Empowering through Taste and Food Education: The Impact of a School-based Intervention on Students Food Preferences

Kristin Kiesel[1], Lilia Smialkova[2], Sofia B. Villas-Boas[3], Michael L. Anderson[4],

[1] Assistant Professor, Department of Economics, California State University (corresponding author)

[2] Food Project Manager, Center for Science in the Public Interest

[4] Associate Professor, Department of Agricultural and Resource Economics, University of California, Berkeley

[3] Associate Professor, Department of Agricultural and Resource Economics, University of California, Berkeley

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Abstract

This study evaluates the short-term effects of implementing a comprehensive food education curriculum aimed at encouraging healthier and more sustainable food choices among children. In designing this pilot program as a quasi-experiment, we collected information on the preferences and food choices of treated and untreated students prior and post implementation in three public schools in Belarus. Differences-in-differences regressions, comparisons of means, and graphical analyses support the hypothesis that educational interventions can change preferences and empower students in making healthier choices. Our results also highlight difficulties in evaluating education programs, and the need to develop more comprehensive and effective evaluation tools.

1. Introduction

Obesity has become a worldwide health epidemic, burdening the US economy alone with obesity-related costs of $270 billion annually (SOA 2010). At the same time, agricultural production of food is one of the largest contributors to global environmental problems (UNEP 2010). In addition to changes in our surroundings that detach us from food production, leave less time to prepare and cook foods at home, and promote physical inactivity, many specific influences have been proposed as driving these trends in our food system. Factors that promote overconsumption of food include a decrease in relative prices of calorie-dense and highly processed foods (Andreyeva, Long, and Brownell 2010), an increase in sophisticated food marketing and practices that take advantage of behavioral reactions to food (Smith 2004), an increase in the prevalence of snack foods (Cutler, Glaeser and Shapiro 2003; Chou, Grossman and Saffer 2004; Chandon and Wansink 2011), increased portion sizes (Wansink and van Ittersum 2007), and growth in distractions in the eating environment (Wansink 2004). Policy approaches have focused on increased availability and affordability of healthier and more sustainable food choices, or targeted information provision. Yet, increased information provision does not always improve choices (Wansink and Chandon 2006; Variyam and Cawley 2006) and could lead to unintended consequences (e.g. Wisdom, Downs, and Loewenstein 2010; Kiesel and Villas-Boas 2013).

In the search for effective policy tools to address the obesity epidemic, the school environment has become the focus of a multitude of interventions. Children spend approximately one-third of their waking hours in school, and the school's physical, social and educational surroundings offer a unique opportunity to teach and promote healthy and sustainable lifestyle choices to a large audience of school-aged children and their families. Recent literature promotes

the potential of low-cost changes to breakfast and lunch programs and school cafeterias (e.g. Just and Wansink 2010), the use of monetary incentives (Price and Just 2014), evaluates more restrictive approaches such as banning of soft drinks from schools (e.g. Huang and Kiesel 2012), and investigates potential cost and nutritional differences of scratch cooking versus heat-and-serve operations at schools (Woodward-Lopez, et al. 2014). In contrast, this study evaluates the effects of a comprehensive taste and food education program on students' attitudes, food preferences, and food choices. It adds needed quantitative evidence of the effectiveness of school-based educational interventions (Rudd Center 2009).

The Taste and Food education implemented in public schools in Belarus encouraged healthier and more sustainable food choices among participating students. Students studied the origin and production methods of local foods, their quality characteristics, and their social and economic importance within the Belarusian culture using educational material designed by Slow Food ("To the Origins of Taste", Slow Food 2010). While this research ultimately aims at implementing effective food education in general, and relates to previous research in Western context such as in the United States (US), an initial implementation and evaluation of a pilot program in Belarus is appealing. Belarus has been influenced by Western diets for only 20 years, recently exposing students to many of the factors highlighted above. In Belarus the percentage of income households spend on food is very high (54%) (HDR 2009), which makes food choices an important part of budgetary decisions for most households.[1] The majority of households still have access to subsistence farming or urban allotments, potentially allowing a closer connection

[1] In comparison, in the US, 10% of disposable household income is allocated to food expenditures on average (ERS-USDA 2014).

to where their food comes from.[2] Finally, food related programs and interventions in the school environment and greater community are not as multifaceted and rapidly emerging as in the US. The control group in this study is thus closer to a "pure control", potentially improving the identification and measurement of the educational effects in this study.

Food choices by children and adolescents are influenced by trade-offs between healthiness and taste, as well as their own preferences and habits observed in their environment (Contento et al. 2006). Children may lack personal concern to follow basic recommendations about healthy eating (Croll et al. 2001). The existing literature suggests that effective interventions should address taste preferences even if they are primarily aimed at improvements in accessibility and availability (Blanchette and Brug 2005). They should also incorporate sensory perceptions of food (Drewnowksi 1997), food culture, food production, and preparation (Lang and Rayner 2007). The curriculum design translated these general findings into hands-on education empower students in making healthier and more sustainable food choices. The lesson plan included numerous taste tests. In addition to connecting students to local traditions, such as preparation of home-made sausages and fish, a particular emphasis was placed on fruits and vegetables that were local and in season. This emphasis on local, in-season produce is both consistent with recent developments in the US, such as new nutrition requirements in guidelines[3], and recent research findings. The recent literature suggests that increased consumption of fruits and vegetables is particularly important in reducing the incidence of chronic diseases and obesity among children (Knai et al. 2006) and indicates a need for repeated

[2] All of the participants of this study, for example, have access to gardens and garden foods through parents or extended family. Being dependent on home-grown food is seen as a sign of low-income, however, and the purchase of food items influenced by a Western diet, such as Coca Cola can serve as a status symbol.

[3]New guidelines that aim at increasing consumption of fruits and vegetables in the National School Lunch Program (NSLP) were introduced in 2012 (USDA 2013), and are supported by recommendations and guidelines published by the Center for Disease Control and Prevention (CDC) and Institutes of Medicine (IOM) (CDC 2011, IOM 2012).

exposure as well as methods that focus on specific fruits and vegetables rather than nutrition as a whole to influence children's preferences (Anzman-Frasca et al. 2012). It also highlights the potential of school-based taste events to reach beyond the school environment and increase household fruit and vegetable availability and consumption (Heim et al. 2011).

The analysis presented here aims at establishing a causal link between the educational intervention and a change in student's attitudes, preferences and food choices in this context. In designing this pilot program as a quasi-experiment, we collected information in two treatment schools from students that participated in the program, as well as one additional control school. An initial qualitative data analysis based on group interviews suggested that project participants reduced consumption of energy-dense foods (such as chips and soda) mainly due to increased health considerations and peer influence (Smialkova 2010). Here, we quantify these effects. We analyze survey responses as well as daily food diaries documenting student's food choices in a reduced-form differences-in-differences (DID) framework commonly used in the policy evaluation literature (Meyer 1995; Bertrand, Duflo, Mullainathan 2004; Imbens 2004; Imbens and Wooldridge 2009). We augment these findings with additional comparisons of means, and graphical analyses.

Our results suggest that preferences for chips (one of the classified less-healthy alternatives) significantly decreased in the group of students participating in the taste and food education curriculum. While the observed decrease in preferences for soda (another less-healthy alternative) was not statistically significant, additional analyses of food diary entries suggests a reduction of preferences for soda, and a reduction in consumption of unhealthy foods overall. We also find that participating students are more aware that they are picky eaters, more likely to try new food, such as fish, and more likely to cook with their parents. In conclusion, our results are

suggestive of a causal influence on students' attitudes and food choice behaviors. We further reflect on challenges and limitations in the evaluation approach used and aim at informing future evaluation strategies.

The paper proceeds as follows. Section 2 describes the study design and data in more detail, while Section 3 introduces our econometric specifications. We present our results in Section 4 and conclude the paper with a discussion and implications for future evaluation strategies.

2. Study design and data

This study investigates how an extra-curricular program on food and nutrition introduced in public schools in the Brest region of Belarus affects food preferences and choices of children and adolescents. The curriculum "To the Origins of Taste" was designed by Slow Food (Slow Food 2010). Slow Food is an international grassroots organization with over 150,000 members in more than 150 countries worldwide. Founded in 1986 in Italy as a reaction to a McDonald's franchise opening in Rome, education has been central to Slow Food's mission of "good, clean and fair food." More specifically, Slow Food aims at linking the pleasures of eating with a commitment to protect the community, culture, knowledge and environment that make this pleasure possible. The developed Taste and Food education curriculum emphasizes hands-on and sensory experiences along with the provision of information on nutrition and food production. Table 1 summarizes a lesson plan.

School home-economics teachers were recruited to deliver lessons over a period of 9 to 15 months (from March 2009 to May 2010). While Slow Food provided the necessary teaching materials and support for the program, the research team supplied the surveys and food diaries to

assess determinants of food choices prior and post program implementation. Berioza School 3 was initially contacted to implement the Slow Food curriculum, and two additional schools (Berioza School 2 and Kobrin School) were added to strengthen the experimental design of the study. Student participation in the extra-curricular program was voluntary, so the assignment of treatment (intervention) and control groups *within* each school may be affected by selection bias or spillover effects.[4] To address this issue, a school in Kobrin (an adjacent city with similar socio-economic background) was added to the sample as a control school. This school was interested in implementing the program in the future, suggesting that it may serve as a good comparison school for the two schools that participated in our program (i.e., any "selection bias" that influenced the participation of the first two schools should also be similarly present in our comparison school, and ultimately will be differenced out in our research design). Students in all three schools range in age from 8 to 17 years, have similar socio-economic demographics, and are mostly native Belarusians.

All participating students completed questionnaires at the beginning and end of the program during their lessons. [5] Students in the control group varied throughout the research, as teachers distributed the questionnaires randomly within the schools and classes, and students from the control group could either fill out the questionnaire at school or take it home. The student questionnaires (in Russian and English) are included in the appendix. Table 2 reports the number of questionnaires distributed and collected across the treatment and control groups in the three schools.

[4]As the program was implemented as an extra-curricular activity, it cannot be made obligatory or assigned to one class only. However, and more students wanted to join than were able to, such that the participation constraint was binding. We do not have data or an identifier for students who wanted to join the program but did not get in, which would be the best within school control group, an issue we address in the next section.

[5] Due to the duration of the program in the Berioza school 3 (March 2009 – May 2010), a few 9th grade participants graduated, and were replaced by new participants (16 students).

In addition, daily food choices were recorded for a subsample of students in a form of a diary. Daily food diaries were distributed in two classes in the Berioza School 3 only, and students were asked to record what they ate, either selected from a menu of food choices offered at the school cafeteria, or brought from home. Participating students were encouraged to fill in the diaries as part of the lessons resulting in up to 63 individual student food diaries and more than 3000 entries for a given month in the program.[6] 42 of the students that filled out the food diaries participated in the program for the entire period. The sample for the control group varied as a random sample of 30 non-participating students at the same school also filled out food diaries for one month at the beginning and the end of the program. These students did not fill out their diaries under the supervision of teachers, and responses are slightly less detailed. We did not observe food choices for students in the control school.

3. Econometric specification

The regression analyses reported here focus on student questionnaire responses in the treatment (or intervention) group and control groups described above. In order to credibly test for potential changes in taste preferences and food choices, we make use of the quasi-experimental variation of the implemented program. Our reduced-form econometric approach builds on difference-in-differences (DID) specifications commonly used the policy evaluation literature (Meyer, 1995; Bertrand, Duflo, Mullainathan 2004). Estimation of average treatment effects on the treated in this framework rests on the assumption that differential changes in outcomes between treated and control groups are attributable to the intervention. This condition—the

[6] Participating students were broken up in classes taught by three different teachers. Only two teachers had students fill out food diaries. In addition, students did not fill out diaries during the summer break and due to administrative and financial constraints, they did not resume filling out diaries till October of the fall semester, but continued to fill out the diaries till the end of the program under the supervision of the teachers during their lessons. For participating students we therefore have a total of 9 month of dairy entries.

common trends assumption—is satisfied when, absent intervention, the outcome would have followed similar trends in the treatment and control groups.

Within each school, we examined a control group of students not participating in the extra-curricular program. As participation in the program was voluntary, intervention and control groups within schools are potentially affected by selection bias. In addition, participating students might disseminate information, share their experiences, and potentially influence non-participating student responses within a school. Assignment of the program across schools is exogenous, however. Furthermore, since the control school is in a different city, we do not expect spillover effects across schools. Student responses from the Kobrin School therefore serve as a more robust control for both Berioza Schools. We thus use the school level program assignment to instrument for the individual level program assignment at a given school. School level program assignment should be a valid instrument because: (1) it clearly affects the probability that an individual participates in the program, and (2) it is plausibly exogenous to other factors affecting the outcomes.

We begin our analysis by estimating the following DID regression model:

$$y_{it} = \beta_0 + \beta_1 d2 + \beta_2 dI + \delta_1 d2 * dI + u_{it} \qquad (1)$$

Students are indexed by *i*, and *t* indexes time periods (taking the value of one pre-treatment and the value of two post-treatment). Therefore, y_{it} is defined as the individual student response to a particular question at a particular time period. The variables *d2* and *dI* are dummy variables for the treatment period (post implementation) and the group of treated students respectively. Therefore, the coefficient δ_1 on the interaction between those two variables denotes the DID

estimator. If $\bar{y}_{i,t}$ denotes the sample average across either the intervention or control group in a given time period, then δ_1 measures the change in question responses due to our educational intervention. The DID design allows for both group-specific and time-specific effects by comparing mean changes over time between the control and treatment groups:

$$\hat{\delta}_1 = (\bar{y}_{I,2} - \bar{y}_{I,1}) - (\bar{y}_{C,2} - \bar{y}_{C,1}) \quad (2)$$

We estimate equation (1) separately for the two schools implementing the intervention (Berioza Schools 2 and 3), as the timing and implementation of the program varied slightly across those two schools.[7] We also added additional controls such as the age and gender of the students to reduce any potential biases.

The DID identification and unbiasedness of the DID estimator relies on the common trends assumption. That is, in absence of the intervention, the unobservables that are correlated with students participating in the program follow a similar time trend as for students not participating in the program. This common trends assumption is not likely to hold if students participating in a given school have very different preferences and make very different choices than students not participating, e.g., if they have much healthier preferences or are more aware and thoughtful of their food choices than the students not participating. We capture time-invariant differences across students with the inclusion of the treated student fixed effect. As an additional robustness check, we exploit the fact that students in other schools in the same region should have similar preferences on average but are not affected by the intervention. We estimate a DID specification that instruments for students' program participation, the interaction between

[7]Both schools implemented the same lesson plan, but Berioza School 3 implemented the plan with one lesson per week, starting in March 2009, and Berioza School 2 implemented the lesson plan with two lessons per week starting in September 2009.

treated student (*dI*) and treated time period (*d2*), with school-level program participation. Let w_{it} denote the interaction between *dI* and *d2*. We estimate the following two-stage DID regression:

$$w_{it} = \beta_0 + \beta_1 d2_t + \beta_2 dS_i + \beta_3 d2_t * DS_i + u_{it}$$

$$y_{it} = \beta_0 + \beta_1 d2_t + \beta_2 dS_i + \delta_1 \hat{w}_{it} + u_{it} \quad (3)$$

This approach adds an additional interaction, the dummy variable for the treatment period (*d2*) with the treated school (*dS*), as an instrument in the first stage. In addition, the treatment month fixed effect (*d2*) controls for time trends that are common across schools, and the treatment school fixed effect (*dS*) controls for time-invariant characteristics of students that may differ across schools. In both estimation approaches we specify heteroskedasticity-robust standard errors.[8]

Finally, this regression approach is complemented by reporting mean differences in student questionnaire responses across treatment and control groups, as well as graphical comparisons. The additional analysis of food diaries is summarized in reported mean differences and graphical representations of food choices of participating students across time.

4. Results

After collecting, translating, and editing the received questionnaire responses, our analytic sample contained 1,418 student responses.[9] One advantage of the DID approach is that graphical analyses can support the existence (or the lack of) treatment effects. Our regression analysis

[8] We are not able to cluster standard errors at the student level as students in the control group vary and individual student identifiers are incomplete.

[9] Complete responses to questions vary, and information on gender and grade is incomplete, with a greater number of missing observations for the control groups.

focuses on questions 6 and 13, preferences for soft drinks (henceforth called soda) as compared to other drink options, and preferences for chips as compared to other food options.[10] The rationale behind focusing on these two questions is that they ask about actual food choices, and that soda and chips are easily classified as less healthy among the available alternatives.[11]

In Figure 1, we take a first look at student responses to question 6 for Berioza School 3. The left panel records the frequency of student preferences for soda prior to, mid-point and post intervention for the within-school control group, while right panel records these preferences for students participating in the Food and Taste education. We observe a slight increase mid-point and then a decrease at the end. However, we also observe a decrease for the within-school control group in post-treatment period.[12] For the regression analysis, we defined the dependent variable, y_{it}, as an indicator for soda preference (equaling one if students select soda, and zero otherwise). The distribution of student answers to question 13, corresponding to the liking of chips, is reported in Figure 2 for the Berioza School 3.[13] Here, we see a clear shift in the distribution of answers towards liking chips less for program participants. It is not entirely clear what other food choice replaces the liking of chips, however. A graphical analysis of all other choices suggests an increased liking of apples, supported by the fact that apples are used in a number of taste tests and exercises throughout the lessons. In addition, participating students seem to like meat slightly more after the program completion. This might be a result of a lesson on making homemade sausages, a local Belarusian tradition.[14]

[10] For the complete survey questions see the appendix.
[11] While other questions such as question 1 and 9 also ask about actual food choices, they either group choices available in the cafeteria, or ask students what they do not like. Questions that measure potential changes in attitude and knowledge are included in the additional graphical analysis and summary statistics.
[12] Only soda preferences are graphed here as these are our primary concern of interest.
[13] This questions asks: From 1(best) to 6(worst), indicate which food do you like best, and gives students the following choices: chips, apples, soup, sauerkraut, ice cream, steak.
[14] Graphs for other choices are not included here, as changes in distribution are less distinct. These additional graphs are available upon request from the authors.

The econometric analysis focuses on these two questionnaire questions as well. We start with a simple comparison of mean responses across treatment and control groups. Table 3 reports these simple comparisons of means and differences for responses to question 6, with regards to soda preferences. The differences next to intervention and control means capture the average differences across intervention and control group at given points in time, while the differences in the last row report the change in differences between these two groups (DID estimates). The reported comparisons of means are suggestive of an effect on soda preferences. In particular, in Berioza School 3 we observe an initial increase in soda preferences, and a drop back to almost the initial level at the end of the program for participating students. In comparison, the preference for soda increases for non-participating students over time, resulting in a DID decrease of soda preferences by 8.1% for the students participating in the program. For Berioza School 2, we see a more pronounced decrease in preferences by participants of 13.2%, but we also observe a less pronounced decrease for the control group, resulting in a double difference in means of about 8.7% in preferences for soda for the students participating in this school. Finally, for students in the non-participating Kobrin School, all of whom are untreated, we observe a slight 1.1% decrease of preferences for soda, from 17.9% to 16.8%.

Table 4 reports the mean responses and differences for question 13 with regards to chips. Again, the differences next to intervention and control means compare the two student groups at a given point in time, while the differences in the last row report the change in differences between these two groups (DID estimates). For the Berioza School 3, the mean difference of student preferences across intervention and control group at the beginning of the program is relatively small. While these preferences do not change much for the control group, for participating students, they move by more than one order of ranking, from a mean response of

3.4 to 4.7. This results in an overall double difference in means of about 1.2 indicating that participating students adjust their preferences by liking chips less by one order (on a scale from 1-6) on average post intervention. While participating students already seem to like chips somewhat less at the beginning of the program compared to the control group within Berioza School 2, we observe an adjustment of more than one order of ranking within the participation group over time (from 4.2 to 5.5), resulting in a mean DID response across groups of 0.9. For the Kobrin School we do not observe a significant increase or decrease in preferences for chips across time; the change is only 0.05.

Turning now to the panel regression econometric specification, Tables 5 and 6 report the corresponding regression estimates for questions 6 and 13, respectively. The first column reports the DID estimates within each school, while the second column adds the responses from the Kobrin School to estimate the instrumental variable approach specified in equation (3). Looking at soda first, in Table 5 we reproduce the Table 3 decrease of around 8% in soda preferences students participating in the program in the Berioza School 3, but this effect is not statistically significant. We do, however, observe that preferences overall for soda increase slightly over time (by 9.8%) for students in the Berioza school 3, and this increase is statistically significant at the 10% significance level. As we also observed an initial increase in preferences for soda in the graphical analysis, it might point to a potential compensation or adverse response, giving more weight to taste considerations rather than health considerations. Over a longer time horizon, and continuous participation in the program, some students might be more willing to incorporate the intervention's information and adjust their preferences. Alternatively, it might point to an influence that is independent of the program. However, we do not detect the same significant increase in the comparison across schools. In these comparisons, the decrease in soda

preferences becomes more pronounced (16.4%), but is still insignificant. The results for Berioza School 2 follow a similar pattern.[15]

Table 6 reports the regression results for question 13 with regards to preferences for chips. Here we estimate a statistically significant shift in preferences of 1.2 units towards liking chips less for Berioza School 3 and 0.98 units for Berioza School 2 in the within-school comparisons. This effect increases for both schools in the across-school regressions. It is statistically significant in Berioza School 2, but only significant at the 10% level for Berioza School 3.[16] In both participating schools students adjusted their preferences for chips as a result of our educational intervention by about one order of ranking on average.

Turning now to the analysis of the student food diary entries, the results further support the questionnaire-based findings. Table 7 summarizes the frequency of observed food entries after translating and classifying all collected food diaries for a subset of participating students in one of the schools, Berioza School 3.[17] While we initially focus on reported consumption of soda and chips to strengthen our regression analysis, we extend our investigation to other potentially healthy and unhealthy categories indicated in italics in Table 7. The selection of these categories

[15] We further included gender and grade level (either as a continuous variable, or fixed effects) in alternative regression specifications. These regressions reproduced average treatment effects reported here. However, due to the missing number of observation (biased towards the control group) especially for gender, inclusion of these additional controls resulted in significantly fewer observations and dropping of some of our primary control variables such as treatment month and/or the interaction of the treatment month and treatment school. These results are not reported here.

[16]This decrease in significance is expected as we are instrumenting program participation using the school indicator, a less precise measure than actual participation. These results are also robust to adding gender and grade level as additional controls in regression specifications not reported here.

[17] While students were asked to record both their food choices and consumption of food and drinks brought form home and in the cafeteria, our analysis exclusively focuses on items brought from home. The Cafeteria experienced a safety concern during our program period, resulting and students are offered very limited choices.

was based on both the frequency of responses and the potential to clearly classify an entire category as unhealthy, such as sweets, or healthy, such as vegetables.[18]

Table 8 presents the comparisons of mean student entries by focusing on the beginning and end month of the program (March 2009 and May 2010). It compares the frequency of reported food items for 42 participating students and two random samples of 30 non-participating students each at the beginning and the end of the program.[19] At the beginning of the program, 8.0% of the entries corresponded to chips for the intervention group, while chips consumption was not reported at the end of the program. As students only report their food choices during school hours, soda consumption is very infrequently observed in general in this data. We therefore extend our analysis to other food items potentially high in sugar such as candy, sweets, and chocolate, and an aggregated unhealthy food category.

With the exception of fruit consumption, all reported mean differences trend in the expected direction. For the fruit category, we observe less frequent consumption at the end of the program. This declining trend is somewhat puzzling, but is observed both in the treatment and control group of students. It could be an indication of a substitution effect connected to the observed more frequent vegetable consumption.[20] When looking at the aggregated healthy food choices, we observe the expected increase in consumption frequencies once more. However, for all of the specific food choices as well as the aggregated categories, the control group exhibits

[18] For a category like sandwich we are not able to distinguish between healthy and unhealthy options for instance. We did include the soup category, however and classify it as a healthy option. Soups such as Borscht are a traditional lunch or dinner option in the Belarusian culture.

[19] We report the responses of the balanced sample of 42 students participating for the entire time period of the program.

[20] It is worth repeating that households in Belarus spend approximately half of their income on food. Fruits are relatively expensive in Belarus and considered somewhat of a treat, unless they are grown in the households own gardens. Usually, stored apples last through the winter, and storage runs out around March. In addition, the Belarusian currency underwent a devaluation in 2009, which might have resulted in additional constraints on food purchases and relatively more expensive goods. Finally, May 1st is a major holiday with big family celebrations such that households might be particularly income constrained during the month of May. All of these factors could have at least partially contributed to our observed reduction in fruit consumption.

the same trends, and the changes are more pronounced in all categories for this group, resulting in DID effects that go in the opposite direction. This might be due to the fact that the program was very popular at this school. The random sample of non-participating students may not serve as a good control group as these students might be influenced by spillover effects and response bias. The control students also reported their food choices without any supervision, and their entries are less detailed and thorough. A comparison of pre and post frequencies suggests higher frequencies of unhealthy and lower frequencies of healthy categories for this group as compared to the subsample of students participating in the program, while the direction of the post treatment response is reversed. Furthermore, contrary to the continuous entries over nine months for the participating students, these control students only recorded food choices for one month, and the samples do not consist of the same students at the beginning and the end of the program. This limitation in our study design might have affected our results, such that we focus on the participating students in our graphical analysis. We aggregate the number of responses within each category by student and month and graph changes in students' consumption patterns over time. Figures 3 aggregates student consumption of chips and vegetables for each month and graphs changes over time. Figure 4 and 5 also graph consumption of chips and vegetables for each student over time. Here, each panel represents the number of food diary entries that corresponded to chips or vegetables for one particular student over a 9 month period. These graphs suggest that students participating in the program decreased their chips consumption and increased their vegetable consumption significantly, both in the aggregate, as well as individually. They provide further support for our interpretation of the results from our questionnaire analysis. Students appear to have altered their food preferences away from less healthy towards healthier food choices due to the education program.[21]

[21] Due to the limited entries of soda consumption during school hours, we did not graph this category over time. The

Finally, we return to the analysis of the questionnaire responses to investigate potential changes in awareness, attitude, and involvement among participating students. Table 9 summarizes the mean differences in response to questions 7, 8 and 11. These questions address whether students perceive themselves as picky in their food choices and like to try new things. Question 11 asks whether they are involved food preparation at home. These comparisons of means suggest that participating students become more aware of the fact that they are picky eaters, are more likely to try new foods and drinks, and cook more often with their parents than students in the control group. In addition, Figure 6 illustrates changes in the likelihood of cooking with parents across all three possible responses (0 = never, 1 = sometimes, 2 = often) and further indicates a shift towards cooking with parents often for students participating in the lessons. We interpret these results as an indication of students increased interest and involvement in food preparation. Students also became slightly more aware of the fact that they are picky in their food choices, but do not seem to be more likely to try new foods as a result of the program. Peer pressure and exposure to some traditional foods in the Belarusian cuisine during the lessons might have resulted in a change in students' attitude towards certain foods, however. Figure 7 illustrates that student exposure to particular foods such as fish might have decreased their dislike of it. Meetings with fishermen, cooking demonstrations and preparation of dishes with local varieties, followed by taste tests might have reinforced this change in particular.

5. Conclusions

Many aspects of our food system have been identified as driving factors in increased food production and consumption. Although each of these factors can potentially contribute to the

remaining categories follow similar patterns illustrated by the chips and vegetable graphs presented here and are available upon request.

obesity epidemic and global environmental problems, consumers that are educated and well-informed about the interdependencies, nutritional characteristics, and environmental footprint of food products could potentially adjust their food preferences. This study investigates changes in student preferences and attitudes as a result of a comprehensive Taste and Food education curriculum implemented in a public school in Belarus. The program aimed at empowering students to make healthier and more sustainable food choices by studying the origin and production methods of local foods and natural ingredients, their quality characteristics, and social and economic importance within the Belarusian culture. In comparison to recent literature that focuses on an experimental approach targeting school cafeterias in order to promote healthier choices, or investigates the effects of more restrictive approaches such as banning of soft drinks from schools in quasi-experimental settings, this study focuses on the evaluation of the effects of an educational intervention.

Overall our results suggest that the educational intervention changed preferences away from unhealthy foods and affected attitude and awareness of healthier and more sustainable food choices. We find evidence for a significant adjustment with regards to preferences for chips for students participating in our program relative to the controls. While the adjustment in preferences for soda is not statistically significant in the panel regression analysis, the qualitative results presented here are suggestive of a change in preferences over time. Additional qualitative analyses are further consistent with our conclusion and can be summarized in statements such as: “I would rather buy a piece of fruit or juice instead of a soft drink” (student in intervention group) versus “You can have a party without Coca-Cola, but it will be boring” (student from the control group, see Smialkova 2010).

The analysis of student choices documented in food diaries also highlights a potential shortcoming of our study design. While the trends for reported healthy and unhealthy foods go in the expected direction, we find that the students in the within-school control group exhibit even stronger reactions than participating students. We argue that the seemingly stronger effect in the control group may be due to a potentially stronger response bias for these students. The program was very popular with the students, and spaces were limited. We did not implement additional controls across schools for the food diary analysis, however, and thus we must interpret these results with caution.

Finally, we also find that students are slightly more aware about their perceptions and prejudices towards food, more involved in food preparation, and open-minded towards consumption of highlighted foods (such as fish) as a result of the program.

Our reported results also highlight the need for developing more rigorous evaluation techniques in future work. Our analyses were limited in scope and based on a small sample of students. Failure to detect significant changes for soda consumption might be due to the fact that the question included in the questionnaires did not address frequency of consumption, and reported soda consumption was very infrequent in the school environment. While data collection from within-school control groups was logistically attractive, relying on these controls may limit the statistical power of our design due to potential spillover effects and possible longer-term adjustments. In our case, the fact that non-participating students received less supervision in the data collection process, and the popularity of the program in combination with binding participation constraints, may have resulted in a stronger response bias for these students. Finally, all of our results reported here rely on stated preferences rather than revealed

preferences. In the future, actual choice experiments could be included in evaluation strategies as well.

In spite of these limitations, we believe that our analysis establishes changes in students' preferences as a result of the educational intervention and suggests that the magnitude of these effects is potentially sizable. For instance, we find a significant decrease in the liking of chips by one order magnitude on a scale from 1 to 6, a significant reduction of aggregate chip consumption, and a reduction by almost all participating students individually over the duration of the program. At the same time, reported vegetable consumption increases significantly. These findings are an important contribution to the attempts at quantifying the effects of comprehensive food education programs on behavior, and they add important evidence of the effectiveness of educational interventions to the existing literature. In working closely with similar food education programs rapidly being implemented in US schools, we hope to increase our sample size and strengthen our experimental design by incorporating elements previously employed in the cafeteria studies into our evaluation toolkit.

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Table 1: Taste and Food Education Lesson Plan

Taste and Food Education Lesson Plan (Berioza school 3)	
Lesson (week)	Title
1	Journey to the origins of taste
2	The orchestra of taste: recognition of basic tastes
3	The eye plays its role!
4	How's your nose?
5	What kind of taste do you have?
6	Not just the hands!
7	The ear wants some!
8	Honey
9	Tasting of three different types of apples and chocolate
10	School garden
11	Cooking with a chef
12	School garden
13	Farm visit
14	Preparing a school snack
15	Cheese and dairy products
16	Meeting with a fisherman
17	School garden
18	Food vocabulary
19	Meeting with a journalist
20	Just like an orchestra
21	Video: "A sensory path"
22	Meeting with a farmer
23	Cooking: Belarussian food
24	Compare the quality!
25	Preparing a salad
26	Journey to the origins of taste
27	Let's bake!
28	Home-made or industrial?
29	Cooking competition
30	Film: "Supersize me"
31	31 Beetroot tasting
32	Colour and food
33	Vitamins
34	Hearing
35	Cooking with potatoes
36	Rosson infusions and wild fruit project
37	How to choose at the supermarket?
38	Touch and smell
39	Nutritional value of food
40	End of the journey to the origins of taste

Note: Lesson plan was provided by Slowfood and is based on their curriculum "To the Origins of Taste".

Table 2: Summary of questionnaires distributed and collected

Number of student questionnaire responses (seperated by control and treatment groups)					
School		Pre-treatment	Mid-treatment	Post-treatment	
Berioza school 3	treatment	119		122	106
		125		*125*	*125*
	control	120		113	135
		150		150	150
		Mar-09		Sep-09	May-10
Berioza school 2	treatment		49	52	52
			52	*52*	*52*
	control	150	119	123	121
		200	*150*	*150*	*150*
		Apr-09	Sep-09	Jan-10	May-10
Kobrin school	control	117			95
		150			*150*
		May-09			May-10

Note: In Berioza school 3, 125 students participated in the extra-curricular Taste and Food education, in Berioza school 2, 52 students participated. The received quessionnaires at a given school and time are reported. The number in italics below indicates the number of questionnaires distributed.

Table 3: Comparison of means for student responses to question 6 focusing on soda

Descriptive statistics: intervention's effects on soda preferences							
Question 6: When you are thirsty, what do you drink? (mean percentage of students including soda as one option into this response)							
	Berioza School 3			Berioza school 2			Kobrin school
	intervention	control	Difference	intervention	control	Difference	control
pre-intervention period							
(March 2009)	0.143	0.117	**0.026**		0.233		0.179
	0.351	*0.322*			*0.424*		*0.385*
	[119]	[120]			[150]		[117]
(September 2009)				0.286	0.193	**0.092**	
				0.456	*0.397*		
				49	119		
intervention period							
(September 2009)	0.230	0.186	**0.044**				
	0.422	*0.391*					
	[122]	[113]					
post-intervention period	0.160	0.215	**-0.054**	0.154	0.149	**0.005**	0.168
(May 2010)	*0.369*	*0.412*		*0.364*	*0.357*		*0.376*
	[106]	[135]		[52]	[121]		[95]
Difference-in-Differences			**0.081**			**0.087**	

Note: The difference denotes the difference between the intervention and control group at a given time period, while the difference-in-differences compares preferences at the beginning and the end of the intervention. Standard deviations are denoted in italics and the number of responses is reported in square brackets.

Table 4: Comparison of means for student responses to question 13 focusing on chips

Descriptive statistics: average treatment effects for Chips							
Question 13: From 1(best) to 6(worst), indicate what food you like best (mean student responses for chips)							
	Berioza School 3			Berioza school 2			Kobrin school
	intervention	control	Diff	intervention	control	Diff	control
pre-intervention period							
(March 2009)	3.430	3.672	**-0.242**		3.555		3.876
	1.869	*1.752*			*1.742*		*1.867*
	[107]	[119]			[146]		[113]
(September 2009)				4.245	3.410	**0.835**	
				1.665	1.758		
				[49]	[117]		
intervention period							
(September 2009)	4.221	3.225	**0.996**				
	1.756	*1.715*					
	[122]	[111]					
post-intervention period	4.686	3.729	**0.956**	5.462	3.729	**1.907**	3.922
(May 2010)	*1.476*	*1.620*		*0.727*	*1.805*		*1.886*
	[105]	[133]		[52]	[118]		[90]
Difference-in-Differences			**-1.199**			**-1.072**	

Note: The difference denotes the difference between the intervention and control group at a given time period, while the difference-in-differences compares these differences at the beginning and the end of the intervention. Standard deviations are denoted in italics and the number of responses is reported in square brackets.

Table 5: Regression results for responses to question 6 focusing on soda

Regression results for difference-in-difference within and across schools				
Dependent variable: percentage of students reporting to drink soda when they are thirsty				
independent variable	Berioza school 3		Berioza school 2	
	within school	across schools	within school	across schools
treatment effect	-0.081	-0.164	-0.065	-0.216
(interaction term)	*0.067*	*0.142*	*0.041*	*0.213*
treatment month	0.098 *	-0.011	-0.067	-0.011
	0.046	*0.053*	*0.041*	*0.053*
treatment school		-0.050		-0.047
		0.042		*0.043*
treatment students	-0.242		0.070 ***	
	0.242		*0.070*	
constant	0.117 ***	0.179 ***	0.216 ***	0.179 ***
	0.029	*0.036*	*0.025*	*0.036*
number of observations	480	692	491	703

Note: The treatment effect denotes the interaction of students participating in the Taste and Food education and the final month of the program for the within school regressions. For the across school regressions, student participation interacted with the final month of the program is instrumented using the interaction of the final month of the progam and the participating school. The regessions were run separately for the two participating schools as the time frame and data collection for the program varied across schools. Single, double, and triple Asterisks (*, **, and ***) represent significance at the 10%, 5%, and 1% level. Heteroskedasticity-robust standard errors are reported in italics.

Table 6: Regression results for responses to question 13 focusing on chips

Regression results for difference-in-difference within and across schools				
Dependent variable: ranking of liking of chips from 1 (best) to 6 (worst)				
independent variable	Berioza school 3		Berioza school 2	
	within school	across schools	within school	across schools
treatment effect	1.199 ***	1.241 *	0.978 ***	1.974 **
(interaction term)	*0.314*	*0.698*	*0.324*	*1.003*
treatment month	0.057	0.046	0.046	0.046
	0.213	*0.265*	*0.265*	*0.265*
treatment school		-0.319		-0.267
		0.175		*0.202*
treatment students	-0.242		0.754 ***	
	0.242		*0.260*	
constant	3.672 ***	3.876 ***	3.490 ***	3.876 ***
	0.161	*0.176*	*0.108*	*0.176*
number of observations	464	667	482	685

Note: The treatment effect denotes the interaction of students participating in the food and taste education and the final month of the program for the within school regressions. For the across school regressions, student participation interacted with the final month of the program is instrumented using the interaction of the final month of the progam and the participating school. The regessions were run separately for the two participating schools as the time frame of the program and data collection for the program varied across schools. Single, double, and triple Asterisks (*, **, and ***) represent significance at the 10%, 5%, and 1% level. Heteroskedasticity-robust standard errors are reported in italics.

Table 7: List of coded food entries in food diaries

Entry (translated and coded)	Frequency	Percent
Bread	1,079	4.61
Candy	*1,150*	*4.91*
Drinks (other)	4,691	20.04
Sweets	*3,476*	*14.85*
Fruit	*2,275*	*9.72*
Meat	1,726	7.37
Vegetable	*1,499*	*6.4*
Sandwich	1,347	5.75
Soup	*979*	*4.18*
Cereal	817	3.49
Chips	*548*	*2.34*
Pancakes (Blini)	544	2.32
Eggs	509	2.17
Chocolate	475	2.03
Macaroni	400	1.71
Milk	355	1.52
Sides and Misc.	317	1.35
Preserves	228	0.97
Rice	214	0.91
Fish	187	0.8
Dumpling	152	0.65
Yogurt	116	0.5
Kefir	85	0.36
Nuts	81	0.35
Potatos	65	0.28
Pizza	54	0.23
Soda	*28*	*0.12*
Snacks	7	0.03
Tea	6	0.03

Note: These entries describe the entries brought from home recorded by students participating in the program. Entries in italics indicate entries examined closer and used to create healthy and unhealthy specifications. Other entries might have been recored more often, but are not easily classified as healthy or unhealthy, e.g. bread and cereal. In addition, soups are a very traditional food in Belarusian culture, and are classified as a healthy choice. * these entries code otherwise not classified condiments and

Table 8: Comparison of means for student responses in food diaries (home)

Descriptive statistics: average treatment effects			
	intervention	control	**DID**
Soda			
pre-intervention period	0.000	0.010	
(March 2009)	*0.000*	*0.098*	
	[1170, 42]	[2603, 30]	
post-intervention period	0.000	0.000	
(May 2010)	*0.000*	*0.000*	
	[2639, 42]	[1347, 30]	
mean difference	0.000	0.010	**-0.010**
Chips			
pre-intervention period	0.080	0.089	
(March 2009)	*0.092*	*0.2849831*	
	[1170, 42]	[2603, 30]	
post-intervention period	0.000	0.000	
(May 2010)	*0.000*	*0.000*	
	[2639, 42]	[1347, 30]	
mean difference	0.080	0.089	**-0.009**
Sweets			
pre-intervention period	0.209	0.233	
(March 2009)	*0.406*	*0.2849831*	
	[1170, 42]	[2603, 30]	
post-intervention period	0.102	0.070	
(May 2010)	*0.303*	*0.255*	
	[2639, 42]	[1347, 30]	
mean difference	0.106	0.163	**-0.057**
Unhealthy			
pre-intervention period	0.423	0.541	
(March 2009)	*0.494*	*0.498419*	
	[1170, 42]	[2603, 30]	
post-intervention period	0.124	0.093	
May 2010	*0.330*	*0.291*	
	[2639, 42]	[1347, 30]	
mean difference	0.299	0.448	**-0.149**
Vegetables			
pre-intervention period	0.015	0.008	
(March 2009)	*0.123*	*0.009*	
	[1170, 42]	[2603, 30]	
post-intervention period	0.097	0.157	
(May 2010)	*0.296*	*0.364*	
	[2639, 42]	[1347, 30]	
mean difference	-0.081	-0.149	**0.068**
Fruit			
pre-intervention period	0.161	0.147	
(March 2009)	*0.367*	*0.353928*	
	[1170, 42]	[2603, 30]	
post-intervention period	0.047	0.007	
(May 2010)	*0.296*	*0.086*	
	[2639, 42]	[1347, 30]	
	0.114	0.139	**-0.025**
Soup			
pre-intervention period	0.009	0.003	
(March 2009)	*0.092*	*0.058711*	
	[1170, 42]	[2603, 30]	
post-intervention period	0.059	0.102	
(May 2010)	*0.237*	*0.302*	
	[2639, 42]	[1347, 30]	
mean difference	-0.051	-0.098	**0.047**
Healthy			
pre-intervention period	0.185	0.158	
(March 2009)	*0.388*	*0.365073*	
	[1170, 42]	[2603, 30]	
post-intervention period	0.203	0.267	
(May 2010)	*0.402*	*0.442*	
	[2639, 42]	[1347, 30]	
mean difference	-0.018	-0.108	**0.090**

Note: Mean responses or the percentage of student entries corredonding to a specific food choice are reported for the students that participated throughout the entire program (intervention group) as well as the two random samples of non-participating students at the beginning and the end of the program (control group). The mean difference denotes the changes over time for each group. The difference-in-differences (DID) compares double differences across time and across groups. Standard deviations are denoted in italics, and the number of responses and students is reported in square brackets. The unhealthy category combines entries in the soda, chips, candy, sweets, chocolate category, while the healthy category combines responses for fruit, vegetables, and soup. The soup category was added as it can be viewed as a healthy option that ican be a traditional food in Belarus, such as Borscht. A complete list of observed food categorries is reported in Table 7.

Table 9: Comparison of means for student responses in additional questions

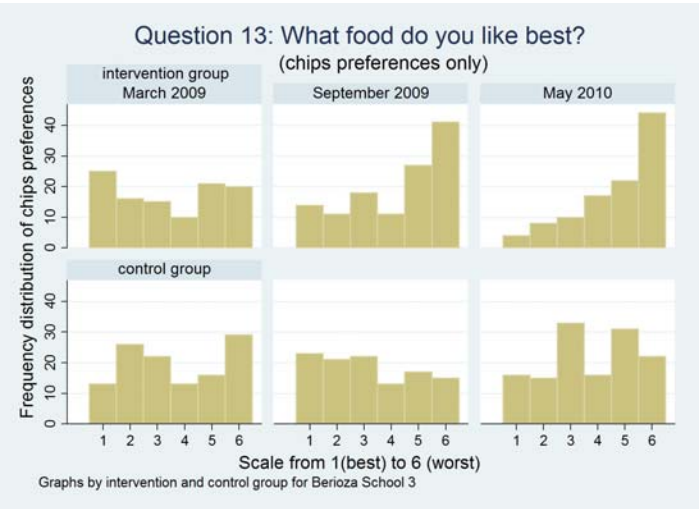
Descriptive statistics: average treatment effects							
Question 7: Are you a picky Eater ? (1=yes)							
	Berioza School 3			Berioza school 2			Kobrin school
	intervention	control	DID	intervention	control	DID	control
pre-intervention period	0.868	0.808			0.720		0.836
(March 2009)	*0.340*	*0.395*			*0.451*		*0.372*
	[114]	[120]			[150]		[117]
(September 2009)				0.776	0.771		
				0.422	0.422		
				[49]	[118]		
post-intervention period	0.896	0.830		0.788	0.775		0.853
(May 2010)	*0.306*	*0.377*		*0.412*	*0.419*		*0.356*
	[106]	[135]		[52]	[120]		[95]
mean difference	-0.028	-0.021	**-0.007**	-0.013	-0.004	**-0.009**	
Question 8: Do you like trying new foods/drinks? (1=yes)							
	Berioza School 3			Berioza school 2			Kobrin school
	intervention	control	DID	intervention	control	DID	control
pre-intervention period	0.965	0.933			0.913		0.829
(March 2009)	*0.185*	*0.250*			*0.282*		*0.378*
	[114]	[120]			[150]		[117]
(September 2009)				0.939	0.924		
				0.242	0.266		
				[49]	[119]		
post-intervention period	0.953	0.919		0.962	0.899		0.853
(May 2010)	*0.213*	*0.275*		*0.194*	*0.302*		*0.356*
	[106]	[135]		[52]	[120]		[95]
mean difference	0.012	0.015	**-0.003**	-0.023	0.025	**-0.048**	
Question 11: Do you help your parents cook (0=never, 1=sometimes, 2=often)							
	Berioza School 3			Berioza school 2			Kobrin school
	intervention	control	DID	intervention	control	DID	control
pre-intervention period	1.345	1.345			1.223		1.412
(March 2009)	*0.514*	*0.574*			*0.519*		*0.561*
	[113]	[120]			[148]		[117]
(September 2009)				1.224	1.288		
				0.550	*0.541*		
				[49]	[119]		
post-intervention period	1.438	1.444		1.308	1.254		1.319
(May 2010)	*0.570*	*0.542*		*0.579*	*0.587*		*0.512*
	[105]	[135]		[52]	[118]		[95]
mean difference	-0.093	-0.100	**0.007**	-0.083	0.053	**-0.137**	

Note: The mean difference denotes the changes in the mean student respones over time for each group. The difference-in-differences (DID) compares double differences across time and across groups.Standard deviations are denoted in italics and the number of responses is reported in square brackets.

Figure 1: Stated preferences for soda in Berioza School 3

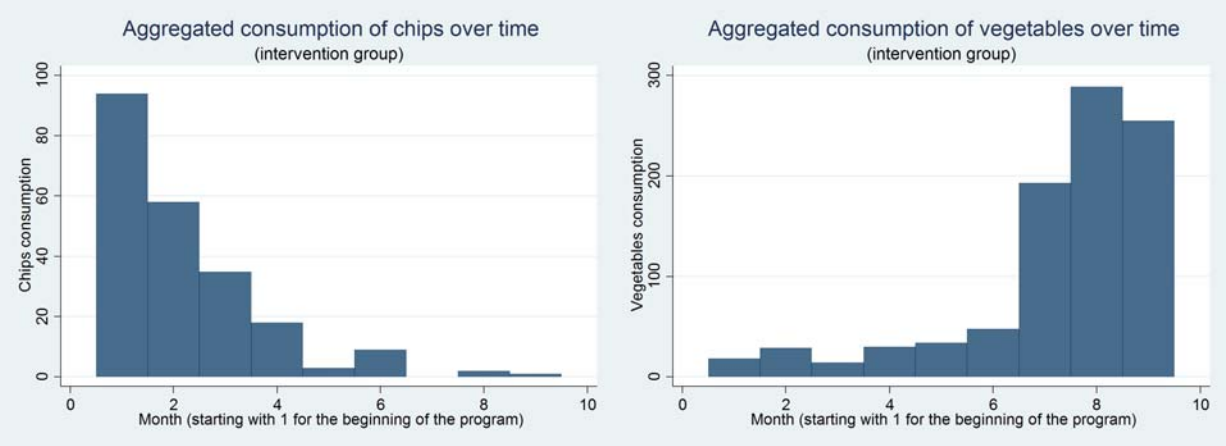
Note: The first panel corresponds to stated soda preferences of the control group, while the second panel corresponds to stated preferences of the control group. The first bar in each panel captures assessment at the beginning (March 2009), the second bar in the middle (September 2009), and the third bar at the end (May 2010) of the Taste and Food Education curriculum. Students were able to choose among the following drink alternatives: Water, Juice, Milk/Kefir, Kompot (Fruit Punch), Soft drinks (Soda), Tea, Coffee, Other (see student questionnaire in appendix). For clarity, only soda preferences are displayed here.

Figure 2: Stated preferences for chips in Berioza School 3



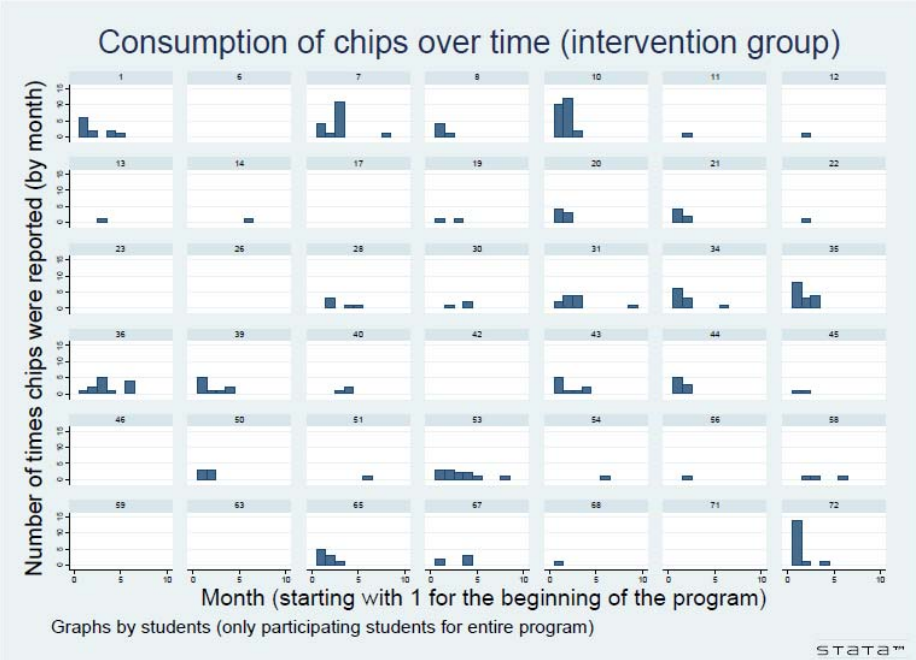
Note: The top row of panels correspond to the stated chips preferences for the intervention group, while the lower row corresponds to the stated preferences for the control group. The first panel in each row captures the distribution of student responses at the beginning, the second panel in the middle, and the third panel at the end of the Taste and Food Education curriculum. Students compared the following foods in this question: Chips, Apples, Soups, Sauerkraut, Ice cream, Steak (see student questionnaire in appendix). For clarity, only chips preferences are displayed here.

Figure 3: Aggregated consumption of chips and vegetables for participating students over time in Berioza School 3



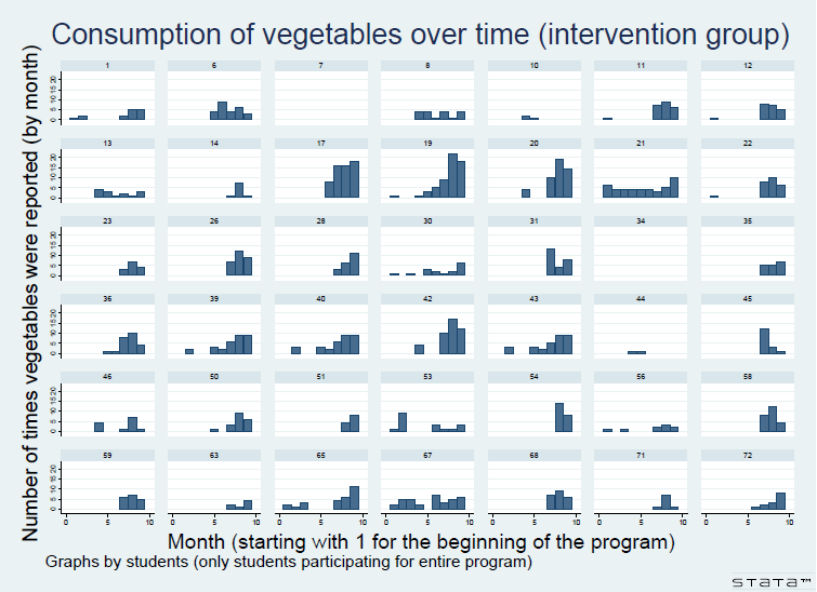
Note: Individual student responses for the 42 students that participated throughout the entire program are aggregated by month. Students filled out food diaries starting in March 2009 (month 1), resumed after the summer break in October till the end of the program, resulting in a total of 9 month of dairy entries. The height of each bar indicates the number of times a student reported bringing chips from home and consuming them at school during a given month. This graph illustrates a significant decrease in aggregated consumption of chips and increase in aggregated consumption of vegetables throughout the program.

Figure 4: Individual consumption of chips for participating students over time in Berioza School 3 over time



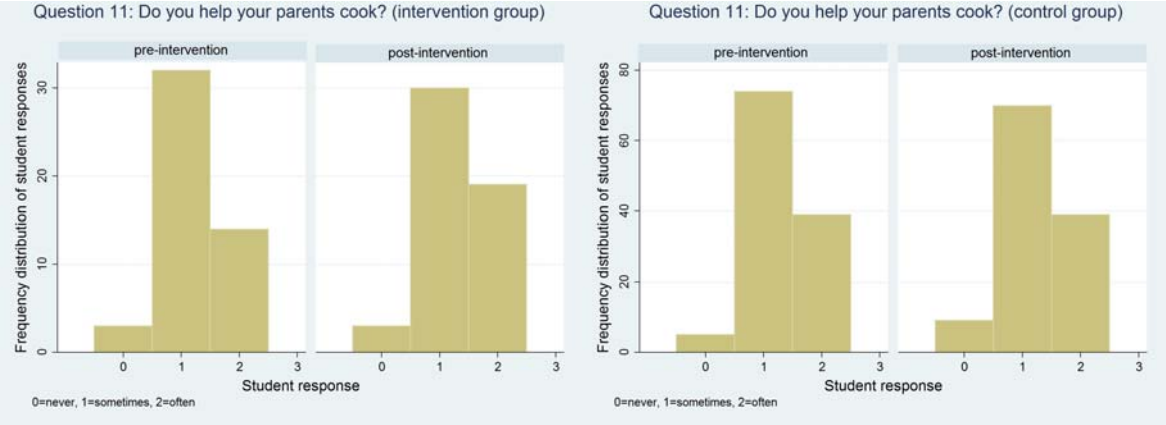
Note: Each display in this panel corresponds to reported consumption of chips aggregated by each month for an individual student from the beginning to the end of the program. Students filled out food diaries starting in March 2009 (month 1), resumed after the summer break in October till the end of the program, resulting in a total of 9 month of dairy entries. The height of each bar indicates the number of times a student reported bringing chips from home and consuming them at school during a given month. This graph illustrates a decrease in the consumption of chips for all participating students as the program progressed.

Figure 5: Individual consumption of vegetables for participating students over time in Berioza School 3



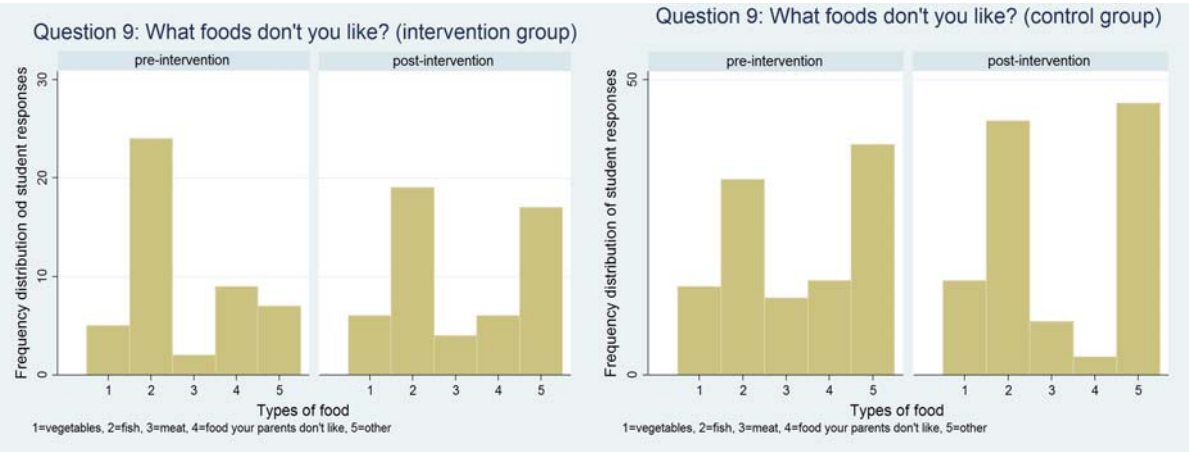
Note: Each display in this panel corresponds to reported consumption of vegetables aggregated by each month for an individual student from the beginning to the end of the program. Students filled out food diaries starting in March 2009 (month 1), resumed after the summer break in October till the end of the program, resulting in a total of 9 month of dairy entries. The height of each bar indicates the number of times a student reported bringing vegetables from home and consuming them at school during a given month. This graph illustrates an increase in the consumption of vegetables for participating students as the program progressed.

Figure 6: Attitudes towards cooking in Berioza School 2



Note: The program included a number of cooking lessons. While the left two panels (intervention group) indicate an increase in the percentage of students cooking often with their parents by a shift in distribution from *sometimes* (1) to *often* (2), the control group (right two panels) do not show the same change.

Figure 7: Dislikes of specific foods in Berioza School 2



Note: The program featured lessons on fish and had a local chef come to the lessons to prepare fish with the students. The two left panels (intervention group) show a decrease in the dislike of fish among students, while the control group experiences an increase in the dislike for fish (two right panels).