hispanic	0.113***	0.107***			0.160***	0.058***
	(0.009)	(0.015)			(0.022)	(0.021)
Asian	0.054***	0.066**			0.137***	0.007
	(0.016)	(0.031)			(0.043)	(0.044)
African American	0.100***	0.078***			0.061***	0.094***
	(0.009)	(0.016)			(0.023)	(0.021)
Other Races	0.058***	0.038			0.033	0.042
	(0.018)	(0.035)			(0.049)	(0.049)
Free School Meals (years)	-0.004*	0.017***	0.006	-0.014***	-0.024***	-0.010
	(0.002)	(0.004)	(0.007)	(0.005)	(0.006)	(0.006)

Notes: *, **, *** indicates significance level at p<0.1, p<0.05, and p<0.01. Robust standard errors are in parentheses. All regressions also include controls for characteristics of children's census block groups as reported in table 1. Low-income refers to children in block groups with more than 50 percent of households below 185 percent of poverty.

Table 3. Regression Estimates, the Dependent Variable is Kindergarten BMI z-score

	All Children (N= 68,552)	Low-Income (N=18,430)	Hispanic (N=8,667)	African American (N=13,429)	Low-Income Boys (N=9,131)	Low-Income Girls (N=9,299)
FFVP Exposure	0.0003	-0.004	0.014	-0.005	-0.025	0.020
	(0.016)	(0.029)	(0.053)	(0.039)	(0.042)	(0.039)
Female	-0.050***	-0.044***	-0.156***	-0.012		
	(0.008)	(0.016)	(0.024)	(0.019)		
Hispanic	0.286***	0.227***			0.266***	0.185***
	(0.015)	(0.027)			(0.040)	(0.037)
Asian	-0.144***	-0.125**			-0.006	-0.232***
	(0.028)	(0.050)			(0.076)	(0.066)
African American	0.102***	0.054*			0.056	0.051
	(0.016)	(0.028)			(0.040)	(0.038)
Other Races	0.042	0.046			0.003	0.085
	(0.031)	(0.059)			(0.084)	(0.083)
Free School Meals (years)	0.021***	0.028***	0.045***	-0.002	0.023***	0.033***
	(0.004)	(0.008)	(0.012)	(0.009)	(0.011)	(0.011)

Notes: *, **, *** indicates significance level at p<0.1, p<0.05, and p<0.01. Robust standard errors are in parentheses. All regressions also include controls for characteristics of children's census block groups as reported in table 1. Low-income refers to children in block groups with more than 50 percent of households below 185 percent of poverty.

Table 4. Average Treatment Effect on the Treated (ATT) from the Generalized Random Forest Estimation.

	All Children	Low-Income	Hispanic	African American	Low-Income Boys	Low-Income Girls
	Second-grade BMI z-score					
ATT	-0.056**	-0.068	0.006	-0.194***	-0.139**	0.067
Std. Error	(0.0267)	(0.052)	(0.058)	(0.074)	(0.058)	(0.047)
	Kindergarten BMI z-score					
ATT	-0.028	0.056	0.002	0.105	0.0428	0.0824*
Std. Error	(0.028)	(0.053)	(0.059)	(0.098)	(0.064)	(0.048)

Notes: Low-income refers to children in block groups with more than 50 percent of households below 185 percent of poverty.