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The impact of nutrition on school grades at the primary school level: a study of the School Breakfast Program in Mexico City

El impacto de la nutrición en las calificaciones escolares a nivel primaria: un estudio del Programa de Desayunos Escolares de la Ciudad de México

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Abstract

This paper investigates the effect of participation in the School Breakfast Program of Mexico City on children's achievements. We use data from a survey to assess the impact of such program on 4th and 5th grade students of 17 elementary public schools in the city for the 2017-2018 school year. The study has a comparative approach between students of beneficiary and non-beneficiary schools. Controlling for other factors, the results of the estimates suggest that the program does not promote significant changes on scores, which contrasts with findings in other countries where a significant effect has been found. Our results also suggest the existence of an inverse relationship between scores and absenteeism, and a positive relationship with the family's educational background and the availability of other social programs.

JEL Code: I18, I28, H51, H52
Keywords: school performance; nutrition; school breakfast program

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Resumen

Este artículo investiga el efecto de la participación en el Programa de Desayunos Escolares de la Ciudad de México sobre las calificaciones de niñas y niños de primaria. Los datos provienen del levantamiento de encuestas para la evaluación de impacto del programa, las cuales contienen información de estudiantes de cuarto y quinto grado de 17 escuelas públicas de la ciudad para el ciclo escolar 2017-2018. El estudio del impacto tiene un enfoque comparativo entre alumnos de escuelas beneficiarias y no beneficiarias. Los resultados de las estimaciones sugieren que el programa de alimentación escolar no propicia cambios significativos en las calificaciones, lo cual contrasta con hallazgos en otros países donde sí se ha encontrado un efecto significativo. Los hallazgos permiten además identificar la existencia de una relación inversa entre las calificaciones y las faltas a clases, así como de una relación directa con los antecedentes educativos de la familia y la disponibilidad adicional de otros programas sociales.

Código JEL: I18, I28, H51, H52
Palabras clave: desempeño escolar; nutrición; programa de desayunos escolares

Introduction

There is strong empirical evidence at the international level suggesting that children with greater access to nutritious food tend to perform better in school –in their grades– than those who are malnourished. A diet rich in vitamins and minerals could improve the retention and memory of students (World Food Program, 2017; Frisvold, 2015). Thus, children living in poverty are often the most prone to different forms of malnutrition (Federal Interagency Forum on Child and Family Statistics, 2007) and are at greater risk of being affected in their physical and cognitive development at an early age.

Moreover, nutrition problems such as overweight and obesity are known to impact countries' economic development and human capital formation (Torres & Rojas, 2018). Given such circumstances, social food assistance programs play a crucial role in reducing gaps in nutrition, school performance, and child development.

In this context, in Mexico City, the School Breakfast Program (Spanish: Programa de Desayunos Escolares) seeks to contribute to the improvement in the nutrition of the school-age population, providing cold breakfasts to children enrolled in basic level public schools and preferably to those of limited resources (Official Gazette of Mexico City, 2018). The change in eating habits promoted by such a program could have an impact not only on nutrition but also on the academic results of the participants. Despite its benefits, this wide-ranging and long-lasting Mexican school feeding program has not been subject to a quantitative evaluation regarding its effects on the children's grades who consume the food rations.

This article aims to analyze for the first time the possible existence of a causal relationship between participation in this program and the results in the grades of children who consume breakfast. The aim is to find out whether the program has other positive collateral effects on participating children, as well as the nutritional impacts sought by the program. The data used come from a new survey conducted to evaluate the impacts of the program in schools in Mexico City, which makes possible the analysis of fourth and fifth-grade students from 17 schools, with information for the August-December period of the 2017-2018 school year. The study has a comparative approach between students from participating and non-participating schools.

The underlying theoretical model consists of a production function of school achievement (grades) that broadly considers the impact of nutrition. The estimations are carried out with multiple regression models and ordered probit models. The results suggest that participation in the School Breakfast Program does not show a significant relationship with students' grade averages, implying that the program only contributes to nutrition and does not generate additional effects on school performance, as is the case in similar programs in other countries. Additionally, it was found that children's grades are inversely associated with school absences and directly with variables such as the parents' level of education and the availability of other social programs that could be complementary to the School Breakfast Program.

This document is organized in four sections in addition to this introduction and the conclusions. The first section presents the background of the program and the main findings of the previous bibliography. The second section describes the data collected and the main statistics. The third section develops the theoretical framework and estimation methods used for the research. The fourth section discusses the results.

Background

The School Breakfast Program in Mexico City was established in 1942, preceded by charitable organizations which provided food rations to children in poverty. It was not until 1997 that, by decree of the Official Gazette of the Federation, the decentralization of the program and its national scope were established. With this reform, the nutritional content of the breakfasts was also transformed. Since then, its composition has evolved toward greater adherence to federal guidelines and standards, which seek to comply with the nutrients required for the healthy development of school-age children (Official Gazette of Mexico City, 2018).

According to the Guidelines of the Comprehensive Food Social Assistance Strategy (EIASA, 2017) of the National System for the Integral Development of the Family (Spanish: Sistema Nacional para

el Desarrollo Integral de la Familia, SNDIF), each breakfast contributes 360 total kilocalories, which represents 25 percent of the recommended daily energy content for this stage of growth. Specifically, breakfast contributes 5.0 grams of added sugars, 5.4 grams of fiber, 360 milligrams of sodium, a maximum of 60 percent of kilocalories from carbohydrates, 15 percent of kilocalories from protein, 25 percent of kilocalories from total fat, and 10 percent of kilocalories from saturated fat.

In 2017, the program served 686,661 students in basic, special, and initial education public schools in the 16 boroughs of the city. It gave priority to the population of limited resources and territories with a very low, low, and medium social development index where this indicator represents a measure of unsatisfied basic needs.[1] The above makes it possible to compare the social development conditions of the population of different territories (Official Gazette of Mexico City, 2016).

Previous studies have evaluated the impact of school feeding programs implemented in various countries on two types of outcomes: nutrition indicators and school achievement indicators. This article will focus on the study of school performance. In this regard, Frisvold (2015) examines the impact of the School Breakfast Program in the United States of America using difference-in-differences and regression discontinuity methods, taking advantage of state mandates to compare schools with high and low levels of eligible students. The results indicate that breakfast availability contributes to improved math and reading scores. Meyers et al. (1989) examine this same American program, comparing students who participated for the first time in the program with those eligible but not participating. The findings show that the participating children significantly improved their scores on standardized tests.

Anzman-Frasca et al. (2015) estimate the impact of the U.S. school breakfast program but in its classroom delivery mode. Their design is quasi-experimental, and they use propensity score weights to adjust for unobservable characteristics. The authors conclude that school grades showed no statistically significant differences between treated and untreated. Imberman and Kugler (2014) also study the within-classroom breakfast mode. Unlike previous authors, they employ a difference-in-differences methodology and find that math scores increase by 0.09 standard deviations and reading scores by 0.06 standard deviations when students are included in the new mode.

Another piece of evidence for the United States is the evaluation of the National School Lunch Program (Hinrich, 2010), which showed long-term impacts on the educational outcomes of beneficiaries. The evaluation uses instrumental variables and considers a mandated change in lunch composition and

[1]The unsatisfied needs indicators that are used in the calculation of the Mexico City social development index are: 1) housing quality and available space indicator; 2) access to electricity indicator; 3) durable goods indicator; 4) sanitary adequacy indicator; 5) access to social security and medical service indicator; 6) educational backwardness indicator. By combining these indicators through a weighted arithmetic average, the geographic areas are classified into four categories. Where this index ranges from 0 to 1 and 1 represents the most developed. According to this classification there are 4 categories: very low (less than 0.7), low (between 0.7 and 0.8), medium (between 0.8 and 0.9), and high (greater than 0.9).

the availability of cohorts of individuals with exposure to the two types of breakfast. The evidence indicates that the program positively impacts years of schooling. A 10% increase in exposure to lunch with the new change of mode leads to an increase of 0.36 years of schooling in women and almost one year in men.

Vermeersch and Kremer (2004) evaluate a meal subsidy program for schoolchildren in western Kenya with a comparative approach between participating and non-participating schools. Their findings indicate that participating students in schools where teachers have more years of experience improved their grades by 0.38 standard deviations. Belot and James (2011) use the modification in a 2004 U.K. law that radically changes the composition of meals in schools in Greenwich to identify the causal impact of the program. Using a difference-in-differences approach, the authors find an increase in the proportion of children achieving better grades in mathematics, English, and science.

Afridi (2011) studies the effects of a change in the mandate of a nutrition program on school participation in rural India. The mandate implements the transition from a scheme that provides grains and take-home food to a scheme where prepared food is provided to children directly in their schools. Using a difference-in-differences methodology, the author finds that the reorientation of the program had a significant effect on the daily participation rates of students in the early grades, and the results show significant effects for girls.

A study for the Philippines indicates that improved nutrition in early childhood, resulting from the implementation of a child feeding program, has a positive impact on children's school outcomes (Glewwe et al., 2001). Specifically, the authors find that school enrollment increases and grade repetition decreases and conclude that each dollar of investment in a child feeding program can provide gains of up to 3 dollars in academic performance for these children.

However, the evidence for Chile shows that the School Breakfast program implemented in this country does not affect school achievement results (McEwan, P., 2013). In this study, indicators of school enrollment, grade repetition, attendance, and grades were evaluated using regression discontinuity. The results reveal that none of these indicators presented significant changes as a result of the program. The author attributes this finding to the high caloric content of the breakfasts and low nutritional content.

In this context, it is worth noting that the School Breakfast Program in Mexico City has never been evaluated in terms of its impact on the school performance of participating children. Nor has the impact of school breakfast on academic achievement been studied employing a survey of a population of students with a comparative design that considers treatment and control groups. Therefore, the main contribution of this research is to carry out a first statistical study that provides reliable causal empirical evidence based on a novel survey on the impact of participation in the program and the average school results of the children who receive the benefit.

Data, survey, and descriptive statistics

The database comes from a survey of 1,112 questionnaires to mothers and fathers to evaluate the impact of the School Breakfast Program in Mexico City. To these data were also added the administrative records of the program.[2] The data were collected during November and December 2017 and provided information from the 2017-2018 school cycle. The target population was fourth and fifth-grade students from 17 elementary schools in the morning and continuous shifts, located in eight boroughs of Mexico City,[3] as seen in Figure 1.

Figure 1. Distribution of the evaluated population
Source: created by the author based on the Survey conducted for the Impact Evaluation of the School Breakfast Program in Mexico City (2017)

[2]Additionally, information on services and housing quality based on the National Household Income and Expenditure Survey 2016 (Spanish: Encuesta Nacional de Ingresos y Gastos de los Hogares, ENIGH) (2016), information on school size and infrastructure based on data from the Ministry of Public Education (Spanish: Secretaria de Educación Pública, SEP) (2015), and information on basic food prices by geographic region were imputed into the database. ENIGH and price data were assigned by means of ArcGis software with precision at the Basic Geostatistical Area (Spanish: Área Geoestadística Básica, AGEB) level. The SEP data were attributed through the work center key.
[3]Additionally, a pilot test was carried out in an elementary school in the Miguel Hidalgo borough.

The choice of schools participating in the study was restricted by infrastructure conditions or availability due to the earthquake in Mexico City on September 19, 2017. Those schools with appropriate conditions were invited to participate, and from these, a group of 17 schools self-proposed to collaborate with the study. Consequently, the statistical results are only applicable to the population of those schools, and it is not possible to extend the results to the total number of schools in the city.

Of the 17 schools that participated, 13 are beneficiaries of the program, and 4 are non-beneficiary schools. All children enrolled in the fourth and fifth grades of the selected schools were considered for the study. Formal requests to the participating schools were sent in advance, and principals sent communications to parents to inform them about the evaluation; therefore, students whose parents refused consent were excluded.

Of the total number of students enrolled in fourth and fifth grades in the 17 participating elementary schools, 1,112 completed questionnaires were obtained. However, it was detected that not all beneficiaries consumed breakfast. Therefore, based on the questions to tutors, the participating students who consumed the program's food were identified, which ensures that the impacts are properly evaluated for those exposed to the benefits of the program. The final population consisted of 1,051 students, of whom 749 (71.3%) belonged to the treatment group and 302 (28.7%) to the control group (see Figure 2).

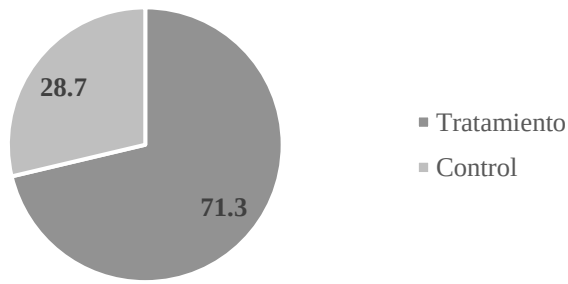

Figure 2. Distribution of students according to treatment and control groups (August-December, 2017)
Source: created by the author based on the Survey conducted for the Impact Evaluation of the School Breakfast Program in Mexico City (2017)

In terms of the academic performance indicator, this is measured as the overall grades of the children in the August-December period of the 2017-2018 school year. This indicator is made up of intervals, where: 1 is a grade lower than 6; 2 indicates between 6.0 and 6.5; 3 is equivalent to a range between 6.6 and 7.0; 4 represents between 7.1 and 7.5; 5 between 7. 6 and 8.0; 6 refers to scores between

8.1 and 8.5; 7 between 8.6 and 9.0; 8 between 9.1 and 9.5; and 9 is between 9.6 and 10. On average, students in both groups scored between 8.6 and 9.0.

When comparing the average grades of the control group with the treatment group, without controlling for any other variable, the result is that students enrolled in control schools that do not receive breakfast have a higher percentage of higher averages (above 9.0) compared to their treatment counterpart (see Figure 3). However, these results do not yet reflect the causal impact of the program on school results because observable and unobservable characteristics are not controlled for, as in a regression model.

Since participation in the program was not randomly assigned, participating and non-participating students could present different profiles. Certain characteristics could predict both the probability of participating in the program and the probability of obtaining more favorable grades, which may bias the statistical results. For example, the level of household income or parental schooling could affect the school performance of daughters and sons, and these characteristics should be taken into account in the models to estimate causal impacts.

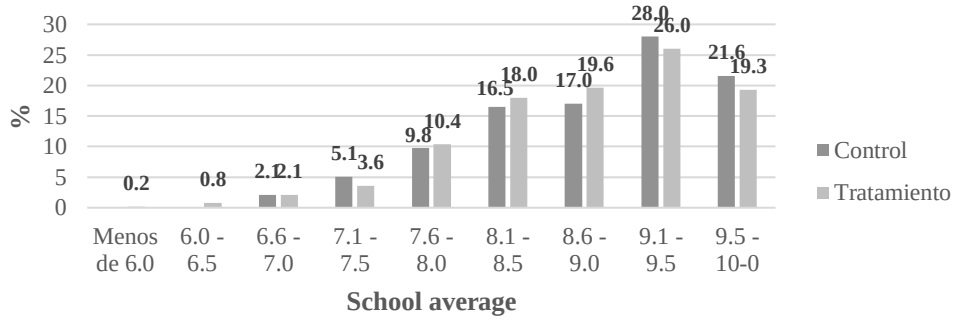

Figure 3. School average according to treatment and control groups (August-December, 2017)
Source: created by the author based on the Survey conducted for the Evaluation of the Impact of the School Breakfast Program in Mexico City (2017)

In order to control for most of the factors that explain the grades, and following Behrman and Hoddinot (2001) and Glewwe (2005), tests for differences in means were performed, including different groups of regressors: student characteristics, household factors, school characteristics, availability of social programs, basic food prices and geographic location. Table 1 presents the summary statistics of these characteristics. The first column presents the mean and standard deviation of the population characteristics. Columns two and three display these statistics broken down for beneficiaries and non-beneficiaries, respectively. Columns four, five, and six provide evidence of the statistical difference

between the results of the two groups. Specifically, the fourth column presents a simple test of means, while columns five and six also consider school fixed effects and school and borough fixed effects.

The distribution of the population according to sex is equal, 50.3% girls and 49.7% boys. The student population averaged 118 months of age (9.8 years). It was found that 47.9% of the students were absent from school on at least one occasion in the month prior to the data collection. The average monthly income of the households in which these children live was 6,024.4 pesos. 95.7% of the children live in the same household as their mother, while in the father's case, this percentage is 69.2%.

Mothers in these households who participate in the labor market represent 68.9%, while the figure for fathers is 93.7%. Regarding the education level of mothers, 47.1% have a high school education, and only 17.9% have a bachelor's degree or higher. On the other hand, 42.8% of fathers have a high school education, and 15.6% have a bachelor's degree or higher. Regarding the quality of the population's homes, they have an average of nine light bulbs.

Of the students evaluated, 5.4% are beneficiaries of the Mexico City School Scholarship Program for Children in Conditions of Social Vulnerability (Spanish: Programa de Becas Escolares para Infantes en Condición de Vulnerabilidad Social de la Ciudad de México). In addition, 13.7% belong to this city's Talented Children Program (Spanish: Programa de Niños Talento). The schools attended by the students evaluated have an average of 32 children per teacher. The directors of these schools have an average of nine years of experience in the management area.

From the analysis of the simple and conditional mean differences, it is possible to point out that there are no significant differences between both groups in terms of most of the characteristics described. Therefore, the control and treatment groups could be comparable. However, some of these factors indicate a difference in the means of the two groups under certain specifications, so it is important to control for the estimations for these variables.

Specifically, the household variable referring to the availability of light bulbs in homes shows a significant difference under the three specifications used. This could indicate disparities in the quality of homes so that the number of light bulbs is higher in the control homes (11) than in the treatment homes (8). In turn, the probability of non-attendance shows a difference in the tests in the fourth and sixth columns, indicating that beneficiaries may have a higher probability of missing classes (50.8%) than non-beneficiaries (40.8%).

The mother's employment showed differences in the simple means and school fixed effects specifications. However, this variation disappeared when controlling for borough effects in the regression model. Finally, the group size variable indicates that there could be differences between the control and treatment groups in terms of this variable in simple tests of means. Thus, the average number of students per teacher is 30 in the beneficiary schools and 36 in the non-beneficiary schools.

Table 1
Statistical description of the characteristics of the population

Variables	Total (1)	Treatment (2)	Control (3)	P-Value (4)	P-Value with school fixed effects (5)	P-Value with school and borough fixed effects (6)
Gender (girl)	0.503	0.505	0.500	0.891	0.987	0.922
	(0.500)	(0.500)	(0.500)			
Age in months	118.414	118.179	118.997	0.092	0.842	0.166
	(7.126)	(7.259)	(6.761)			
Probability of non-attendance	0.479	0.508	0.400	0.005	1.000	0.042
	(0.499)	(0.500)	(0.490)			
Income	6 024.391	6 128.022	5 773.787	0.190	0.000	0.919
	(3 681.853)	(3 776.471)	(3 436.323)			
Logarithm of income	8.553	8.567	8.520	0.225	0.000	0.998
	(0.539)	(0.545)	(0.525)			
The mother lives at home	0.957	0.958	0.953	0.700	0.763	0.217
	(0.203)	(0.200)	(0.212)			
The father lives at home	0.692	0.681	0.718	0.245	0.889	0.968
	(0.461)	(0.466)	(0.450)			
The mother works	0.740	0.760	0.689	0.020	0.002	0.102
	(0.438)	(0.427)	(0.463)			
The father works	0.950	0.956	0.937	0.267	0.596	0.586
	(0.217)	(0.206)	(0.243)			
Education of the mother: high school	0.468	0.467	0.471	0.914	0.558	0.511
	(0.499)	(0.499)	(0.500)			
Education of the mother: Bachelor's degree or higher	0.176	0.174	0.179	0.872	0.079	0.840
	(0.380)	(0.379)	(0.383)			
Education of the father: high school	0.396	0.383	0.428	0.228	0.857	0.960
	(0.489)	(0.486)	(0.495)			
Education of the father: bachelor's degree or higher	0.203	0.222	0.156	0.032	0.140	0.916
	(0.402)	(0.415)	(0.363)			
Number of light bulbs in the home	9.024	8.160	11.167	0.000	0.000	0.000
	(4.769)	(2.617)	(7.474)			
Scholarship Program	0.054	0.056	0.050	0.679	0.640	0.963
	(0.226)	(0.230)	(0.217)			
	0.137	0.136	0.139	0.902	0.124	0.152

Variables	Total (1)	Treatment (2)	Control (3)	P-Value (4)	P-Value with school fixed effects (5)	P-Value with school and borough fixed effects (6)
Talented Children Program	(0.344)	(0.343)	(0.346)			
Student/teacher ratio	31.565 (3.782)	29.893 (2.602)	35.713 (2.976)	0.000	-	-
Experience of the principal	9.313 (6.156)	9.286 (6.952)	9.394 (2.684)	0.809	-	-

Source: created by the author based on the Survey conducted for the Impact Evaluation of the School Breakfast Program in Mexico City (2017)
[a] The variables of students per teacher and principal experience are at the school level, so it is not possible to apply fixed effects

Analytical framework: academic achievement production function

The analytical framework is based on a production function of academic achievement –grades– that broadly considers the influence of variables associated with children's nutrition (Glewwe, 2005). This model establishes that school achievement is determined not only by the individual, family, and market factors in the current period but also by their influence in previous periods. The model considers different variables in three time periods as determinants of school achievement.

The first period is from the conception stage until 24 months after birth. The second period is from 24 months to 6 years of age. And the third period is from 6 to 11 years of age when students are generally in elementary school. It is then possible to dynamically study the relationship between present and past nutrition and academic achievement, as presented in Equation 1. The outcome variable, in this case, refers to the grades obtained by students in the third period (at school age) and is represented by the variable L_3.

$$L_3 = L(N_1, N_2, N_3, RE_1, RE_2, RE_3, \gamma, E, AE) \quad (1)$$

Where: N_t is student nutrition in period t; RE_t is the school inputs provided by parents in period t (books, educational materials, and time spent supporting school activities); γ is the student's innate cognitive abilities; E are school characteristics; AE is the years of schooling.

For simplification purposes, school inputs, school characteristics, the child's innate ability, and years of schooling are generally considered constant. It is then possible to determine how changes in nutritional conditions in the three periods mentioned above will affect schoolchildren's grades. Educational inputs (RE_1, RE_2, RE_3) and years of schooling (AE) are largely under parents' control and reflect their preferences about their children's education. At the same time, the budget allocated by families to purchase educational inputs also reflects the guardians' preferences in terms of nutrition of the children, since they must decide the greater or lesser allocation between the two types of goods.

Such variables under total or partial parental control could be considered endogenous. One way to deal with the endogeneity of such variables is to pose a reduced form of the schooling skills production function, where education inputs are a function of children's nutrition in previous periods. The above is explained by the fact that parents update their decisions at each stage based on nutrition shocks that occurred in previous stages.

Thus, a reduced form of the equation of school inputs purchased by parents is as follows:

$$RE_1 = re_1(Y, EM, EP, P_E, E, \sigma, P_{S,1}, A_1, \delta, \lambda) \tag{2}$$

$$RE_2 = re_2(S_1, Y, EM, EP, P_E, E, \sigma, P_{S,2}, A_2, \delta, \lambda) \tag{3}$$

$$RE_3 = re_3(S_1, S_2, Y, EM, EP, P_E, E, \sigma, P_{S,3}, A_3, \delta, \lambda) \tag{4}$$

The years of schooling for period 3 have the same structure as Equation 4:

$$AE_3 = ae_3(N_1, N_2, Y, EM, EP, P_E, E, \sigma, P_{S,3}, A_3, \delta, \lambda) \tag{5}$$

Where: Y is parental income; EM is the mother's education level; EP is the father's education level; P_E is the prices of school items (for simplicity, they are assumed to be constant over time); σ are parents' preferences regarding their children's schooling; $P_{S,t}$ is the nutrition care prices for each period; A_t refers to the nutrition environment in each period; δ are parents' preferences regarding their children's nutrition; λ is the student's innate health.

Substituting equations 2 through 5 into Equation 1, the following is obtained:

$$L_3 = L(N_1, N_2, N_3, Y, EM, EP, P_E, E, \sigma, \gamma, P_{S,1}, P_{S,2}, P_{S,3}, A_1, A_2, A_3, \delta, \lambda) \quad (6)$$

Equation 6 represents a reduced form of Equation 1, containing the endogenous variable N_3. According to this specification, the child's academic skills (L_3) and nutrition in the third period (N_3) change simultaneously because of parental decisions made based on exogenous variables. Thus, L_3 changes in response to N_3. Food prices and the nutrition environment are set by government public health policy.

Based on such governmental decisions, parents select the educational resources they will consume. Finally, there will be random shocks to student nutrition, such as the impact of a social policy program, with a focus on feeding students. Thus, N_3 is determined by government policy decisions, parental choices, and nutrition shocks. However, equation N_3 depends in turn on other values, so the determinants of student nutrition in each period must be considered through the following equations:

$$N_1 = N_1(RS_1, A_1, SS_1, \lambda) \quad (7)$$

$$N_2 = N_2(N_1, RS_2, A_2, SS_2, \lambda) \quad (8)$$

$$N_3 = N_3(N_2, RS_3, A_3, SS_3, \lambda) \quad (9)$$

Where: RS_t is the nutrition acquisitions by parents in period t; SS_t is the nutrition shocks occurring in period t.

Just as Equation 1 is a production function for educational attainment, equations 7, 8, and 9 represent the nutrition production functions of students. These equations show that nutrition from previous stages, nutrition-related acquisitions by parents in the current period, current nutrition environment, and innate health directly affect students' current nutrition status.

Because the nutrition purchases made by parents for their children are under their direct control, this variable is endogenous. Therefore, this variable must be disaggregated. Since parents select both education and nutrition purchases at the beginning of each period, both are selected simultaneously so that nutrition purchases are determined by the same variables that affect education purchases, as presented in the following equations:

$$RS_1 = rs_1(Y, EM, EP, P_E, E, \sigma,, P_{S,1}, A_1, \delta, \lambda) \tag{10}$$

$$RS_2 = rs_2(Y, EM, EP, P_E, E, \sigma,, P_{S,2}, A_2, \delta, \lambda) \tag{11}$$

$$RS_3 = rs_3(Y, EM, EP, P_E, E, \sigma,, P_{S,3}, A_3, \delta, \lambda) \tag{12}$$

Based on these equations, it is possible to substitute N_1, N_2 and N_3 in Equation 6 with their determinants presented in equations 7 to 9, and then the nutrition acquisitions of these three equations must also be replaced by their determinants equation represented by equations 10 to 12, obtaining the true reduced form of the grades function, where all the variables that are in the function are exogenous:

$$L_3 = l_{FR}(Y, EM, EP, P_E, E, \sigma, \gamma, P_{S,1}, P_{S,2}, P_{S,3}, A_1, A_2, A_3, \delta, \lambda, SS_1, SS_2, SS_3) \tag{13}$$

This last equation is a reduced form of the determinants of school achievement. Equation 13 has the characteristic that the explanatory variables are considered exogenous, which makes it possible to identify the effect of a public nutrition policy program on children's grades. This specification will be the basis for the empirical model in the next section.

Ordered probit model

To estimate an approximation of Equation 13, this work used a standard regression that controls for the different groups of covariates included in the equation. School and borough fixed effects are also incorporated. The following specification gives the basic estimating equation.

$$Y_{aed} = \alpha + \varphi T_{aed} + \tau X_{aed} + \upsilon_e + e_d + \mu \tag{14}$$

Where: Y_{aed}: is the school achievement score –grades– for each student a in school e in borough d; T is equal to 1 for all participants in the School Breakfast Program; X is a vector of covariates of the student, household, school, social policy, and community characteristics; υ_e are school fixed effects; e_d are borough fixed effects, and μ: is the random error term.

When the variable that this work wishes to explain is not continuous but of multiple ranges, the estimation through Ordinary Least Squares (OLS) models has limitations like those of all binary type estimations: heteroscedasticity and predicted probabilities greater than the unit (Jackman, 2000). The so-called multinomial models are the most appropriate and widely used models for this type of data. This type of model is used when the dependent variable is categorical and takes discrete values that, unlike binomial models, consider several mutually exclusive outcomes. Because the distribution of such data is multinomial, the estimation method used is the maximum likelihood (Cameron & Trivedi, 2005).

Specifically, when the nature of the data means that the categories are ordered, a standard model for their treatment is the ordered probit model. In ordered response models, the values assigned to each response are not arbitrary, but rather a higher rank represents a higher value. The ordered probit model can be derived from a latent variable model, where y is an ordered response variable taking values of $\{1,2,3,\ldots N\}$ (Wooldridge, 2002). The initial latent variable model can be expressed as:

$$y^* = x\beta + e, \qquad e|x \sim \text{Normal } (0,1) \tag{15}$$

Where: x does not consider intercept, and β is of size Jx1. Moreover, $\alpha_1 < \alpha_2 \ldots < \alpha_N$ represent the cut-off points. The following is defined:

$$\begin{gathered} y = 0 \text{ if } y^* \leq \alpha_1 \\ y = 1 \text{ if } \alpha_1 < y^* \leq \alpha_2 \\ \vdots \\ y = N \text{ if } y^* > \alpha_N \end{gathered} \tag{16}$$

Accordingly, when y takes values of 1, 2, and 3, there will be two cut-off points: α_1 and α_2.

Under the assumption of normality for e it is possible to derive the distribution of y given x, calculating each response probability as follows:

$$\begin{gathered} P(y = 0|x) = P(y^* \leq \alpha_1|x) = P(x\beta + e \leq \alpha_1|x) = \Phi(\alpha_1 + x\beta) \\ P(y = 1|x) = P(\alpha_1 < y^* \leq \alpha_2|x) = \Phi(\alpha_2 - x\beta) - \Phi(\alpha_1 + x\beta) \\ \vdots \\ P(y = N - 1|x) = P(\alpha_{N-1} < y^* \leq \alpha_N|x) = \Phi(\alpha_N - x\beta) - \Phi(\alpha_{N-1} + x\beta) \\ P(y = N|x) = P(y^* > \alpha_N|x) = 1 - \Phi(\alpha_N - x\beta) \end{gathered}$$

The sum of the probabilities is the unit, and Φ is the standard normal cumulative distribution. Since the ordered probit model is the generalization of the binary probit model when $N = 1$, the standard probit model is obtained:

$$P(y = 1|x) = 1 - P(y = 0|x) = 1 - \Phi(\alpha_1 - x\beta) = \Phi(x\beta - \alpha_1),$$

The regression parameters $\alpha\ and\ \beta$ are estimated by maximum likelihood, where the function for each i is:

$$\ell_i(a, \beta) = 1[y_i = 0]log\left[\Phi\left(\alpha_{1_1} - x_i\beta\right)\right] + 1[y_i = 1]log\left[\Phi\left(\alpha_{1_2} - x_i\beta\right)\right]$$
$$-\Phi\left(\alpha_{1_1} - x_i\beta\right) + \cdots + 1[y_i = N]log\left[1 - \Phi\left(\alpha_{1_N} - x_i\beta\right)\right] \quad (17)$$

Since in this type of model the response probability $P(y = n|x)$ and not $E(y^*|x) = x\beta$ is of interest, then, the marginal effects on the probabilities are calculated as:

$$\frac{\partial p_0(x)}{\partial x_k} = -\beta_i\phi(\alpha_1 - x\beta), \frac{\partial p_N(x)}{\partial x_i} = \beta_i\phi(\alpha_N - x\beta)$$
$$\frac{\partial p_N(x)}{\partial x_i} = \beta_i[\phi(\alpha_{N-1} - x\beta) - \phi(\alpha_N - x\beta)], 0 < n < N$$

Results

Table 2 includes the estimates of Equation 14, with which this study evaluates the results in the academic average of the 2017-2018 school cycle as a function of participation in the School Breakfast Program, as well as a set of individual, family, school, and community variables that could affect student performance. Estimates are made for the 17 schools in Mexico City that are the object of study in this work. All specifications consider fixed effects by school and borough and prices of basic food basket products.

The first and third columns present the OLS results for fourth and fifth-grade children, respectively. Columns two and four contain the estimates using ordered probit models for each corresponding grade. Given the categorical nature of the dependent variable, it is better modeled through multinomial methods, such as the ordered probit, so that these results will be emphasized. However, as shown in the table, the results are robust in direction and magnitude under both specifications.

After controlling for all possible factors that could affect school average, participation in the School Breakfast Program shows a positive but not significant relationship with academic scores. The

results of the ordered probit models indicate that the effect could be 2.3% in fourth-grade students and 57.8% in fifth-grade students. However, although the direction of the impact is positive because the coefficients lack statistical significance in both the OLS specification and the ordered probit, it is possible to point out that the program does not have collateral effects that would lead to a significant increase in school grades. The program would only have an impact on the nutrition of participating children.

This finding is important as similar nutrition programs in other countries did have positive effects on school performance (Meyers et al., 1989; Vermeersch & Kremer, 2004; Belot & James, 2011; Imberman & Kugler, 2014; Frisvold, 2015), probably because of the different nutritional content of the breakfasts and the years of exposure to the program. Thus, follow-up and evaluation over time are required to further study these types of temporary effects.

In addition, Table 2 suggests that there are other characteristics of students, their families, their schools, and their communities that could affect the grades of elementary school students. To start, gender stands out. In this regard, the fourth and fifth-grade girls show better grade averages than their male peers in the same grade. According to the ordered probit model, the differences are 35.8% and 16.2% for each grade, respectively, although this relationship is not statistically significant in the fifth-grade results. However, according to empirical evidence, it could be that girls make a greater effort at school and spend more time studying and doing homework compared to boys (Valle et al., 2015). This is an aspect that would be worth delving into in future lines of research.

It is also highly significant that the average of the previous school year and the number of absences significantly explain the current grade average. Students with better grades in the 2016-2017 cycle also tend to obtain better grade averages in the 2017-2018 cycle. Students with high grades in the previous school cycle present a higher grade average by 90.1% in fourth grade and 95.2% in fifth grade. In comparison, truancy does contribute to lower overall student grades. Students in fourth grade who have at least one absence per month reduce their grade average by 40.6%, and those in fifth grade do so by 33.1%.

There is previous empirical evidence that household conditions also affect the academic outcomes of children (Meyers et al., 1989; Frisvold, 2015). Estimates from this study suggest that fourth-grade students belonging to households with higher incomes could see their school averages improved by 6.3%. However, in the case of fifth grade, the coefficients are null and not significant.

The parents' education level had a significant impact on the academic performance of the study population. The grade average in fourth grade was better when the father had a bachelor's degree or higher, increasing the grade average by 42.4%. On the other hand, fifth-graders showed better grades when the mother had a high school diploma (35.0 %) and a bachelor's or postgraduate degree (39.9 %). As

Hernández et al. (2006) point out, when parents have a high education level, their expectations that their children will study are higher.

This same indicator shows an increase for fifth graders with families where the mother and child live together (63.9 %) and for fourth-graders whose father has a job (36.3 %). Likewise, school results are better for those who live in homes with more light bulbs (1.0 %). In other words, the economic well-being represented by the quality of housing could be a determinant of school achievement among elementary school students.

Academic scores could be affected by the conditions of the school the students attend (Vermeersch & Kremer, 2004). One of these characteristics is the experience of the principals. According to the estimates, this variable could positively impact academic achievement. Thus, when the teachers in charge of the schools have more years of experience, students could show an improvement in their grades by 4.2% and 2.3% in fourth and fifth grade, respectively.

Finally, the presence of other social programs such as Talented Children and Mexico City Scholarships could have a relationship that favors better school grades. The model for fourth grade indicates that the Talented Children Program could have a positive impact of 42.9% on the school average. On the other hand, fifth-grade students show better scores when they are in the Scholarship Program (56.3%). These results could indicate that several programs that address different needs of the vulnerable population could create positive synergies and impact the school grades of these children.

Table 2
Results in school average for participation in the School Breakfast Program

Determining factors	4th Grade		5th Grade	
	OLS (1)	Ordered probit (2)	OLS (3)	Ordered probit (4)
Participation in School Breakfasts	0.103	0.023	0.475	0.578
	(-0.257)	(0.321)	(0.312)	(0.352)
Gender	0.270**	0.358**	0.160	0.162
	(0.120)	(0.150)	(0.124)	(0.140)
Age in months	0.020	0.026	0.006	0.014
	(0.015)	(0.018)	(0.016)	(0.018)
Previous school average	0.737***	0.901***	0.852***	'0.952***
	(0.045)	(0.072)	(0.044)	(0.067)
Probability of missing classes	-0.317**	-0.406**	-0.272**	-0.331**
	(0.127)	(0.157)	(0.126)	(0.142)
Income			0.000	0.000
			(0.000)	(0.000)
Income logarithm	0.048	0.063		

Determining factors	4th Grade		5th Grade	
	OLS (1)	Ordered probit (2)	OLS (3)	Ordered probit (4)
	(0.119)	(0.146)		
The mother lives at home			0.489	0.639*
			(0.323)	(0.354)
The father works	0.381	0.363		
	(0.274)	(0.328)		
Education level of the mother: High school			0.328**	0.350**
			(0.144)	(0.162)
Education level of the mother: Bachelor's degree or higher			0.407**	0.399*
			(0.201)	(0.228)
Education level of the father: Bachelor's degree or higher	0.234	0.424**		
	(0.161)	(0.202)		
Number of light bulbs	0.016	0.010		
	(0.020)	0.025		
Student/teacher ratio	0.060	0.075		
	(0.040)	(0.049)		
Experience of the principal	0.032*	0.042	0.016	0.023
	(0.018)	(0.022)	(0.014)	(0.016)
Talented Children Program	0.256	0.429*		
	(0.187)	(0.244)		
Scholarship Program			0.493*	0.563**
			(0.251)	(0.285)
Location	-0.044	0.051	-0.721**	-0.873**
	(0.360)	(0.452)	(0.344)	(0.388)
Food prices	Yes	Yes	Yes	Yes
Boroughs	Yes	Yes	Yes	Yes
Schools	Yes	Yes	Yes	Yes
Constant	-2.613		4.560	
	(6.492)		(2.813)	
R squared	0.723		0.672	

Source: created by the author based on the Survey conducted for the Impact Evaluation of the School Breakfast Program in Mexico City (2017)
Note: * p<0.10, ** p<0.05, *** p<0.010
Standard errors in parentheses

Conclusions

The quality of children's nutrition during the early stages of life is a fundamental factor in their physical and mental development, which could be an important determinant of their school achievement (World

Food Program, 2017). Children living in poverty are more likely to be food insecure and, therefore, may miss out on the learning opportunities that come with adequate nutrient intake.

In Mexico City, the School Breakfast Program aims to contribute to the healthy nutrition of school-aged children. Even though the immediate objective of the program is to improve nutrition and not cognitive achievement, it is known that a change in nutrient intake could have an impact on academic outcomes, as shown by the evidence in the United States (Frisvold, 2015; Imberman & Kugler, 2014), Kenya (Vermeersch & Kremer, 2004), United Kingdom (Belot and James, 2011), India (Afridi, 2011), and the Philippines (Glewwe et al., 2001). Such a relationship has not been previously studied in the case of the School Breakfast Program beneficiaries in Mexico City.

Therefore, this article contributes to the literature by estimating for the first time the effects of participation in the School Breakfast Program in Mexico City on students' grades. This is achieved through a counterfactual approach, where the results of the beneficiary and non-beneficiary students were compared. The data used came from the survey for the impact evaluation of the program, which provided information on the academic average and the consumption of school breakfast during the August-December 2017 period for 17 schools in Mexico City.

The estimates are based on an equation of school achievement, where these are determined by nutrition and other individual, family, school, and community-related factors. Using linear regression and ordered probit models, it was found that participation in the program did not present a statistically significant relationship with the grade averages achieved by the students. Although the coefficients are positive (2.3% and 57.8% in fourth and fifth grade, respectively), the relationship is not significant, so it is possible to conclude that the food intake as part of the program does not make a significant difference in the school grades of students.

Other significant findings of the study were the importance of factors such as gender, school absences, the education level of the parents, and the availability of additional social programs in determining school averages. In this regard, the results of the estimations indicate that girls had higher-ranking grade averages compared to boys. Likewise, truancy lowered school scores. Students with mothers and fathers with higher education levels obtained more favorable results in their grades. Finally, the presence of additional social programs was also positive for the academic scores of these children.

The fact that the School Breakfast Program has improved nutrition variables and school grades would imply that the public policy program would have a direct effect on nutrition and a positive collateral effect on school achievement. This would contribute to reducing the high rates of overweight and obesity in children, a national health problem. It would also reduce the educational gaps between those who have access to better nutrition and those who, for reasons of social vulnerability and income, do not have access

to adequate nutrition. Finally, it would contribute to the formation of human capital, which is essential for the long-term economic growth of a country.

The research results also open the way for future studies on the synergies between social programs in Mexico City, so it would be pertinent to wonder whether the strategies that serve children as a whole contribute positively to the formation of human capital. Additionally, it would be important to explore the effects of the School Breakfast Program on nutritional quality indicators, such as vitamin and mineral intake levels.

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