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Testing Methods to Increase Consumption of Healthy Foods

Evidence from a School-Based Field Experiment in Viet Nam

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Contents

Tables

Figures

ABSTRACT

Schools are an attractive entry point to improve children's diets, as their eating habits can be shaped during childhood and the information disseminated from school can reach adults through children. We implemented a cluster-randomized trial in 12 schools in peri-urban Viet Nam to assess if two school-based interventions increased knowledge of healthy diets among children and their parents, as well as children's consumption of healthy foods. First, children were given lessons about food before school lunch and encouraged to share the lessons with their parents. Second, children were provided with healthy snacks for five weeks to reinforce messages about healthy eating. We found that in the short term, the nutrition lessons raised the knowledge index score of the children by 0.35 standard deviation. After six months, this intervention retained its effectiveness only for the children who also received free access to fruit, emphasizing the linkage between knowledge and practice. By itself, free access to fruit at school increased the children's daily fruit consumption by half a portion, but not at the expense of home fruit consumption. Access to healthy foods at school can therefore be an effective measure to raise children's healthy consumption. Child-parent communication was not a reliable channel for knowledge dissemination in our setting.

Keywords: Consumption of healthy foods, fruit and vegetable consumption, healthy diets, child nutrition and health, school-based nutrition education

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ACRONYMS

A4NH	CGIAR Research Program on Agriculture for Nutrition and Health
FAV	Fruit and vegetables
ICC	Intra-cluster correlation
IFPRI	International Food Policy Research Institute
ITT	Intention to treat
LATE	Local average treatment effect
LMIC	Low- and middle-income countries
LPM	Linear probability model
NIN	Viet Nam National Institute of Nutrition
OLS	Ordinary least square
WHO	World Health Organization
WUR	Wageningen University & Research

INTRODUCTION

Unhealthy dietary patterns are posing global challenges, especially for low-and-middle-income countries (LMIC). Fueled by economic growth and rapid urbanization, LMIC have begun to experience a switch from mostly starchy, low fat, high fiber diets to increased consumption of processed foods higher in fats, sugar and salt. Their public health concerns are no longer limited only to undernutrition and micronutrient deficiencies but also to the high prevalence of overweight, obesity and diet-related non-communicable diseases (Popkin, 2014; Global Panel on Agriculture and Food Systems for Nutrition, 2016; Kelly, 2016). Viet Nam, economically one of the fastest growing countries in the world, illustrates the detrimental consequences of this nutrition transition. In 2018, an average Vietnamese was estimated to consume double the World Health Organization (WHO) recommendation for salt (Jensen et al., 2018) and sugar (Anh, 2018). In 2015, more than half of adult Vietnamese were found not to meet the WHO recommendation for fruit and vegetable (FAV) consumption (T. T. Nguyen & Hoang, 2018). A recent study by the National Institute of Nutrition on 5,028 students aged 7 to 17 from 75 schools in Hanoi, Ho Chi Minh City, Thai Nguyen, Nghe An and Soc Trang found that 42 percent of primary school students in urban areas were overweight or obese (Viet Nam National Institute of Nutrition, 2019).

To combat the burden of unhealthy diets, many LMIC have included school-based interventions in their nutrition policies. Recent systematic reviews of policy actions to improve diets in LMIC indicated that school-based activities, such as school gardening, nutrition curriculum inclusion and school meal standard enforcements, are present in several different regions (Lachat et al., 2013; Darfour-Oduro et al., 2019). Schools are an attractive leverage point for improving diets for several reasons. First, schools are in continuous and intensive contact with children, whose eating habits are formed early in life and can still be shaped (Loewenstein et al., 2016; DeCosta et al., 2017). Second, healthy meals can have positive impacts on children's school performance (Jomaa et al., 2011). Third, schools offer strong potential to reach adults through children, particularly in environments where children are likely to be more educated than their parents (He et al., 2015; Gunawardena et al., 2016).

Two of the most commonly implemented approaches to improve diets through schools are nutrition education and access to healthier foods. While the former aims to change behavioral intentions, the latter strives to improve the food environment. Nutrition education programs can positively influence the knowledge and attitude of children regarding healthy foods (Katz et al., 2011; Prelip et al., 2012; Lerner-Geva et al., 2015) while exposure and access to healthy food can induce demand and increase intake of healthier foods due to the strong relationship between familiarity and preferences (Cooke, 2007; DeCosta et al., 2017). Providing children with free and accessible FAV has been found to positively influence children's eating behavior, even in the long term (DeCosta et al., 2017).

Although providing nutrition education and facilitating food access are popular approaches to improve children's diets, they are not foolproof, as nutrition education alone does not always lead to behavioral changes (Katz et al., 2011; Prelip et al., 2012; Mittmann et al., 2016). Reasons that nutrition education may not lead to behavior change include a lack of parental engagement, lack of a standardized implementation plan, inadequate intervention duration, and a lack of age-appropriate activities (Murimi et al., 2018). Several studies have concluded children's diets can be more effectively improved if nutrition education curriculum and parental involvement are combined with FAV availability in schools (Van Cauwenberghe et al., 2010; Sharma et al., 2016). In these studies, however, it is not always possible to distinguish the separate effects of these two approaches because they are either combined as part of a multi-component program, or compared directly with each other (Reinaerts et al., 2008). In practice, not all schools have the capacities and resources to do both. It is therefore still useful to evaluate how the two approaches complement each other, to advise practitioners on whether to pursue a holistic program in the face of constraints.

Despite the host of evidence in developed countries, there is a paucity of rigorous evaluations of school-based interventions related to healthier eating in LMIC. Experimental studies, utilizing the gold standard method to establish causality, have typically been implemented in developed countries (DeCosta et al.,

2017). For LMIC, evidence has been limited to pre-post comparisons (Lagerkvist et al., 2018), or randomized control trials with a small sample size (He et al., 2015). While a large body of research studying interventions to reduce undernutrition in developing countries exists, when it comes to promoting healthier food options, such as FAV consumption, existing systematic reviews show a bias for evidence in developed countries (Evans et al., 2012).

School-based interventions can potentially disseminate their messages beyond the school environment; however, the body of literature examining this type of spillover is relatively small. No conclusive evidence has been found on whether at-school interventions for children lead to dietary changes at home (Taylor, Darby, Upton, & Upton, 2013). In addition, one question of growing significance in LMIC is whether interventions targeting children can influence other household members. A few studies have shown that providing nutritional knowledge to children can improve the eating behaviors of other household members, such as diet improvements among overweight mothers in Sri Lanka (Gunawardena et al., 2016) and salt intake reduction among households in China (He et al., 2015).

In this study, we carried out a randomized control trial to measure the impacts of a pilot intervention that combines nutrition education and access to healthy foods to increase FAV consumption of children in Viet Nam.[1] Through a cross-randomized design, we aimed to examine the separate and combined impacts of the two components, offering important contributions to the debate on the effectiveness of school-based intervention in LMIC. For this evaluation, we collected extensive at-home and at-school dietary data among almost 2000 children in 12 schools in peri-urban Hanoi. With this rich data set, we can examine the overall effect of the interventions beyond the school environment, for example by accounting for the substitution effect between at-school and at-home consumption.

[1] The study was registered with AEA RCT Registry (RCT ID AEARCTR-0003779). An updated version of the pre-analysis plan was submitted to Journal of Development Economics in August 2019 as a pre-registered report.

Our intervention provides nutrition knowledge messages to children and seeks to evaluate whether providing information through children can lead to knowledge, attitude or behavior change among their corresponding parents. We explicitly encouraged children to communicate the nutrition knowledge to their parents and collected outcome data among parents. We can therefore estimate the spillover effects of the intervention onto adult household members.

We developed materials for the interventions in collaboration with the Viet Nam National Institute of Nutrition (NIN) under the umbrella of the National Strategy on Nutrition. Any success in this intervention is therefore poised to go to scale quite easily, particularly as it was designed to minimize any extra burden exerted on teachers. The research findings will be especially helpful for the school nutrition program, which is as a key component of the Viet Nam National Nutrition Strategy until 2030. The strategy stipulates a focus on health and nutrition education in the school system and the need to develop models to implement school nutrition programs (MoH Viet Nam, 2012). Our findings can help draw important policy implications for other LMIC who are implementing nutrition curricula and other school-based interventions. We thereby contribute to evaluating policy-driven interventions on promoting healthy diets through nutrition education and changes in the food environment. Most evidence in this domain has come from research interventions rather than actual programs initiated by government or the private sector (Hawkes, 2013). The remainder of this paper is organized as follows: In Section 2, we describe the school-based interventions and the relevant theories that motivate them. The data and our empirical analysis strategy are presented in Section 3. We then discuss our findings in Section 4. Section 5 contains the conclusions and a discussion of policy implications.

RESEARCH DESIGN

Sample

The intervention was carried out in Dong Anh district. Located 15km to the north of central Hanoi, Dong Anh is a suburban district characterized by rapid urbanization, intensive crop-livestock production and important food connections to other provinces. The district holds a typical peri-urban population with a large proportion of migrants from outside Hanoi and a commuting labor force to nearby industrial parks. Although Dong Anh is poorer than the districts in central Hanoi, the district has the lowest poverty rate among peri-urban districts of the city, at 2.9 percent (Dong Anh District Department of Statistics, 2018). As the district makes its way to become classified as urban in 2025, it is increasingly facing issues similar to urban districts of Hanoi. Educators in Dong Anh are just as concerned about childhood obesity as their counterparts in the urban area, where overweight and obesity rates among primary school children are estimated at 41.9 percent.

The sample was selected through a multi-stage procedure (Figure 1). Out of 28 primary schools in Dong Anh, 12 schools proposed by the local Department of Education and Training and scattered throughout the district were included in the study. Annex 1 shows a map of the district with the schools' locations. In these 12 schools, all 197 classes of grades 3, 4, and 5 were included in the study, and the children in these classes became our research subjects. We then randomly sampled 10 children and their corresponding parents from each class for data collection. Our final baseline sample consisted of 1917 children (Figure 1).

The sampling frame was obtained directly from the schools, with the support of the district-level Department of Education and Training office. We validated and updated the list of classes and students with the schools before the start of baseline data collection. The sampling frame for children only included those who ate lunch at school; about 80 percent of all students registered to eat lunch daily at school across the 12 schools. By targeting these school lunch eaters, we could more accurately estimate

the impact of our interventions by observing their consumption at school.

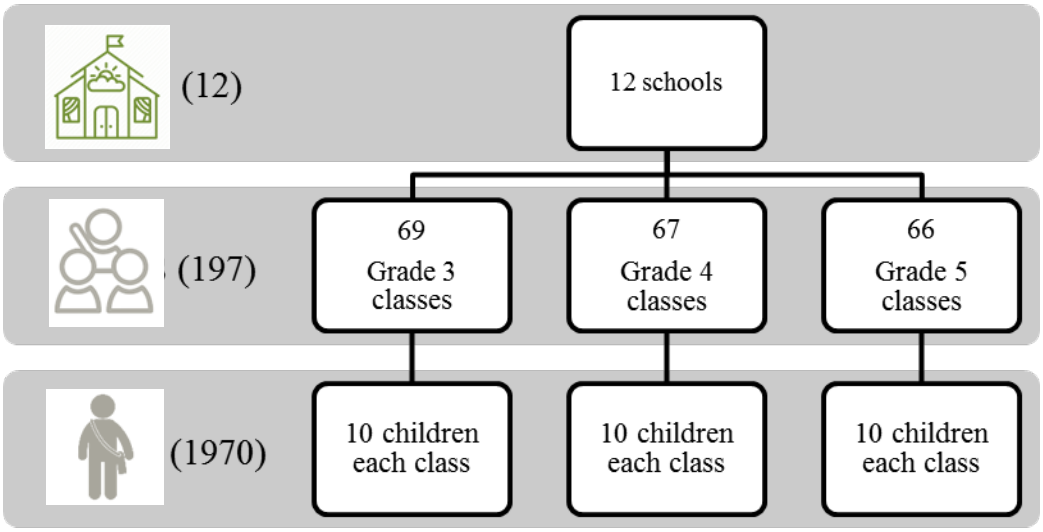


Figure 1. Sampling procedure for data collection

Experimental Design

The study was designed as a cluster randomized control trial, cross-randomizing the two treatments included. In the first treatment, we provided nutrition lessons for children, focusing on hands-on content and opportunities for children to share their consumption practices. Children were encouraged with rewards to share their knowledge with their parents. Second, we delivered healthy snacks to classrooms during morning school breaks.

Treatment 1 - Nutrition Information Communication

Rationale for treatment design

Although nutrition education is currently included in the national curriculum as units in science textbooks, primary-level children do not retain this knowledge well. Our formative qualitative study shows that the heavy cognitive load from other schoolwork prevented children from remembering and understanding nutritional issues, let alone applying them in daily consumption practices. The children

found the lessons boring, and they could only recall a generic understanding of a healthy diet. Instead of naming specific health benefits, the children would resort to terms like "containing all the necessary nutrients like fibers, vitamins, minerals" or "balanced in nutrition" to talk about the benefits of eating enough FAV.

In collaboration with the National Institute of Nutrition (NIN), we designed a more integrative approach to nutrition education. In our approach, the lessons can be part of the school meal experience instead of being separate and abstract (Oostindjer et al., 2017). Lunch in Vietnamese schools is typically served in classrooms with all the children eating simultaneously. We timed the nutrition lessons to take place just before lunchtime. This arrangement allowed children to link the knowledge they just acquired with lunch consumption practices. We also kept the nutrition education and communication activities for children short and relevant, given the limited time and facility available at schools. By not exerting an extra teaching burden on teachers, this proposed approach also has higher replicability, potentially increasing the research's external validity.

Additionally, we included a communication channel for parents to address the lack of communication between parents and schools about children's diets. In general, parents and teachers only communicate about the school meals and children's diets at a parents' meeting occurring once per semester. As it is impossible to involve parents directly in the lessons on a regular basis, we used children to communicate nutrition messages to parents in this study.

Description of treatment

Messages presented to children focused on balanced diets, recommended daily consumption of FAV, benefits of FAV, and how to incorporate more FAV into their meals. The teachers were trained by NIN specialists to provide these messages to children in five-minute show-and-tell talks right before lunch, for five consecutive weeks. Each week covered a topic, which was presented to children on two different weekdays. Complementing the presentation were leaflets/posters with the same contents. We did not provide extra materials and only remunerated the teachers by lessons, so that no sharing to the control

group could take place. The lesson plans, posters and activity guides for each week were developed by NIN in collaboration with the research team. These materials were field tested with teachers and students in two schools in Dong Anh to optimize their relevance, comprehensibility and applicability.

Children were encouraged to share what they had learned during the nutrition education sessions with their family members. They received small gifts such as storybooks and school utensils for their participation. In the lessons, children were given leaflets bearing the same contents as the lessons for children to share with their parents. Parents were requested to sign a form confirming their receipt of the leaflets, as well as to commit to help children eat more fruits and vegetables.

Treatment assignment

The 36 grades across 12 schools (three grades per school) served as clusters in our cluster randomization trial, and clusters were assigned to treatments as follows (Figure 2). The schools were first randomly matched into six pairs (A – F). Within each pair: In School 1, one of the three grades, 3rd, 4th, or 5th, was selected as treatment, and the other two grades were placed in the control group; In School 2, the two grades in the control group of School 1 were selected for treatment, and the other grade was placed in the control. In other words, the control-treatment groups mirrored each other in a school pair. As a result, six schools had two grades in the treatment group and one grade in the control group, while the other six schools had one grade in the treatment group and two grades in the control group. Consequently, 18 grades served as treatment clusters, and 18 as the control group. Within schools, each grade included between four and eight classes. In the end, out of 197 classes in 12 schools, roughly half were in the treatment group (94) and half in the control group (103) (Table 1).

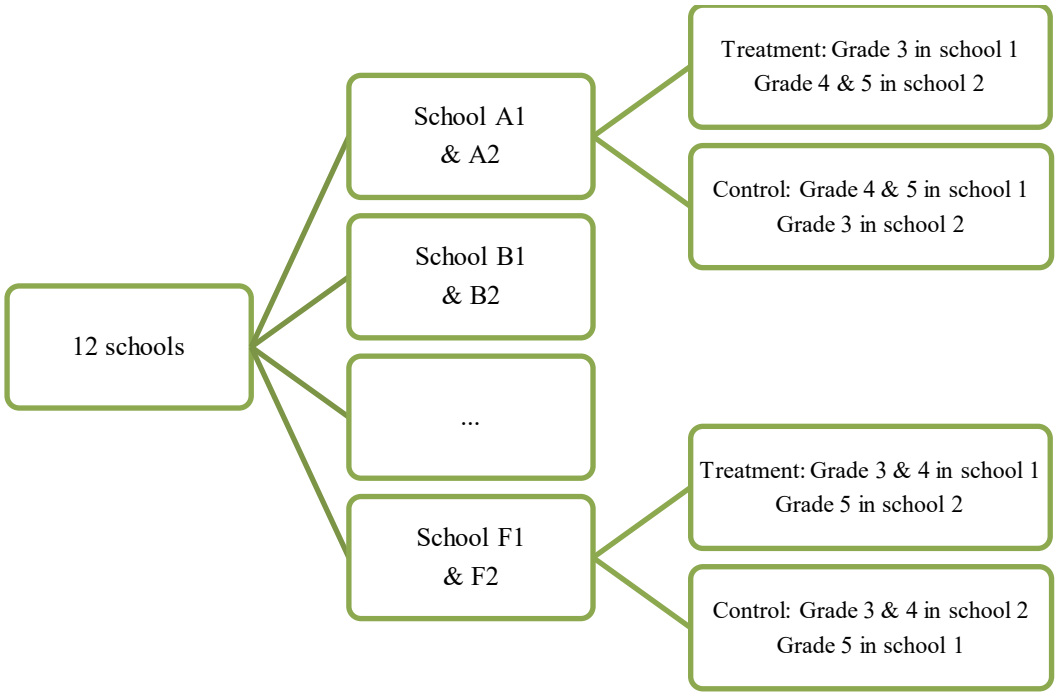


Figure 2. Assignment of Treatment 1

Although statistical power is sacrificed in this design relative to randomizing classrooms, the design offers several advantages. First, it was easier to convince the schools to participate given that the lessons were to take place in entire grades rather than in selected classrooms across grades. Second, if the treatment is effective, children within grades are more likely to spread messages among their cohort. Under this design, the treatment and control groups are far less likely to interact with one another about the lessons, reducing treatment diffusion at least in the short run.

Table 1. Results of treatment 1 assignment

School	Control			Treatment 1		
	Grade 3	Grade 4	Grade 5	Grade 3	Grade 4	Grade 5
A1	4	-	-	-	4	4
A2	-	7	6	7	-	-
B1	4	4	-	-	-	3
B2	-	-	7	7	7	-
C1	6	5	-	-	-	2
C2	-	-	6	7	6	-
D1	4	-	-	-	4	4
D2	-	7	6	7	-	-
E1	-	5	-	5	-	5
E2	6	-	6	-	6	-
F1	4	-	-	-	4	4
F2	-	8	8	8	-	-
Total classes	28	36	39	41	31	27

Treatment 2 - Healthy Food Provision

Rationale for treatment design

In Viet Nam, fruit and vegetable intake is largely considered insufficient to meet dietary recommendations, with 57 percent of the adult population not consuming five portions a day (Nguyen & Hoang, 2018). Among children, our formative qualitative work identified FAV as a particularly important class of healthier foods with inadequate consumption among children. Our baseline data within surveyed schools shows that a child typically eats only 87.2 grams of FAV daily, of which 27 grams is fruit. At school, children hardly eat FAV. Although on average a child is given about 55.7 grams of vegetables to eat during lunch, only a third (18.68 grams) is consumed.

Although vegetables are undoubtedly no less important than fruit, we decided to introduce fruit to the school environment for several reasons. First, fruit is not typically part of the school meal. Children tend to eat a snack in the morning and then lunch in the middle of the day. Whereas schools in urban Hanoi provide snacks, no snack is provided by schools in Dong Anh. Therefore, children either bring their own snacks (e.g. sweetened milk or cakes, seldom fruits or nuts) or buy processed snacks outside schools. The

fruit snacks will serve as (i) an outcome measurement to see if the information session motivates children to eat more FAV, and (ii) a default healthier option, which can potentially replace their less healthy snacks. Second, it is much simpler to introduce fresh fruit than vegetables into a specific school's ongoing food preparation scheme. Very few schools in Viet Nam have the facilities to cook vegetables, either by boiling or frying them, on site. Even vegetables that can be eaten raw, which is not popular in Viet Nam, would have to be washed before use. For food safety reasons, all the fruits we selected (banana, grapes and guava) had to be peeled or have the skin removed. The fruit was provided to children during the morning break, so that it did not clash with the on-going school milk program, in which children drink bottled milk during the afternoon break. Third, fruit has yet to be recognized as a daily food in Viet Nam, unlike vegetables. In our sample, children only eat fruit five times a week on average, compared with eating vegetables 17 times on average.

Description of treatment

The snack provision took place over the same five weeks as the education treatment. Budget constraints limited this treatment to two schools. Therefore, in the selected schools, every child in Grades 3 through 5 of these two schools was given a portion (around 80 grams) of fresh seasonal fruits: bananas, grapes or guavas (rotating through the weekdays) during implementation.

We recruited a contractor to supply seasonal fruits as snacks, ensuring the selected company meets legal, safety and any school-based requirements to provide food for children at school. In early morning, the contractor delivered the fruit directly to teachers, who would then bring the fruit to the classrooms. The children could take the fruit during the morning break.

Treatment assignment

To select the two schools for treatment, one out of the six pairs of schools was randomly selected to receive fruit. All the classes of the three grades in these two schools were given fruits as snacks during the morning break. For this treatment, we had 10 schools in the control group and two schools in the

treatment group. Accordingly, 30 clusters (165 classes) were in the control group and six (32 classes) in the treatment group.

In this design, spillover of treatment effect to other schools was impossible. The fruit not consumed by the treated children would simply be transferred to 1st and 2nd graders in the same school, who were not part of the study.

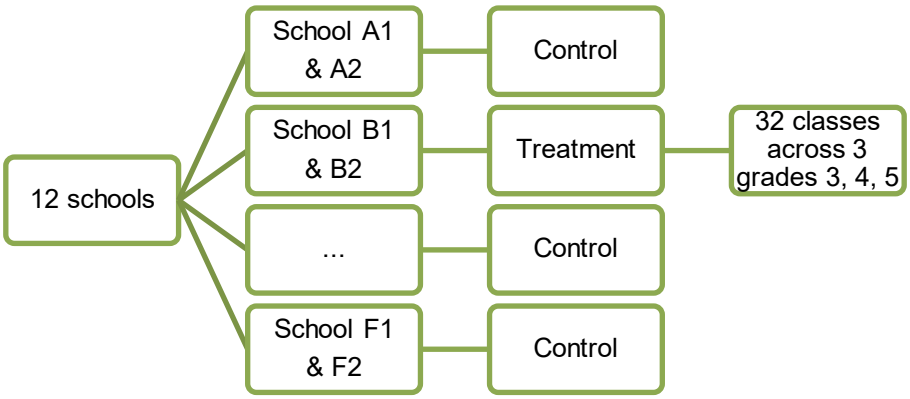


Figure 3. Assignment of Treatment 2

Data Collection

The study involves three data collection rounds: Baseline (four weeks prior to the intervention), Endline 1 (during the last week of the intervention) and Endline 2 (six months after the intervention ended). In each school, the class teachers helped send information sheets and consent forms to participants, and to gather signed consent forms.

Baseline and Endline 1

For the two data collection rounds that took place during the 2018 – 2019 school year, the following data collection tasks were conducted:

- Food diary collection: Enumerators instructed the children to fill in a food diary with the support of

the class teachers. Every other day (the day following the recorded day), the enumerators checked the diaries to ensure that all the contents in the diary were covered. As the food diary covered a record during the weekend, the enumerators would go back to the same school the following week to collect the diaries.

- Child questionnaire: The enumerators conducted face-to-face interviews with the sampled children during school breaks (Annex 3).
- Lunchtime observation: An enumerator was assigned a classroom to observe the 10 children and measure their food consumption during lunchtime.
- Parent questionnaire: The schools helped the research team obtain contact information (phone numbers) of all parents of the selected students and informed them about the phone interview. The enumerators made phone calls directly to parents to conduct parent interviews.

This study benefited from the use of e-data collection technologies. The interviews were conducted using tablets using the package SurveyCTO. Date entry forms for food diary and lunch observation data were also developed in SurveyCTO. The forms make use of the 2017 Food composition table (FCT) of Viet Nam (Viet Nam National Institute of Nutrition, 2017). This table consists of 620 foods divided into 15 food groups and 500 dishes in a common Vietnamese recipe book (Nguyen et al., 2014). The respondents were asked to report cooked food quantity. Where necessary, e.g. the respondents could only report the quantity in raw form, the quantity was converted using a conversion factor taken from the photo book developed by NIN, according to type of processing. A data collection pilot was conducted in two schools in Dong Anh that were not in the primary sample. The objective of the pilot was to check the contents of the questionnaires and the feasibility of the use of food diaries. The outcome measures from the data collection are displayed in Annex 2.

Endline 2

The second endline took place in December 2019, during the 2019 – 2020 school year. The children who have graduated from primary school, the 5th graders in the 2018 – 2019 school year, could not be tracked, so only two-thirds of the baseline sample were retained.

In this round, we carried out the same questionnaire-based survey for children, measuring children's knowledge and attitude, as well as FAV consumption frequency. We did not collect food diaries or conduct lunchtime observations because we did not expect to be able to detect an effect on daily FAV consumption due to the reduction in sample size. Instead, the goal of this survey round was to examine whether any knowledge deterioration had taken place. We are particularly interested in the retention of knowledge taught to the children using the lessons with simple messages. We also did not conduct interviews with parents, due to the lower response rate (80 percent at baseline and 68 percent at Endline 1) and the smaller sample size relative to the previous rounds of data collection.

RESULTS

Balance between treatment arms

We used two approaches to compare treatment and control group characteristics. First, we did a series of linear ordinary least square (OLS) regressions to compare the nutrition education lessons treatment group ("Lessons" treatment) with the Control group, and the fruit provision treatment group ("Free fruit" treatment) with the Control group, using treatment variables and explanatory variables obtained from our baseline questionnaires (Table 2). Second, we conducted a joint test of orthogonality using a χ^2 test. We ran a binary logit with the treatment variable on the left-hand side, and explanatory variables on the right hand size. The null hypothesis is that all the regression coefficients across two models (for three treatment values) are simultaneously equal to zero. In both approaches, we used clustered standard errors to account for the randomization process. Although fruit provision was randomized at the school level, we used 36 clusters for both treatments. For baseline outcomes, the intra-cluster correlation (ICC) at both the school and grade levels were both small (ranging from 0.01 – 0.07) and not meaningfully different from one another, suggesting that clustering at the grade level should sufficiently account for intra-cluster correlation.

Table 2. Baseline variables

Variables	Type	Description	Mean	SD
Child				
Knowledge index	Continuous	The scores from the knowledge questions were aggregated into a mean effects index (Kling et al., 2007). The control group takes the mean 0 and standard deviation 1.	-0.01	1.00
Attitude index	Continuous	The scores from the attitude questions were aggregated into a mean effects index (Kling et al., 2007). The control group takes the mean 0 and standard deviation 1.	0.05	0.98
Consumption frequency (fruit)	Continuous	The number of times the respondent ate fruit in the past 7 days	7.08	5.24
Consumption frequency (vegetable)	Continuous	The number of times the respondent ate vegetable in the past 7 days	16.56	8.24
Male child	Dummy	0 = No; 1 = Yes	0.56	0.50
Age of the child	Continuous	8 – 14 years	9.96	0.82
Parent				
Knowledge index	Continuous	The scores from the knowledge questions were aggregated into a mean effects index (Kling et al., 2007). The control group takes the mean 0 and standard deviation 1.	-0.01	1.02
Attitude index	Continuous	The scores from the attitude questions were aggregated into a mean effects index (Kling et al., 2007). The control group takes the mean 0 and standard deviation 1.	-0.05	1.01
Consumption frequency (fruit)	Continuous	The number of times the respondent eats fruits in the past 7 days	11.09	6.7
Consumption frequency (vegetable)	Continuous	The number of times the respondent eats vegetables in the past 7 days	18.48	8.11
Male parent	Dummy	0 = No; 1 = Yes	0.16	0.37
Household size	Continuous	1 – 10	4.51	1.21
Household income quartile	Categorical	1. 1st income quartile 2. 2nd income quartile 3. 3rd income quartile 4. 4th income quartile	2.37	1.18

Child sample: Using the first approach, we found no statistically significant difference between the Lessons and Control groups, and between Free fruit and Control groups (Table 3). The second approach came to a similar conclusion (Table 4). With p-value > 0.05 (Prob > χ^2 = 0.50), we could not reject the null hypothesis, which implies that Lessons and Control were similar on the explanatory variables.

Between Free fruit and Control, we rejected the null hypothesis (p-value < 0.05), as there was an imbalance in the male variable. This slight imbalance was expected given the sample size imbalance and the small number of clusters for the second treatment (Table 4).

Parent sample: Using both approaches, we found virtually no difference between Lessons and Control. Nevertheless, we detected some differences in baseline variables between Free fruit and Control, which was also expected due to the imbalanced sample. Besides, the parent sample had a higher attrition rate than the child sample. Checking for missing data reveals that attrition was higher among some schools, including the two schools that got the Free fruit treatment, than the others. The difference between Free fruit and Control on the consumption frequency of vegetable was small (1.5) and only significant at 10 percent level. The differences on the knowledge and attitude variables are more of a concern, which require caution in analyzing the data to calculate treatment effects on the parent sample (Table 4).

Table 3. Regressions of Outcome Variables Measured at Baseline on Treatment Indicators

Child	Knowledge index	Attitude index	Consumption frequency (fruit)	Consumption frequency (vegetable)	Age	Male
Treatment 1: Lessons	-0.04	0.10	0.45	1.11	-0.32	0.03
	(0.08)	(0.07)	(0.31)	(0.81)	(0.27)	(0.03)
Treatment 2: Free fruit	-0.12	0.07	0.51	-0.47	0.01	0.06
	(0.08)	(0.12)	(0.50)	(1.33)	(0.38)	(0.04)
Observations	1,917	1,917	1,917	1,917	1,917	1,917

Parent	Knowledge index	Attitude index	Consumption frequency (fruit)	Consumption frequency (vegetable)	Male	Household size	Household income quartile
Treatment 1: Lessons	-0.03	-0.10	0.13	1.64	-0.00	-0.18*	-0.00
	(0.08)	(0.08)	(0.56)	(1.08)	(0.03)	(0.09)	(0.08)
Treatment 2: Free fruit	0.16**	-0.16**	0.25	-1.57*	0.03	-0.08	-0.07
	(0.06)	(0.06)	(0.41)	(0.81)	(0.04)	(0.06)	(0.08)
Observations	1,570	1,570	1,570	1,570	1,570	1,569	1,570

Cluster robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 4. Test of joint orthogonality using logistic regression

Child	Treatment 1: Lessons	Treatment 2: Free fruit
Knowledge index	-0.0102	-0.12
	(0.0699)	(0.10)
Attitude index	0.0725	0.09
	(0.0640)	(0.11)
Consumption frequency (fruit)	0.00972	0.02
	(0.0136)	(0.02)
Consumption frequency (vegetable)	0.00535	-0.01
	(0.0102)	(0.02)
Age	-0.465	0.02
	(0.413)	(0.56)
Male	0.125	0.24*
	(0.118)	(0.15)
Constant	4.296	-1.93
	(4.151)	(5.59)
Observations	1,917	1,917
chi-square test	5.375	17.86
p-value, Chi-square test	0.497	0.0066

Parent	Treatment 1: Lessons	Treatment 2: Free fruit
Knowledge index	-0.03	0.18***
	(0.07)	(0.06)
Attitude index	-0.09	-0.15***
	(0.08)	(0.05)
Consumption frequency (fruit)	-0.00	0.02
	(0.01)	(0.01)
Consumption frequency (vegetable)	0.03**	-0.03***
	(0.01)	(0.01)
Male	-0.07	0.22
	(0.20)	(0.34)
Household size	-0.14**	-0.03
	(0.06)	(0.05)
Household income quartile = 2	-0.01	0.15
	(0.17)	(0.20)
Household income quartile = 3	0.12	-0.16
	(0.19)	(0.29)
Household income quartile = 4	0.03	-0.12
	(0.18)	(0.20)
Constant	-0.02	-1.21
	(0.55)	(0.88)
Observations	1,569	1,569
chi-square test	16.15	112.8
p-value, Chi-square test	0.0638	0.000

Cluster robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Treatment effects

Short term treatment effects on children

We estimated the intention to treat (ITT) effects of the treatments using the following specification:

$$y_{ij} = \alpha_0 + \alpha_1 L_j + \alpha_2 F_j + \alpha_3 L_j F_j + X'_i + \epsilon_{ij} \quad (1)$$

The effect of the nutrition lesson (L), free food provision (F) and the interaction between the two treatments (LF) is given by α_1, α_2 and α_3, respectively. y_{ij} includes the outcome measure at endline for individual i in cluster j. X'_i is a vector of covariates (controls).

Knowledge and Attitudes

In the short term, the nutrition lessons had a moderate positive effect on the children's nutritional knowledge (Table 5). Using an OLS regression under specification (1), we found that on average the children who were offered the lunchtime nutrition lessons gained 0.33 standard deviations in the knowledge index score. We obtained similar results when we added socio-economic control variables or the baseline value covariates (Columns 2 and 3). Although we expected combining both interventions to have an additional influence on the knowledge score due to the knowledge-practice connection, we did not find an additive effect.

Table 5. Short term treatment effect on children's nutritional knowledge

Knowledge index	(1) No controls	(2) With socio-economic controls	(3) With baseline value of outcomes
Education lessons	0.33**	0.44***	0.41***
	(0.13)	(0.10)	(0.08)
Fruit provision	-0.00	0.07	0.03
	(0.11)	(0.11)	(0.09)
Interaction	-0.03	-0.18	-0.06
	(0.15)	(0.17)	(0.15)
Male child		-0.07	-0.09*
		(0.06)	(0.04)
Age of child	-	0.27***	0.24***
		(0.03)	(0.03)
4th income quartile	-	0.23***	-
		(0.08)	
Household size	-	-0.05**	-
		(0.02)	
Male parent	-	0.02	-
		(0.0675)	
Knowledge index (baseline)	-	-	0.23***
			(0.02)
Constant	0.00	-2.52***	-2.34***
	(0.09)	(0.36)	(0.32)
Observations	1,893	1,501	1,891
R-squared	0.02	0.09	0.12

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Contrary to expectations, neither the nutrition lessons nor fruit provision led to a significant change in children's attitudes about FAV consumption. This result is consistent across the three specifications in Table 6. The combined intervention appears in some specifications to raise attitudes of children towards eating FAV by around 0.3 standard deviations, but it is only statistically significant at the 10 percent level in two of the three specifications. The relatively small sample of 146 children who got the combined intervention may help explain the lack of significance.

Table 6. Short term treatment effect on children's attitude index on FAV consumption

Attitude index	(1) No controls	(2) With socio-economic controls	(3) With baseline value covariate
Education lessons	0.03	0.02	-0.01
	(0.04)	(0.04)	(0.05)
Fruit provision	-0.16	-0.02	-0.14
	(0.19)	(0.17)	(0.12)
Interaction	0.35*	0.29	0.26*
	(0.20)	(0.18)	(0.13)
Male child	-	-0.10*	-0.08
		(0.06)	(0.05)
Age of child	-	-0.09***	-0.05*
		(0.02)	(0.03)
4th income quartile	-	-0.03	-
		(0.08)	
Household size	-	0.02	-
		(0.02)	
Male parent	-	-0.04	-
		(0.06)	
Baseline attitude index	-	-	0.39***
			(0.02)
Constant	0.03	0.91***	0.60**
	(0.03)	(0.27)	(0.28)
Observations	1,893	1,501	1,891
R-squared	0.01	0.02	0.17

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Additional explanatory data from the questionnaire reveals some clues why children are not willing to eat more FAV, despite the increased awareness of the importance of eating FAV. Eighty-five percent of the children cited the reason for their difficulty in increasing their FAV is that FAV do not taste good. This identified constraint is in line with our qualitative findings, which found that the lack of tastiness in FAV, especially those prepared at school, led to low FAV consumption. In the qualitative scoping study, the children complained that vegetable dishes served at school were too cold and/or too oily. Not surprisingly, at school, a child consumed only about 25 grams of FAV on average, while at home this figure is about 95 grams.

Consumption

From the food diaries and lunch time observation data, we calculated two outcome measures for children's consumption: the amount of fruit and vegetable consumed in a weekday and the amount of fruit consumed per weekday (in grams)[2]. Table 7 displays the results of the OLS regressions to estimate the ITT of the interventions on these two consumption outcomes. Columns (2), (4) and (5) include control variables[3].

Education lessons did not influence the fruit and vegetable consumption, which was not surprising given their lack of influence on the attitude towards fruit and vegetable consumption and the short intervention time span. Access to free fruit, nevertheless, increased children's consumption. Although we provided every treated child a full portion of fruit (80 gram), less than half of this (34.84 grams) was consumed by the children on average. This amount still doubled the daily fruit consumption of children compared with the control group, who ate less than 30 grams of fruit on a weekday (equivalent to a small mandarin or a piece of mango). The effect remained significant (albeit at a p-value = 0.053) when we included the child-level control variables, but lost its statistical significance when we included the parent's control covariates, potentially due to the smaller number of parent samples. As discussed above, attrition in the parent sample was higher among some schools, including the two schools that got the Free fruit treatment. This may have weakened the detected effect of this treatment when including the parent-level controls. When we used the weekly fruit frequency consumption as the outcome measure, fruit provision increased the times the child consumed fruit by two (Column 6 of Table 5), which was less than half the

[2] Although we also collected food diaries of one weekend day, many children failed to fill them in by themselves (without the enumerators by side to assist them and control that the diaries were filled in). During weekends, for example, we only got 77 percent as large a diary sample compared as on weekdays, and many fields were left blank on returned diaries in general. We therefore decided to exclude them from the analysis.

[3] The number of observations under (1) – (4) is much lower than that of the baseline (1917) and the previous endline knowledge and attitude estimations (1893) for several reasons. First, the knowledge and attitude measures were obtained from the face-to-face questionnaire with the children, while the consumption outcome measure had to be calculated from both the food diary and food observations. We had a large proportion of children (12%) who did not return their diaries, while we had only 4% of the children who could not be observed during lunchtime. Missing observations were more likely to belong to control group, while for F, missing observations were more likely to belong to treated group. The number of missing observations for food observation is small and does not qualitatively affect the results of the following analyses.

times they got access to free fruit (five times a week). This measure is arguably not as reliable as the daily consumption measure, as the child had to recall over a longer period (a week) instead of make food records every day.

Table 7. Short term treatment effect on children's FAV consumption and fruit consumption

VARIABLES	(1) Daily FAV consumption No controls	(2) Daily FAV consumption With controls	(3) Daily fruit consumption No controls	(4) Daily fruit consumption Child level controls	(5) Daily fruit consumption Parent level controls	(6) Weekly fruit consumption No controls
Education lessons	-10.89	-8.616	-0.491	1.165	-1.108	0.54
	(7.074)	(7.500)	(3.986)	(3.563)	(3.365)	(0.34)
Fruit provision	30.75	41.79	34.84**	35.73*	33.03	2.25*
	(27.38)	(38.68)	(16.41)	(17.81)	(25.58)	(1.25)
Interaction	28.69	21.03	-7.821	-8.027	-1.530	0.00
	(34.40)	(42.28)	(22.27)	(21.71)	(27.70)	(0.00)
Male child	-	-13.97**	-	-9.673**	-11.13**	-
		(5.779)		(3.627)	(4.095)	
Age of child	-	5.575	-	3.994	2.323	-
		(5.493)		(3.186)	(3.260)	
2nd Income quartile	-	14.10*	-	-	12.90*	-
		(8.255)			(7.035)	
3rd Income quartile	-	18.24***	-	-	12.49*	-
		(6.597)			(6.954)	
4th Income quartile	-	3.330	-	-	4.277	-
		(7.039)			(4.729)	
Household size	-	-1.445	-	-	-1.918	-
		(2.767)			(2.012)	
Male parent	-	-1.815	-	-	8.175	-
		(6.618)			(5.536)	
Control group Mean	123.97	123.97	27.41	27.41	27.41	7.08
Control group SD	104.34	104.34	71.05	71.05	71.05	5.42
Observations	1,557	1,242	1,557	1,556	1,242	1,893
R-squared	0.030	0.043	0.026	0.033	0.036	0.03

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

We also separately looked at the amount of fruit consumed at school and at home to explore potential substitution effects. Table 8 displays the results of the linear probability model (LPM) regression. It was clear that the increase in fruit consumption was exclusively driven by the free access at school. The increase in fruit consumption at school was not offset by a decrease in fruit consumption at home.

Table 8. Daily fruit consumption at school and at home

VARIABLES	(1) Fruit consumption At school, weekday	(2) Fruit consumption At home, weekday
Education lessons	-1.256	1.225
	(1.174)	(2.847)
Fruit provision	34.88***	1.066
	(12.01)	(5.500)
Interaction	-12.38	1.437
	(16.84)	(6.180)
Constant	3.719***	20.44***
	(1.015)	(2.197)
Observations	1,557	1,557
R-squared	0.190	0.000

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Short term treatment effects on parents

For the parents, we only estimated the intention to treat (ITT) effects of nutrition lessons using the following specification:

$$y_{ij} = \alpha_0 + \alpha_1 L_j + X_i' + \epsilon_{ij} \quad (2)$$

The average effect of the nutrition lessons (L) is given by α_1, y_{ij} includes the outcome measure at endline for individual i in cluster j, and X_i' represents the covariates.

Although we incentivized all treated children to share the materials that they had obtained at school with their parents, many parents did not receive the materials. Out of 644 parents whose children were given the nutrition lessons in our endline sample, only 41.8 percent of them confirmed receiving the materials. And only 44.6 percent of the parents who received the materials from their children could recall at least

one topic covered in the materials. Consequently, it came as no surprise that the education lessons taught to the children created no significant changes in knowledge and attitudes among parents (Table 9). The results did not change qualitatively when we included control variables or when we used the local average treatment effect (LATE) estimator with the treatment status instrumenting for actual receiving the leaflets (Annex 4). Although the education lessons raised the reported FAV consumption frequency by 1.64 times per week[4] (ITT estimate) and 3.94 per week (LATE estimate), this result is likely to be at least partly driven by social desirability bias. This effect on consumption also lost its significance when we included baseline value of the FAV consumption frequency in the regression (Annex 4).

Table 9. Treatment effects on parents

	(1)	(2)	(3)
VARIABLES	Knowledge index	Attitude index	FAV consumption frequency
Nutrition lessons	-0.0558	-0.0996	1.642*
	(0.0687)	(0.102)	(0.894)
Observations	1,340	1,340	1,340
R-squared	0.001	0.002	0.011

Cluster standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Longer term treatment effects on children

We applied the same specification (1) to the second endline data, which was collected six months after the treatment ended. We were mainly interested in how the knowledge taught to the children retained after the long summer holidays and wanted to assess the longer-term effect of the interventions on the knowledge and attitude towards FAV consumption of the children. We did not collect consumption outcome data, so our analysis did not include analysis on consumption.

The main effect of the education lessons that we observed in the short term disappeared in the long term

[4] Although we also collected diaries from parents, the quality of these diaries was generally poor. A large number of parents did not return the diary (we only received 1174 diary books out of 1340 interviewed parents). For those that did, the information provided was not detailed enough to calculate the amount of consumed FAV correctly. This would lead to underestimation of the FAV consumption. If we used this FAV amount as outcome measure instead of the consumption frequency, the qualitative result did not change.

(Column 1 Table 10). The children who were given the lessons had a lower knowledge score relative to the control group. This seemingly surprising result was driven by one question on the variety of fruits and vegetables that one should eat. For this question, the child was given a description of an eating habit and was asked to judge if it was a healthy one. This habit involves eating only fruits instead of vegetables. In Viet Nam, fruit is generally not consumed as much as vegetables, and the nutrition lessons may unintentionally have played up the role of fruit. Eating more fruit may have been stickier to the treated children's memory, and they may have misjudged that eating only fruit can be as beneficial as eating both. Control children were not exposed to the lessons, and therefore held on to their usual notion that they should eat both fruit and vegetables.

Interestingly, we found a significant effect of the combined intervention on the knowledge index score. This effect remained its significance when control variables were added. Similar to the case in the short-term endline, we did not detect a change in the attitude of the children toward fruits and vegetables when exposed to either of the interventions.

Table 10. Longer term treatment effects

VARIABLES	(1) Knowledge index	(2) Knowledge index (with controls)	(3) Attitude index
Education lessons	-0.17*	-0.14*	-0.02
	(0.10)	(0.08)	(0.07)
Fruit provision	-0.08	-0.05	0.07
	(0.11)	(0.06)	(0.14)
Interaction	0.29**	0.24**	0.02
	(0.13)	(0.09)	(0.17)
Male	-	0.02	-
		(0.05)	
Age	-	0.17***	-
		(0.06)	
Baseline knowledge index	-	0.18***	-
		(0.03)	
Constant	0.01	-1.61***	-0.01
	(0.07)	(0.57)	(0.04)
Observations	1,240	1,240	1,240
R-squared	0.01	0.05	0.00

Cluster standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

DISCUSSION AND CONCLUSIONS

Our study designed and tested a pilot intervention to improve children's consumption of fruits and vegetables through schools in Viet Nam. We estimated the effects of two interventions through a randomized control trial on over 1900 children in 12 schools in peri-urban Hanoi. Evaluation data was collected immediately after the intervention and six months after the interventions had ended.

We found that the nutrition lessons had a significant effect on improving children's knowledge of FAV. The five-week-long short and relevant nutrition lessons increased the knowledge score by 0.3 standard deviation compared to the control group. The interventions were implemented inexpensively and conveniently for the schools without extra burden for teachers. Besides a one-off cost for developing the materials based on existing nutrition materials available at NIN, we only had to pay for the printing of posters and leaflets delivered to children and remuneration for teachers. This amounted to approximately US$40 per class for the whole intervention package. Therefore, if the purpose of a school nutrition program is to raise knowledge, our one-shot intervention can be a cost-effective way to raise the children's nutritional knowledge. Where resources are tight, this can be a desirable alternative to a full-scale nutrition curriculum, which is being piloted in a limited number of schools in Vietnam[5].

Nevertheless, nutrition lessons have to be combined with practice to sustain its long-term effect. As our result demonstrated, only the children who were also given the access to free fruit scored better than the control group in knowledge about fruits and vegetables in the longer run. We were not disappointed to find a lack of impact of the lessons on the FAV consumption of the children. From scoping qualitative interviews, we understood the poor quality of the meals provided to children during lunch. This supply-

[5] The program "School nutrition education – Nestle for healthier kids" implemented by Primary Education Department (Ministry of Education and Training), National Institute of Nutrition and General Department of Preventive Medicine (Ministry of Health) have been implemented since 2012 in 60 primary schools in 9 provinces (not including Hanoi) in Vietnam. The curriculum for the program includes 16 topics (complemented with interactive slides to be used on computers) and is complemented with other activities like school competitions and school gardening (http://dinhduonghocduong.net/ (only in Vietnamese)

side constraint must have prevented the children from eating more fruit and vegetables, even though they were better aware of the issues of not eating enough FAV. Our follow-up qualitative study confirmed this speculation: the children could not raise their FAV consumption although they wanted to because the vegetables prepared at school tasted bad. Unless the schools are willing to work with the food providers to improve the meals' quality, nutrition education about increasing FAV consumption might lose its effectiveness.

Access to healthy and safe food at school can be an effective measure to raise children's healthy food consumption. A common excuse by parents regarding children's low consumption of healthy foods is that the children do not like to eat such foods and making the fruit available will not help. We proved that it is not the case here. We did not observe a substitution effects between fruit provision at school and home fruit consumption, suggesting that, given the access to healthy and safe food at school, children will gladly consume more of it without offsetting the amount of fruit they eat at home. Providing children with free and accessible FAV has been shown to have an impact on long-term eating behavior (DeCosta et al., 2017). Although we did not have the resources to implement this in the long run – it is worth considering including fruit in the school food environment. The short duration of our pilot fruit provision intervention did not allow us to measure its effectiveness on habit formation, which can be achieved with a larger-scale program. For example, a one-year implementation of the European School Fruit scheme led to a significant increase in children's FAV consumption (Methner et al., 2017). School food programs are not foreign to Viet Nam. A school milk program has been implemented in several provinces in Viet Nam, including Hanoi. Nevertheless, the healthiness of this initiative is questionable because the majority of milk provided is sweetened and a proper evaluation has not been conducted. Our study suggests that inclusion of fruit during school time worked effectively to increase healthy consumption, and natural fruit is superior to sweetened milk as snacks. The habit of adding sugars to foods that are commonly perceived as healthy such as milk may impact the adherence to healthy dietary guidelines and increase in adiposity risk (Russo et al., 2018). The amount of fruit eaten by an average child per day is as low as one portion,

which has to be raised without a doubt. One important concern is food safety, which we could ensure in our pilot, but might be difficult to acquire in other settings.

Child-parent message delivery is seemingly not an effective channel for nutrition knowledge dissemination in our setting. Although the children were encouraged to deliver the nutrition messaging to their parents, the majority of the parents did not receive/recall receiving this information, thus displaying no changes in their knowledge, attitude or practices of FAV consumption. In our follow-up qualitative interviews with the children, they talked about the following reasons for this result: the parent had no time to read the information; the child did not attempt to share the information knowing that his or her parent would not read it; the child did not remember to relay the information to their parents. Admittedly, during the short lessons in school, the child might have not been given enough communication and persuasion skills to follow up with their parents.

The children who successfully delivered the salt-reducing message to their family members in an earlier study received training in 3.5 months, with several homework tasks to do as messengers (He et al., 2015). As our intervention was designed to introduce minimal disruptions to a school day, we did not have dedicated time to train the children. Counting on the children to deliver the information was only part of the problem. Parents' willingness to receive the information from school through their children is low in Viet Nam. Our follow-up qualitative questions with the students revealed that some children did not even attempt to relay the health messages to their parents, believing that the parents would not consider such information. In peri-urban schools in Viet Nam, although information from school frequently reaches parents through letters delivered by the children, the parents usually took notice of only important events such as final term parents' meetings. Apparently, the information relayed by the students from school education was not given such importance. Although we set up a hotline for the parents in our study to share their concerns and wishes about the children's diets, we received virtually no reactions. Rallying the participation of parents given the resource constraints is a challenge that future actions will have to overcome.

As a natural field experiment, our study faced particular risks to both internal and external validity. Although the teachers had no incentive during the duration of the treatment and first endline data collection to provide formal lessons and share the educational materials with students in other grades, we could not ensure they would not include the knowledge they gained from the intervention into their own teaching practices, for example in science lessons. If such channels did occur, we may have underestimated treatment effects. Another concern that affects the study's internal validity is that the treated children's siblings and friends that belonged to control group may have picked up some knowledge from the treated children. Again, such transmission would have led to underestimated treatment effects. To assess the extent of this problem, we identified these spillover children in the baseline and interviewed them in the first endline. The spillover children did not have a higher knowledge score than our pure control children, which suggests that the results remain internally valid. However, this finding also suggests the knowledge did not circulate within the children's extended network (beyond their specific grade).

Our measurements may also suffer from underreporting, as it was mostly the children's responsibility to fill in the food diaries themselves. The use of the food diaries by parents was also very limited. Future studies may consider the use of a more interactive tool, for example a child-friendly mobile app that the child can fill in together with their parents, to increase response rate and completeness of dietary data collected from both children and their parents. Regarding external validity, our results are specific to our sample. The intervention materials must be adapted to fit other contexts. The teachers' skill and the school's facilities would also determine the outcomes of the nutrition lessons. We also provided teachers with a small incentive to ensure they taught the lessons, which might be difficult to scale. The availability and accessibility of fruit and vegetables in the school environment would also influence the effectiveness of treatments similar to the ones in this experiment.

Policy implications

As discussed in the introduction, our study results provide useful considerations for the implementation of Viet Nam's national nutrition strategy where school-based nutrition is a vital component. We identified the short nutrition lessons as a viable, inexpensive option to raise the knowledge of young children. Developed by government nutritionist partners, the lessons have been standardized to meet the national health recommendations, and they can also be adapted to fit different contexts. Nevertheless, we recommend additional measures, such as inclusion of fruit and improvement of lunch meal quality to bridge the knowledge and practice gap. As long as the food providers do not make substantial changes to how vegetables are served at school, the children will not change their attitudes toward the consumption of such dishes. These supply-side measures would require commitment of resources from both schools and families, and more support from the government. Initiatives exist to improve the school meal quality, such as the School Meal Project[6], implemented by Ajinomoto, the Ministry of Education and Training and National Institute of Nutrition. Nevertheless, the school food suppliers in Dong Anh assessed the current menu planning tool to be infeasible given the local contexts. For example, the menu includes salads, which are difficult for the providers given the higher level of hygiene required to serve fresh uncooked vegetables. It remains a challenge to help schools develop school meals that are nutritious, tasty and locally adaptable.

Our study also advocates for the introduction of fruit into the school environment. Currently, in Viet Nam, only some better-off schools in urban areas provide fruit as snacks for primary school children, mostly because they have better access to safe fruit providers and the parents have higher income to pay for the fruit. To realize our recommendations and bring fruit to more schools, both constraints would have to be relaxed, particularly with support from the government and the private sector. Policy makers can ideally build upon lessons they have learned with their current experience with the school milk program,

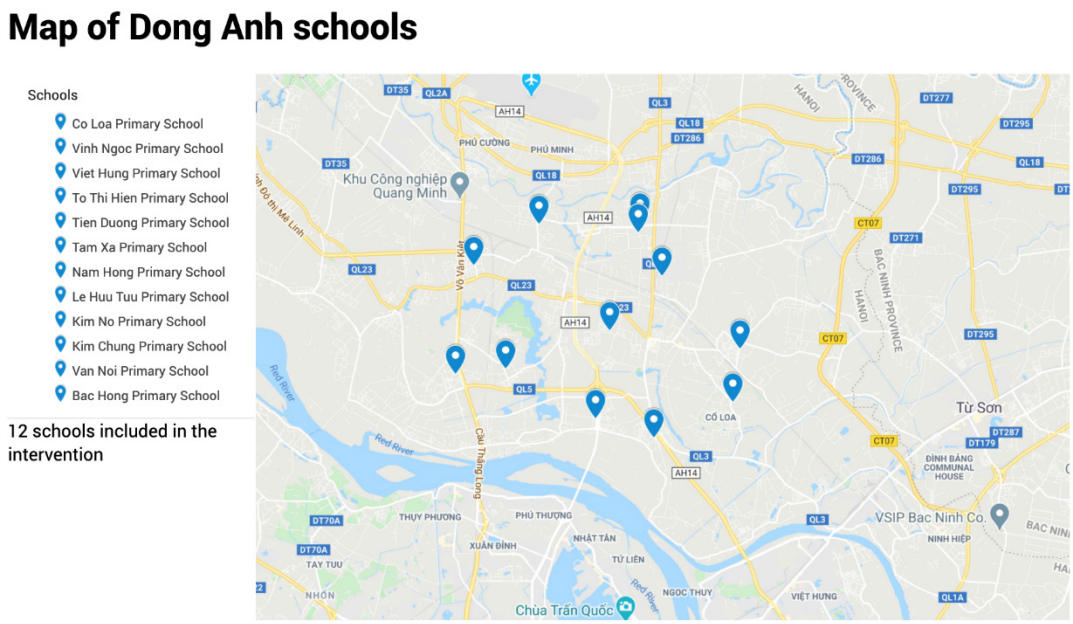
[6] http://buaanhocduong.com.vn/ (in Vietnamese only)

to extend that program to include fruit and vegetables. The progress and lessons from developed countries, such as the EU school fruit, vegetables and milk scheme, will also be helpful for considerations.

We also raised concerns about family participation in improving children's diets. The National Nutrition Strategy states that improper nutrition knowledge and practices are still common among mothers and other family members, including those living in less developed areas, and that participation of communities and family members should be encouraged. The strategy, however, does not specify how to achieve the participation of family members. Our intervention did not successfully reach the parents, as there were no effective communication channels between parents and schools. Meanwhile, the children were not equipped with skills to act as the bridge. This limitation does not only concern only our research, but also fits into the broader pitfall of school—home communications. Therefore, educators and policy makers will have to come up with innovative tools to remove barriers to improved school—home communications. For example, online platforms such as Facebook have been assessed to help overcome the time constraints parents face in accessing nutrition education (Swindle et al., 2018). Future research can search for school-based nutrition tools to which parents will positively respond.

ANNEXES

Annex 1: Map of schools in Dong Anh



The map is available at the following address:

https://drive.google.com/open?id=1SnFXKA1v_qVb3W38sJqImJ2hWTL102bk&usp=sharing

Annex 2: Outcome measure and collection method

Subject	Outcome Measure	Data Collection Method
Child	Knowledge and attitude about fruits and vegetables	A questionnaire was administered to the sampled child through Survey CTO by trained enumerators. The questionnaire was developed based on FAO Guidelines for assessing nutrition-related Knowledge, Attitudes and Practices (2014). The knowledge questions were adapted based on the topics covered by the intervention's material kits.
	School consumption	In Dong Anh, all school lunches are provided in food trays with standardized foods (portioned by the school food provider staff). The enumerators measured 3 standardized food trays for each grade. At the start of lunch time, enumerator handed out the food trays (with stickers to identify the sampled children). After children finished eating, they collected the identified trays, measured the leftover (or extra food – the enumerator could see if he/she asked for extra food from the teacher/enumerator; and/or estimated the amount of food she/he was given by another student) using a standardized food scale and filled in the school food diaries for each child.
	Home consumption	Children's home food consumption is recorded using a 3-day food diary (Prentice et al., 2011). The diary covers 2 days of the school week and 1 weekend day. A class was randomly assigned to one of the 2 day schemes: (1) Tuesday, Thursday and Saturday or (2) Wednesday, Friday and Sunday. We had no records for Mondays for two reasons: - The enumerators had to officially start working at a school on Monday; therefore, they could only give instructions on Monday at the earliest, so children started recording their consumption on Tuesday. We did not want to ask children to do recall of Monday as it induces recall bias, which we wanted to avoid in the first place by using diaries; and

Subject	Outcome Measure	Data Collection Method
		- Consumption on consecutive days is known to be correlated. Vietnamese meals on Monday are in particularly highly positively correlated with the weekend when they usually have bigger, more nutritious meals. While school consumption was observed and recorded by enumerators, to measure at-home consumption, children were instructed by enumerators to fill in the home food diary at home themselves (with the parents' help if necessary). The paper diaries also provide written instructions, as well as pictures of common units of measurements to support respondent's recording. These units are excerpted from the Photographic Atlas of Food Portion Sizes in Viet Nam developed by NIN, which had been used in previous 24-hour recall surveys in the same district. The enumerators checked the completion of the food diaries before leaving the school. This check was done with the aid of a full version of the Photographic Atlas of Food portions.
Parent	Knowledge and attitude about fruits and vegetables	Corresponding parents of sampled children in both treatment and control groups were interviewed over the phone by trained callers. The parents had been informed in advance by the class teachers that researchers would contact them via phone numbers as they received the consent forms. The phone numbers were obtained from the school, and double checked with the children as they were interviewed to limit missed parents.
	Home consumption	The parents were also sent food diaries with the same format as those for their children. They returned the food diaries to the enumerators, who checked for consistencies and could ask for clarifications by phone.
Auxiliary data: - Household key demographics (age and gender of household		The auxiliary data was collected from personal interviews with the children and phone calls with their parents. The questionnaires for parents and children are included in the Annex.

Subject	Outcome Measure	Data Collection Method
	head, household size, income level, etc.) - Child-parent communication frequency - Parental control over children's food choices - Self-assessment if respondent is eating sufficient fruit and vegetables	
	Details of children's close friends from another grade	To estimate the extent of spillovers, in the baseline, we asked the children if they have close friends that they frequently interact with from other grades. Close friends of the treated children were also interviewed at endline to investigate if their FAV consumption also changes.
	Compliance check: if children indeed tell their parents about what they learn in school	The children were requested to obtain a parents' signature to confirm their children have shared the materials. Parents of treated children were also asked if they have received materials from the school during phone interviews.

Annex 3: Endline questionnaire for children

ENDLINE QUESTIONNAIRE - CHILDREN

Improving Diets in Schools in Vietnam

Date of interview		
	Full name	Code
Commune		
School		
Grade		
Class		
Child (Full name)		
Sex of child		1. Male 2. Female
Parent/Caretaker (Full name)		
Enumerator (Full name)		

Section 1. Knowledge of fruit and vegetable	
1. Which of the following are true?	1. Fiber gives energy for the body 2. FAV help prevent constipation 3. Eating fruits brings about more health benefits than eating vegetables 4. FAV can provide all the nutrients that the body requires
2. Which of the following is/are true about orange, red and yellow FAV?	1. All of them are full of protein 2. They can boost your immunity 3. They can help lower the risks of heart- related diseases 4. They can help our bodies heal faster 5. We need to eat at least 5 portions of orange, red and yellow FAV per day 6. They usually contain high amounts of beta-carotene
3. TRUE OR FALSE: Leafy green vegetables usually contain vitamin C, iron and calcium, which helps immunity and bone development	1. True 2. False 99. Don't know

4. FAV of which colour can help you reduce tiredness/ fatique?	1. Red 2. White/brown 3. Purple 4. Green 5. Yellow 99. Don't know
5. What are the health benefits of FAV with purple colour? (*Do not show the options, respondents can choose more than one answer*)	1. Boost energy 2. Help the working of the immune system 3. Make bones strong 4. Good for eyesight 5. Help the body grow 6. Help wounds heal faster 7. Improve memory 90. Others (Specify)
6. According to recommendation of health experts, a child your age should eat at least how much vegetable every day?	1. One cucumber and one tomato or equivalent (Figure 1) 2. Half a cucumber and half a tomato or equivalent (Figure 2) 3. One small bowl of boiled leafy green vegetable or equivalent (Figure 3)
7. According to recommendation of health experts, a child your age should eat at least how much fruit every day?	1. One banana and one segment of pomelo or equivalent (Figure 1) 2. One banana or equivalent (Figure 2) 3. One banana, one segment of pomelo, and one piece of dragon fruit or equivalent (Figure 3)
8. Endline 1: Tu likes pumpkin and carrot very much. He eats these vegetables almost every day. He does not like and rarely eats green leafy vegetables. Do you think that is good? Endline 2: Nam eats very little vegetable: He never eats vegetable during lunch time and only a little bit during dinner. He eats a lot of fruit though. Do you think that's good?	1. Yes 2. No 99. I don't know
9. Which of the following figures do you think represent a balanced meal?	1. Figure 1 2. Figure 2 3. Figure 3
Section 2. Attitude towards fruit and vegetable	

10. What are the benefits of eating FAV for you? (Do not show the options/read the list)	1. To be active/enjoy sports for a long time 2. To look good: e.g. have good skin and good hair 3. To feel energized 4. To concentrate well 5. To grow big and tall/ have strong bones 6. To prevent constipation 7. Help reduce/gain weight 8. To boost the immune system and fight diseases 9. To have better eyesight 99. Don't know 90. Others (specify)
11. How difficult is it for you to eat FAV?	1. Very difficult 2. Difficult 3. Neither easy nor difficult >> Q13 4. Easy >> Q13 5. Very easy >> Q13
12. Why do you think it is difficult to eat enough FAV?	1. FAV do not taste nice 2. I am not given enough FAV to eat at home 3. I am not given enough FAV to eat at school 4. FAV served at school are not clean 5. They are Ok, but there are many other tastier options 6. Others (specify)
13. It is estimated that the majority of Vietnamese do not eat enough FAV. Do you think you are eating enough FAV as recommended by doctors?	1. Yes 2. No 3. Don't know/ Not sure
14. Do you want to increase your intake of FAV	1. Yes, very much 2. Yes 3. No
Section 3. Practice of eating fruit and vegetable	
15. During the past 7 days, how many times did you eat fruit (do not count fruit juice)?	1. I did not during the past 7 days 2. 1 to 3 times during the past 7 days 3. 4 to 6 times during the past 7 days 4. 1 time per day 5. 2 times per day 6. 3 times per day 7. 4 or more times per day
16. During the past 7 days, how many times did you drink fresh fruit juice (do not count fanta, vinajuice or other fruit flavoured drinks)?	
17. During the past 7 days, how many times did you eat green vegetables?	

18. During the past 7 days, how many times did you eat red vegetables?	
19. During the past 7 days, how many times did you eat orange and yellow vegetables?	
20. During the past 7 days, how many times did you eat purple vegetables?	
21. During the past 7 days, how many times did you eat white/brown vegetables?	
22. Do you often bring snacks to school to eat during break times?	1. Yes 2. No >> Q32
23. What types of snack do you often bring? (select up to 3)	1. Milk (sweetened) 2. Milk (unsweetened) 3. Biscuits/cookies 4. Cakes 5. Fruits (fresh) 6. Fruits (dried) 7. Juice (fresh) 8. Juice (packaged) 9. Nuts 10. Crisps (“bimbim”) 11. Sweets 12. Bread 13. Sticky rice 14. Ice-cream 15. Sausage 16. Fizzy drinks 17. Yoghurt (sweetened) 18. Yoghurt (unsweetened) 19. Instant noodle 90. Others (specify)
24. During school days, do you often have snacks at home after school?	1. Everyday 2. 3 – 4 days/ week 3. 1 – 2 days/ week 4. No >> Q34
25. What types of snack do you often have at home? (select up to 3)	1. Milk (sweetened) 2. Milk (unsweetened) 3. Biscuits/cookies 4. Cakes 5. Fruits (fresh) 6. Fruits (dried) 7. Juice (fresh)

	8. Juice (packaged) 9. Nuts 10. Crisps (“bimbim”) 11. Sweets 12. Bread 13. Sticky rice 14. Ice-cream 15. Sausage 16. Fizzy drinks 17. Yoghurt (sweetened) 18. Yoghurt (unsweetened) 19. Instant noodle 90. Others (specify)
Section 4. Perception of the project (for the treatment group only)	
26. Have you been taught about FAV in the last few weeks?	1. Yes >> Q27 2. No >> End of questionnaire
27. What topics were you taught? (*do not read/show the options, respondents can choose more than one answer*)	1. Balanced meal 2. Recommended amount of FAV intake 3. Benefits of FAV 4. How to increase FAV in meals 90. Others (specify) 99. Don’t remember
28. In the lessons you have learnt about [the 4 topics above]. Which topic did you find most interesting? (*only choose 1 answer*)	1. Balanced meal 2. Recommended amount of FAV intake 3. Benefits of FAV 4. How to increase FAV in meals 5. I did not like any of the topics 90. Others (specify)
29. Please state one particular knowledge/ information that you take away from the lessons on FAV at school? (*do not read/show the options*)	1. We need to eat at least 2 portions of vegetables and three portions of fruits per day. 2. We need to eat FAV of a variety of colours namely green, purple, red, orange/yellow, white/brown. 3. Eating FAV helps us stay healthy, boost our immunity and memory, reduce risks of heart diseases and obesity etc. 4. A balanced meal needs to include four groups of food namely carbohydrates (rice, noodles, bread etc.), protein (meat, fish, egg, dairy etc.), fiber and vitamin from FAV. 5. To eat more FAV we can try the ‘take at least one bite’ rule. 6. We should replace sweet snacks with ripe fruits and fizzy drinks/milk tea with fresh fruit juice. 90. Others (specify)

30. Do you feel you have eaten more FAV after the lessons on FAV at school?	1. Yes, a lot more 2. Yes, a little bit more 3. No
31. How do you rate the materials (leaflets, posters) used in the lessons on FAV on a scale from 1 to 5 regarding the following criteria?	31a. Easy to understand 31b. Attractively presented 31c. Easy to apply

END OF INTERVIEW. THANK YOU FOR TAKING PART IN THE SURVEY!

Annex 4: Additional results for treatment effects on parents

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS with control variables			2SLS, with treatment instrumenting for compliance		
VARIABLES	Knowledge index	Attitude index	FAV consumption frequency	Knowledge index	Attitude index	FAV consumption frequency
Nutrition lessons	-0.05	-0.06	1.31	-0.13	-0.24	3.94*
	(0.07)	(0.10)	(0.88)	(0.16)	(0.25)	(2.12)
Male child	-0.05	-0.07	-0.94***	-	-	-
	(0.06)	(0.05)	(0.29)			
Age	0.05	0.08	-0.10	-	-	-
	(0.05)	(0.06)	(0.52)			
Household income quartile = 2	0.10	-0.18**	0.81	-	-	-
	(0.08)	(0.08)	(0.54)	-	-	-
Household income quartile = 3	0.16**	-0.17**	2.20***			
	(0.07)	(0.07)	(0.42)	-	-	-
Household income quartile = 4	0.24***	-0.11	2.27***			
	(0.07)	(0.07)	(0.51)	-	-	-
Household size	0.02	-0.01	-0.04			
	(0.02)	(0.02)	(0.20)			
Male parent	-0.04	-0.01	-0.26	-	-	-
	(0.07)	(0.06)	(0.72)			
Baseline value	0.29***	0.29***	0.18***			
	(0.03)	(0.03)	(0.03)			
Constant	-0.63	-0.58	23.68***	0.00	0.00	24.46***
	(0.49)	(0.58)	(5.27)	(0.05)	(0.08)	(0.73)
Observations	1,308	1,308	1,308	1,340	1,340	1,340

Cluster standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

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