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Odra A. SAUCEDO-DELGADO
odra.saucedo@anahuac.mx
Facultad de Economía y Negocios
Universidad Anáhuac
(Mexico)

Marcela DE-LA-SOTA-RIVA-ECHÁNOVE
marcela.delasotariva@anahuac.mx
Facultad de Economía y Negocios
Universidad Anáhuac
(Mexico)

Leovardo MATA
leovardo.mata@anahuac.mx
Facultad de Economía y Negocios
Universidad Anáhuac
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odra.saucedo@anahuac.mx
Facultad de Economía y Negocios
Universidad Anáhuac
(Mexico)

Marcela DE-LA-SOTA-RIVA-ECHÁNOVE
marcela.delasotariva@anahuac.mx
Facultad de Economía y Negocios
Universidad Anáhuac
(Mexico)

Leovardo MATA
leovardo.mata@anahuac.mx
Facultad de Economía y Negocios
Universidad Anáhuac
(Mexico)

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Abstract

This article estimates the effect of the School Breakfast Program (SBP) on overweight and obese Mexican children aged five to eleven living in a poor and marginalized rural context during 2012-2019. Using data from the 2012, 2016, 2018, and 2019 National Health and Nutrition Surveys (ENSANUT), as well as propensity score matching techniques, this research compares the usual food intake of a group of children enrolled on the SBP with a control group that were not. The results indicate that SBP recipients include more overweight children, and that these consume unhealthy foods, including sugary drinks, snacks, sweets, and desserts, more frequently than those in the control group. There was no significant difference in the children's obesity between the two groups. These findings highlight the need for a more comprehensive school breakfast program, that is connected to the food and nutritional security approach and is designed and implemented according to each Mexican region's specific alimentary requirements and socioeconomic needs.

Keywords: childhood overweight and obesity, rural poverty and marginalization, school breakfasts, propensity score matching.

Resumen

En este artículo, se analiza el efecto del Programa Desayunos Escolares en niños mexicanos de cinco a once años con sobrepeso y obesidad que viven en un contexto rural pobre y marginado durante 2012 a 2019. Utilizando datos de la Encuesta Nacional de Salud y Nutrición (Ensanut) de 2012, 2016, 2018 y 2019, así como técnicas de emparejamiento por puntaje de propensión, en esta investigación, se compara la ingesta habitual de un grupo de niños inscritos en Programa Desayunos Escolares con otro de control que no lo era. Los resultados indican que, entre los receptores de los Desayunos, se incluyen a más niños con sobrepeso, y que estos consumen alimentos poco saludables, incluidas bebidas azucaradas, bocadillos, dulces y postres, con mayor frecuencia que los del grupo de control. No constó diferencia significativa, sin embargo, en la obesidad de los niños entre los dos grupos. Tales hallazgos resaltan la necesidad de un programa de desayuno escolar más integral, vinculado al enfoque de la seguridad alimentaria y nutricional, y a que se diseñe e implemente de acuerdo con los requerimientos alimentarios y socioeconómicos de cada región de México.

Palabras clave: sobrepeso y obesidad infantil, pobreza y marginación rural, desayunos escolares, emparejamiento por puntaje de propensión.

1 Introduction

The World Health Organization (WHO) (2021) defines «overweight» and «obesity» as the abnormal or excessive accumulation of fat, which can be harmful to physical and emotional health. The leading cause of both conditions is an imbalance between consumed and expended calories, resulting in weight gain and affecting the health status of the individuals concerned (Sagar & Gupta 2018). Both diseases are complex and are caused by multiple factors —genetic, metabolic, behavioral, socioeconomic, and environmental—, many of which have their roots in childhood (Centers for Disease Control and Prevention 2019, Samodien *et al.* 2021).

In recent decades, the prevalence of these conditions in children has increased dramatically worldwide. Between 1975 and 2016, the prevalence of overweight and obesity in children aged five to nineteen rose more than fourfold globally, from 4 % to 18 % (WHO 2021). If this trend continues, the number of obese children in the world will increase from 158 million in 2020 to 254 million in 2030 (WOF 2019). This alarming growth trend has resulted in research efforts to understand the origins of unhealthy weight gain. Poor-quality diet (Livingstone *et al.* 2021), low physical activity (Guthold *et al.* 2018), and an obesogenic environment (Jia 2021), that influences children's food choices, have been found to be among the leading causes.

Overweight and obesity are conditions that can limit children's school (Li *et al.* 2018) and physical performance (Delgado-Floody *et al.* 2019), often damaging their self-esteem (Fields *et al.* 2021), and making them victims of stigmatization, bullying, and social exclusion (De la Haye *et al.* 2017, Pajuelo-Ramírez *et al.* 2019, King *et al.* 2020).

Childhood overweight and obesity tend to persist and worsen in adulthood (Geserick *et al.* 2018) and carry a strong risk of developing non-communicable diseases and severe disabilities, restricting participation in the labor market (Kungu *et al.* 2019), and reducing the productivity and life expectancy of those affected (Leung *et al.* 2020). Medical treatment for obesity-related health conditions is costly, impacting socially and economically on family and society (Hecker *et al.* 2022); for example, D'Errico *et al.* (2022) calculate that the total cost of obesity in Italy amounted to €13.34 billion in 2020, and Cecchini and Vuik (2019) estimate that Mexicans who are overweight can lose four years from their life expectancy, and that the overweight and obesity epidemic will cause the country's gross domestic product (GDP) to fall by 5.3 % between 2020 and 2050.

Overweight and obesity, once considered problems of high-income countries, are now increasing most rapidly in low- and middle-income countries (WHO 2021, Zheng *et al.* 2017). In Latin America, overweight and obesity in children and adolescents have increased in the past three decades, and now affect more than 20 % of the young population (UNICEF 2021).

Child malnutrition estimates for the indicators of stunting, wasting, overweight and underweight describe the magnitude and patterns of under- and overnutrition (WHO 2021). In poverty and marginalized contexts, there is a double burden of malnutrition (undernutrition and overnutrition), with a high correlation between obesity in adulthood and episodes of undernutrition at an early age, and even in the uterus (Leiner *et al.* 2016, Popkin & Reardon 2018, Wells *et al.* 2020).

WHO (2016) reports that Mexico has the highest prevalence of overweight or obese children in the world. Between 2016 and 2018, this increased from 33.2 % to 35.6 % (INSP 2020a), and in the latest survey report, conducted in 2020 in the context of the COVID-19 pandemic, found that it had escalated to 38.2 % (INSP 2021). In contrast, data published by ENSANUT (INSP 2012, 2016, 2020a) also shows high levels of undernutrition and anemia in Mexico. In the five to fourteen age, range chronic undernutrition stands at 7.25 % in urban populations and twice that figure in rural communities (UNICEF 2015), and the prevalence of anemia in five to eleven-year-olds is 19.2 % (Cruz-Góngora *et al.* 2021).

About 43.9 % (56.5 million) of Mexico's population live in poverty (CONEVAL 2021). Although around 40.1 % of poor Mexicans reside in urban areas, the phenomenon is more intense in highly marginalized rural contexts; for example, in Mexico's rural towns, defined by INEGI (2011) as «towns with fewer than 2,500 inhabitants», approximately 16.7 % of the population face extreme scarcity, compared to just 6.1 % in urban localities (CONEVAL 2021).

The interrelation between «food» and «nutritional security», defined as «access to food» and «food quality availability» (López Salazar 2015), is relevant in the context of poverty and marginalization. Currently, 22.5 % of Mexico's population (28.6 million) experience this kind of insecurity. According to the ENSANUT 2018 (INSP 2020a), 69.1 % of households in rural settings live with food insecurity. «Food security» and «nutrition security» are not exclusively determined by the economic capacity of individuals and their families. They also relate to a country or region's social and cultural environment; for example, the rate of increase in food production, the production models promoted, and the nutritional conditions that support a better quality of life (López Salazar 2015, Lemus Figueroa *et al.* 2018).

School feeding programs are a food and nutrition security strategy implemented by several countries (Yamaguchi & Takagi 2018, Nugent *et al.* 2020) to serve their poor and vulnerable citizens. It aligns with the UN 2030 Agenda's Sustainable Development Goals (SDG) —mainly SDG 1, End poverty; SDG 2, Zero Hunger, and SDG 3, Good health, and well-being (UNSD 2021)—. Although school meals are a critical safety net that helps to fulfil the right of all children to access to education, health, and nutrition, their effectiveness remains unclear. These programs may have an indirect effect on improving children's nutritional status (Black *et al.* 2020) and academic performance (Metwally *et al.* 2020), but there is also evidence that school meals can trigger overweight or obesity during childhood (Ramírez-Ramírez *et al.* 2020, Sudharsanan *et al.* 2016), or in adulthood (WHO 2021).

The School Breakfast Program (SBP) has been operating in Mexico for several years. In the beginning, its aim centered attention on combatting the hunger of the most disadvantaged children (Morales-Ruan *et al.* 2018). Over time, the program has helped reduce their undernutrition and improve their school performance (Dávila 2018, Figueiredo & Paula 2021), but today the country faces a double burden of malnutrition. In this context, this analysis of the SBP in Mexico and the results' dissemination is highly relevant. Notably, previous arguments have led to the following question: does the SBP positively affect its recipients' eating of nutritious food, such as fruit and vegetables, resulting in a lower prevalence of childhood overweight and obesity?

To answer this question, the present paper uses data from the National Health and Nutrition Survey (ENSANUT) from 2012, 2016, 2018, and 2019, to conduct a comparative analysis based on propensity score matching (PSM) techniques that contrast SBP beneficiaries (the treatment group) with a control group of infants with similar observable sociodemographic characteristics who have not participated in the program. In the present article, it is analyzed weekly relative frequency of both groups' consumption of fruit, vegetables, sugary drinks, dairy products, meat, water, snacks, sweets, and desserts, as well as their impact on the prevalence of overweight and obesity.

The research has some limitations in terms of both detailed information at the SBP front level operation and the design of the PSM methodology; for example, the ENSANUT data (INSP 2012, 2016, 2020a) does not allow reliable verification of the breakfast (cold or hot) offered through the SBP at the school level. Likewise, the performance management system (PMS) methodology does not permit consideration of all the variables that characterize the infants participating in the SBP and the control group, such as eating habits, family structure, spoken indigenous language, and genetic predisposition to overweight or obesity, among others.

The rest of this paper is organized as follows: section 2 provides the background and main components of the SBP currently operating in Mexico; section 3 describes the econometric methodology (PMS) used in the investigation, the data, the descriptive statistics, and the results; in section 4, it is discussed the results, and section 5 presents the conclusions.

2
The School Breakfast Program

The SBP is one of the main food assistance programs provided by the National System for Integral Family Development (SNDIF) (SNDIF 2021).

The Mexican government created the SBP in 1929 to address children's illness and death due to undernutrition, limiting its coverage to Mexico City. However, between 1935 and 1945, doctors and intellectuals who recognized malnutrition as a severe health problem in Mexico promoted the adoption of a children's diet based on cereals and foods of animal origin, including milk and dairy products (Aguilar Rodríguez 2008). The school breakfast consisted of 250 ml of whole milk, a sandwich, a boiled egg, and a dessert.

In 1977 the government founded the SNDIF to organize and direct various social assistance programs. One of these was the SBP, which was extended to other regions to serve the population of public schools in municipalities and localities with high and very high marginalization. Nonetheless, since 1995, the Program has been implemented at the national level, covering all 32 Mexican states (SNDIF 2021).

In 2001 the Mexican national government decided to share the responsibility with the states and developed a new strategy to integrate all the country's food programs. The result was the Comprehensive Strategy for Social Food Assistance (EIASA) which, in addition to food assistance programs, included nutritional food orientation, and quality assurance. Since then, the EIASA has been used to define programs and actions providing social food assistance and to strengthen community development for the vulnerable population, with the objective of improving the nutritional status of social assistance recipients.

Since 2019, the SNDIF has been working on changing the perspective of school feeding programs, to alleviate child hunger and to ensure food and nutritional security, as well as sustainable local development (FAO 2017). The new strategy offers food education to change attitudes, knowledge, and specific food practices, in this way promoting inclusion. The focus on food care and community development was brought together in a single strategy in 2020: the Comprehensive Strategy for Social Food Assistance and Community Development (EIASADC).

The EIASADC promotes a joint action between state institutions, communities, and families, to improve vulnerable populations' well-being. This government strategy also is aligned with the UN 2030 Agenda's Sustainable Development Goals (SDG), primarily SDG 1, No poverty; SDG 2, Zero hunger; and SDG 3, Good health, and well-being (UNSD 2021).

More than six million school breakfasts are currently distributed daily, 24 % in preschool and primary education centers in rural areas, via the SNDIF. Around 12.2 % of five to eleven-year-old Mexican schoolchildren participate in the program, and 55 % of the total recipients are poor (Morales-Ruan 2018). The breakfasts provide them with around 360 kilocalories, approximately 30 % of their recommended daily energy and protein intake (SNDIF 2021).

2.1. Nutrition Quality Criteria for school breakfast preparation

The Nutrition Quality Criteria (NQC) establish the basis to integrate food batches, aiming to regulate the menu design and portions to promote a correct diet that conforms to the EIASADC's objectives.

School breakfasts are designed to comply with the characteristics of a correct diet, according to Official Mexican Standard NOM-043-SSA2-2012 (DOF 2013). One of the EIASADC's first steps was to change the composition of the school breakfast to promote a correct diet, favoring the consumption of vegetables, fruit, legumes, and whole grains, with reduced fat, sugar, and salt.

2.2. Menu nutritional components

There are two school breakfast modes: cold and hot.

Cold breakfasts

These consist of 250 milliliters semi-skimmed or whole milk for preschoolers living in areas where malnutrition prevails, 30 grams of whole-grain breakfast cereal, and 70 grams of fresh or dried fruit. Table 1 presents the portion and nutritional criteria for the whole-grain cereal contained in cold school breakfasts.

Portion	**30 grams**
Calories Fiber	120 Minimum 1.8 grams (< 10 % of RDI)
Sugars	Maximum 20 % of total input calories[a]
Total fat	Maximum 35 % of total input calories[a]
Saturated fat	Maximum 10 % of total input calories[a]
Trans fatty acids	Maximum 0.5 grams
Sodium	Maximum 120 milligrams[b]

[a] Fiber and sodium criteria relative to one 30 grams whole-grain portion.

[b] Labeling and pre-packaged foods and non-alcoholic beverages specifications.

Table 1
Portions and ingredients of whole grains contained in cold school breakfasts
Source: authors' calculations based on DOF (2010).

Fresh or dried fruit must be provided without the addition of sugar, fat, or salt. Dried fruit should be served in 70 grams portions, or 20 grams portions, if combined with 10-12 grams of oilseeds, such as peanuts, almonds, nuts, and sunflower seeds.

SBP operators must design five different menus per week, and the children should eat their breakfast on the school premises at the beginning of the school day. In this way, it is possible to ensure that the food is eaten and to monitor its acceptance by the recipients. The SBP recommends adding at least 70 grams of raw vegetables, such as carrots, yam, cucumber, or celery. The EISADAC offers guidelines for the cold school breakfast operation but highlights that each state may adapt these to their own needs and context (SNDIF 2021, p. 99).

Hot breakfasts

The hot breakfast must comply with the same NQC but offers a greater variety of food, facilitating the adjustment of micronutrients and achieving better nutritional status (FAO 2013). With this objective, the EIASADC's first step was a gradual transition from cold to hot school breakfasts, as in other countries whose school breakfast programs have been successful. Until 2019, the cold modality (around 90 %) predominated, but today the SBP delivers 50 % of its breakfasts in the hot modality (SNDIF 2022).

The hot breakfast consists of skimmed milk or plain water, and the main course must include vegetables, a whole grain, legumes and/or food of animal origin, and fresh fruit. It should have at least fifteen ingredients from a list named «the good food plate» (NOM-043-SSA2-2012) (DOF 2013): for example, skimmed milk; two portions of cereal as sources of dietary fiber; one food that is a source of calcium; one food that is a source of animal protein and/or iron, at least two varieties of legumes; vegetables (if mixed vegetables, without potatoes or corn). Ingredients that are significant sources of sugars, fats, and salt (*i.e.,* containing more than 400 milligrams of salt per 100 grams), and refined flours, should be avoided. The size of the portions must correspond to those established in the menus delivered by the state governments to the SBP recipients.

Each state is responsible for the program and must prepare at least twenty menus so that each week of the month and every day of the week the children receive different foods. Table 2 presents two sample menus.

Menu 1	**Menu 2**
Milk	Plain water
Egg with mushrooms and tomato served with corn tortilla	Noodles with sardines in tomato sauce, green salad (lettuce, cucumber, and chopped tomato)
Fresh seasonal fruit	Fresh seasonal fruit

Table 2
Samples of school breakfast menus
Source: author, based on SNDIF (2021).

Regional fresh input should preferably be sourced mainly from local producers to favor the regionalization of supplies and preservation of local food culture. Committees of parents, teachers, and community members are responsible for the preparation and supervision of these breakfasts (SNDIF 2021).

The program guidelines in Table 3 detail the suggested percentage of daily energy intake to be covered by breakfast, the percentage of energy that the various macronutrients (carbohydrates, proteins, and fats) should provide, the maximum amounts of saturated fat, added sugars and salt, and the minimum amount of fiber that each serving should contain.

Population group	Pre-school	School	Average
Daily energy requirement (kcal/day)	1,300	1,579	1,440
Energy provided by breakfast (kcal) (25 % of total daily kcal)	325	395	1,440
Carbohydrates (mainly from cereals) (% of breakfast kcal)		60 %	
Added sugars (g)		5 %	
Fiber (g)		5.4[a]	
Protein (% of kcal)		15 %	
Total fat (% of kcal)		25 %	
Saturated fat (% of kcal)		10 %	
Sodium c/(mg)		360[a]	

[a] 30 % of recommended daily intake (RDI).

Table 3
Nutritional calculation for the preparation of hot school breakfast menus
Source: SNDIF (2019).

While the EIASADC offers guidelines on the SBP's provision of hot breakfasts (SNDIF 2021, p. 98), each state may adapt these to suit its context and needs.

3 Estimation and results

The present study uses a marginalization index (MI) to identify children aged five to eleven in rural locations with high and very high marginalization. The MI entails four areas of analysis: the percentage of the population lacking access to education services; inadequate housing conditions such as lack of sewage infrastructure and toilets; spatial dispersion (living in small and isolated localities with fewer than 5,000 inhabitants), and a work income of up to two minimum wages (this refers to the lower limit at which people can afford items such basic medicines and essential food) (CONAPO 2015).

Information collected for these areas of analysis is utilized to build the MI under the analysis of principal components. Spain and the EU use these techniques widely, among others, to make intertemporal and spatial comparisons for quality-of-life studies (Somarriba & Pena 2009, Nayak & Mishra 2012, Zarzosa & Somarriba 2013). In Mexico the MI has five degrees of marginalization: very high, high, medium, low, and very low (CONAPO 2012, 2015, 2020).

Since MI data emerges from the National Population Census (INEGI 2020), it is possible to identify the type and intensity of deprivation and the population facing exclusion by geographical area. This index is widely used in Mexico to compare the intensity of infrastructural deficiencies in different localities. It also offers solid criteria for prioritizing federal, state, and local government social policy and action (Bustos 2011, CONAPO 2020).

3.1. Data

The microdata used in this analysis are taken from the ENSANUT (2012, 2016, 2018, and 2019) (INSP 2012, 2016, 2020a). ENSANUT, which began in 1986, has been conducted several times since 2000, most lately in 2012, 2016, 2018, and 2019. It provides information on health and nutrition in Mexican households, the types of housing infrastructure, and each adult household member's occupational, as well as sociodemographic characteristics (INSP 2016).

Within that classification, the treatment group (2,678 observations) comprised children who received cold or hot school breakfasts, and the control group (4,321 observations) who did not (see Table 4). It is worthier noting that sample groups are experimental. Hence, they do not present the sample size.

Variable	Treatment		Control	
	Mean	Standard deviation	Mean	Standard deviation
Age	39.15	9.29	38.23	9.97
Gender	0.75	0.48	0.77	0.61
Education	6.28	4.28	6.68	3.95
Couple	0.85	0.34	0.87	0.39
South	0.62	0.45	0.56	0.64
Language	0.38	0.51	0.35	0.35
Members	5.33	1.27	5.06	1.21
Old	8.40	2.57	8.33	2.56
Girl	0.63	0.59	0.59	0.56

Variable	Treatment		Control	
School	3.40	2.21	3.30	1.30
High	0.96	0.42	0.95	0.31

Table 4
Descriptive statistics of treatment and control groups
Source: author's calculations based on ENSANUT (INSP 2016).

Table 4 shows that heads of households in rural households with high and very high marginalization are largely women, most of whom are married or partnered. This applied to the households of 85 % of the treatment group and 89 % of the control group. These households are mostly in the south of the country, where there is a high degree of social backwardness. On average, the household heads have completed just four years of elementary school and their average age is thirty-eight.

To compare the response variables of the two groups, it is important to ensure a balance of the observed variables (Austin 2008, Zhang *et al.* 2019). For this, all the information available in ENSANUT 2012, 2016, 2018 and 2019 was used, indicating some sociodemographic characteristics of the children according to the following variables:

a. The number of household members (members)
b. A dummy variable with a value of one for individuals living in the south of the country (South) and zero otherwise
c. A binary variable with a value of one when the household head[1] is married or partnered (Couple) and zero otherwise
d. Household head's number of years of schooling
e. A dummy variable, with a value of one for a female head of household (Gender) and zero otherwise
f. A dummy variable, with a value of one where the head of household speaks an indigenous language (Language), and zero otherwise
g. Age of head of household (Age)
h. Age of child (Old)
i. A dummy variable, with a value of one when the child is a girl aged five to eleven (Girl) and zero for a boy in the same age range
j. Number of child's years of schooling (School)
k. A dummy variable, with a value of one when the household is highly marginalized (High), and zero otherwise
l. A dummy variable, with a value of one when the child is overweight according to the WHO's (2016) methodology (Overweight) and zero otherwise

1 A person recognized as such by the habitual residents of the dwelling (INSP 2016).

m. A dummy variable, with a value of one when the child is obese according to the WHO's (2016) methodology (Obesity) and zero otherwise

n. Weekly relative frequency of consumption of fruit, vegetables, sugary drinks, dairy products, meats, water, snacks, sweets, and desserts according to ENSANUT (2012, 2016, 2018, 2019)

o. A dummy variable, with a value of one when the child participates in the SBP (Treatment) and zero otherwise

The observable characteristics *a)* to *k)* above are used in the matching of the control and treatment groups, with the aim of comparing the outcomes of *l)* to *n)* (previously classified) for similar individuals in each group. The procedures used are PSM and the elimination of biases, due to initial differences between treated and untreated subjects (Austin 2008).

3.2. Methodology

The PSM method summarizes the information from the observable variables *a)* to *k)* for the control and treatment groups and generates a univariate indicator that allows the comparison of the groups with minimal bias. Specifically, Rosenbaum and Rubin's (1983) PSM method can be used to compare the groups using the Average Treatment Effect on the Treated (ATT) —*i.e.,* recipients of the SBP during the relevant years according to ENSANUT (INSP 2012, 2016, 2020a)—, which takes the following general form:

$$ATT = E\{E[Y_{(i)1} \mid T_i = 1, p(X_i)]\ E[Y_{(i)0} \mid T_i = 0, p(X_i)]\}\ (1),$$

where T_i is a binary variable indicating the treatment group, $p\ (X_i) = P[T_j = 1 \mid X_j]$, X_i is the vector of observable characteristics of the individual i, $Y_{(i)1}$ is the outcome of the treatment group, and $Y_{(i)0}$ is the outcome of the control group, which paired with the treatment group, according to PSM. At this point, it is verified that the pairing of both groups is balanced in the domain of the probability distributions of the PSM (Austin 2008), for which the balance hypothesis tests indicated when blocks stratify the interval (0, 1) (see Tables 5 and 6), according to Zhang *et al.* (2019), Abadie and Imbens (2016), Becker and Ichino (2002), and Ramírez *et al.* (2021) recommendations.

Once the pairing of the two groups has been carried out, the mean differences between them are estimated, considering the outcomes from *l)* to *n).* Various elements of non-parametric econometrics and asymptotic theory can strengthen the ATT estimates. One of these is inverse probability weighting (IPW), where probability weights correct the existing bias that results from each subject being observed in only one of the potential outcomes (Tan 2010). Regression-adjustment (RA) estimators are used to calculate ATT by the differentiated calibration of various weighted averages over the control and treatment group (Cattaneo 2010). Augmented inverse probability weighting (AIPW) computes the effects of the treatment from the combination of the regression adjustment and inverse probability. Finally, weighted regression coefficients are used to compute average potential outcomes (inverse-probability weighted regression-adjustment, IPWRA) (Cattaneo *et al.* 2013). The set of estimators above indicated is presented in the following section.

3.3. Results

Once it has been ascertained that the variables *a)* to *k)* are correctly balanced after matching using PSM, the ATT estimator of equation (1) is calculated using four different procedures: nearest neighbor (NB), stratification (ST), kernel (KL), and caliper (CA). These procedures compare similar observations from the treatment group versus the control group under various PSM weights (Becker & Ichino 2002, Imbens 2014).

Table 4 shows the ATT estimate using the procedures indicated in Becker and Ichino (2002) and matching the control and treatment groups. In this case, both groups are school-age children aged five to eleven. The estimated coefficients represent the probability that an infant in the treatment group is obese, overweight, or has a higher intake of the foods included in the analysis than the infants in the control group.

The results, presented in Table 5, reveal that the program's effect is not significant for the *obesity* variable since the t-statistic is < 1.64 using procedures ST, NB, KL and CA. At the same time, there is a positive effect of 7.9 % on the probability of a child becoming overweight in the treatment group. There is also evidence that participation in the program increases the likelihood of eating fruit (11.3 %), vegetables (6.4 %), sugary drinks (5.9 %), dairy products (3.9 %), and snacks, sweets, and desserts (2.7 %) each week, while there are no significant differences in the relative frequency of intake of water or meat, as the t-statistic is < 1.64 using procedures ST, NB, KL and CA.

Variable	**Method**	**ATT**	**Standard deviation**	***t*-statistic**
Overweight**	ST	0.077	0.035	2.191
	NB	0.083	0.032	2.606
	KL	0.075	0.040	1.892
	CA	0.082	0.065	1.258
Obesity	ST	0.010	0.033	0.292
	NB	0.010	0.042	0.229
	KL	0.002	0.025	0.091
	CA	0.118	0.075	1.567

Variable	Method	ATT	Standard deviation	*t*-statistic
Fruit***	ST	0.111	0.026	4.261
	NB	0.070	0.038	1.835
	KL	0.025	0.010	2.523
	CA	0.076	0.037	2.042
Vegetables***	ST	0.066	0.025	2.600
	NB	0.084	0.027	3.096
	KL	0.066	0.021	3.128
	CA	0.105	0.072	1.464
Sugary drinks*	ST	0.057	0.028	2.042
	NB	0.053	0.028	1.909
	KL	0.064	0.042	1.535
	CA	0.060	0.032	1.878
Dairy products*	ST	0.038	0.017	2.233
	NB	0.042	0.030	1.412
	KL	0.035	0.014	2.442
	CA	0.021	0.010	2.080
Meats	ST	0.003	0.018	0.163
	NB	0.005	0.030	0.167
	KL	0.015	0.063	0.243
	CA	0.003	0.018	0.166
Water	ST	0.201	0.215	0.935
	NB	0.181	0.102	1.767
	KL	0.294	1.034	0.284
	CA	0.070	0.371	0.190

(Conclusion)

Variable	Method	ATT	Standard deviation	*t*-statistic
Snacks, candies, and desserts**	ST	0.029	0.013	2.254
	NB	0.043	0.026	1.624
	KL	0.035	0.020	1.785
	CA	0.030	0.014	2.094

Test of balancing property
There is no difference between the PSM probability distributions for the control and treatment groups.
t-statistic: 1.53
p-value: 0.1345

*: 10 % significance level. **: 5 % significance level. ***: 1 % significance level.

Table 5

Estimation of the Average Effect of Treatment on the Treated (ATT)

Source: author's calculations.

To strengthen the results obtained, a set of additional estimators are presented in Table 6, which considers alternative specifications for the calculation of ATT (Cattaneo *et al.* 2013, Abadie & Imbens 2016).

Variable	Method	ATT	Standard deviation	*t*-statistic
Overweight**	IPWRA	0.074	0.033	2.228
	RA	0.075	0.060	1.249
	IPW	0.074	0.036	2.067
	AIPW	0.076	0.057	1.332
Obesity	IPWRA	0.011	0.028	0.410
	RA	0.010	0.046	0.214
	IPW	0.004	0.021	0.173
	AIPW	0.105	0.103	1.016
Fruit**	IPWRA	0.102	0.030	3.444
	RA	0.067	0.047	1.442
	IPW	0.024	0.017	1.409
	AIPW	0.068	0.033	2.041
Vegetables**	IPWRA	0.061	0.023	2.689
	RA	0.081	0.046	1.785
	IPW	0.064	0.024	2.682
	AIPW	0.093	0.068	1.363
Sugary drinks*	IPWRA	0.052	0.041	1.277
	RA	0.049	0.025	1.959
	IPW	0.063	0.046	1.383
	AIPW	0.059	0.039	1.522
Dairy products	IPWRA	0.036	0.024	1.495
	RA	0.040	0.023	1.716
	IPW	0.034	0.023	1.476
	AIPW	0.020	0.013	1.527
Meats	IPWRA	0.003	0.022	0.122
	RA	0.006	0.030	0.200
	IPW	0.016	0.087	0.180
	AIPW	0.004	0.016	0.262

(Conclusion)

Variable	Method	ATT	Standard deviation	*t*-statistic
Water	IPWRA	0.186	0.283	0.656
	RA	0.166	0.189	0.878
	IPW	0.358	0.895	0.400

Variable	Method	ATT	Standard deviation	*t*-statistic
	AIPW	0.070	0.344	0.204
Snacks, candies, and desserts*	IPWRA	0.028	0.014	2.104
	RA	0.042	0.034	1.244
	IPW	0.033	0.018	1.822
	AIPW	0.030	0.015	1.917

Test of balancing property
There is no difference between the PSM probability distributions for the control and treatment groups.
t-statistic: 1.49
p-value: 0.1401

*: 10 % significance level. **: 5 % significance level. ***: 1 % significance level.

Table 6
Estimation of the average effect of treatment on the treated (ATT)
Source: author's calculations.

The results that emerge from RA, IPW, AIPW, and IPWRA are qualitatively the same as those shown in Table 5. In other words, the effect of the program is not significant for the *obesity* variable. However, there is a positive effect regarding the probability of a child becoming overweight. In addition, participation in the program increases the likelihood of eating fruit, vegetables, sugary drinks, dairy products, and snacks, sweets, and desserts weekly, since the t-statistic is > 1.64 for at least one of the procedures RA, IPW, AIPW, and IPWRA (see Table 6), but there are no significant differences in the relative frequency of water or meat intake, as the t-statistic is > 1.64 in Table 6.

The set of ATT estimates (since the t-statistic is > 1.64 for at least one of the matching methods in Tables 5 and 6) for the control and treatment groups suggests that in previous years the SBP had an indirect effect on childhood overweight and obesity by encouraging the consumption of additional snacks, sweets, sugary drinks, and desserts.

4 Discussion

This paper uses National Health and Nutrition Survey data (2012-2019) to estimate the positive effect of the SBP on ensuring nutrition food, resulting in a lower prevalence of overweight and obesity in rural Mexican schoolchildren aged five to eleven living in conditions of poverty and high marginalization. The PSM procedure uses five matching algorithms to compare the treatment and the control groups' response variables.

The results find that young children who participate in the SBP program have a greater probability of being overweight. At the same time, there is no difference in obesity between the control group and the treatment group. The weekly relative frequency of consumption of fruit, vegetables, dairy products, snacks, sweets, desserts, and sugary drinks by infants enrolled on the SBP is greater than those in the control group, but their consumption of meat and water is the same across both groups.

Many studies of school feeding policies in low- and middle-income countries also report limited results regarding the prevention of overweight and obesity via the SBP as a preventive nutritional security policy for school-age children; for example, Santos-Ramos *et al.* (2017) found that this program rarely, included fruit or vegetables in southeast Mexico, containing instead various processed foods such as noodles, breakfast cereals, tomato puree, ham, sausages, and soft drinks sweetened with industrialized syrups, none of which are included in the guidelines for such breakfasts. Our estimates of the PSM model (Tables 4 and 5) show similar results. However, our results go further, finding that the relative weekly frequency of consumption of dairy products, snacks, sweets, desserts, and sugary drinks is greater for young children on the SBP. These results reveal that although the SBP is one of the programs with the highest coverage at the national level (16.9 %) (Morales-Ruan *et al.* 2018), malnutrition in school-age children associated with lack of food or excess food consumption persists (Chabite *et al.* 2018, García *et al.* 2017).

The findings of this and other studies (Barrios *et al.* 2013, in Chile, and Agbozo *et al.* 2018 in Ghana) suggest that SBP breakfasts do not always meet the standards set out in the SBP nutritional guidelines. In the Mexican context, their calorific intake exceeds the 30 % of recommended daily intake (RDI) established by the norm (NOM-043-SSA2-2012) (DOF 2013). As stated above, obesity was not statistically significant in our estimates, unlike overweight. This may be because, as some authors imply (Dan *et al.* 2019, Rundle *et al.* 2020), of the overweight children who become obese, some may not develop this condition until they reach adulthood.

Like Barrios *et al.* (2013) and Agbozo *et al.*'s (2018) studies of the SBP, our estimates show that this type of nutritional policy strategy can lead to undesirable effects in the population served, *i.e.,* to the development of overweight. The results presented in Tables 4 and 5 indicate that the probability of being overweight is more significant for those in the SBP (treatment group). Therefore, it is likely that these results might be attributed to failures in SBP everyday provision at the local and school levels rather than the menu guide design itself.

Although the SNDIF makes general SBP policy design recommendations, the government of each state can adapt them to suit its context and needs (SNDIF 2022, pp. 98-99). Hugues *et al.* (2021) report that the main reason for the poor implementation of school feeding programs in northwestern Mexico is that they are not mandatory, and there are no sanctions for noncompliance. Besides this, the lack of dissemination of nutritional information and training of the people involved, and deficiencies in the infrastructure of and essential services to schools (drinking water, or electricity), make it difficult to comply with the established criteria, particularly in the case of hot breakfasts. Ramírez-Ramírez *et al.* (2020) found that in Mexico, being an enrolled on the SBP does not guarantee that children will consume their breakfast, or that they will eat only their own breakfast. The results therefore suggest that failures in the provision and monitoring of the SBP may not only prevent the program from effectively addressing the problem of child malnutrition but also aggravate it.

It is essential to establish that the results obtained correspond to the ENSANUT data between 2012 and 2019 when the EIASADC 2020 was not yet launched. Hence, most of the school breakfasts that the SNDIF offered were in cold mode (90 %).

5 Conclusions

The central research question in this study is whether the SBP ensures eating nutritious food, resulting in a lower prevalence of overweight and obesity among the poor and marginalized rural Mexicans schoolchildren aged five to eleven. The main results reveal that young children who participate in the SBP have a greater probability of being overweight, although there are no differences in obesity between the control and treatment groups. Additionally, the weekly relative frequency of consumption of fruit, vegetables, dairy products, snacks, sweets, desserts, and sugary drinks is greater in schoolchildren enrolled on the SBP. There is no difference in their consumption of meat and water.

Even though the data limitations on the ENSANUT (INSP 2012, 2016, 2020a), that does not allow reliable verification of the type of breakfast (cold or hot), offered through the SBP, the research findings suggest food and nutritional security policy measures to prevent overweight and obesity in rural schoolchildren population (aged five to eleven years old) that lives in conditions of poverty and high marginalization. In this sense, it is essential to highlight the relevance of the design and implementation of nutritional policies that meet the needs of children from rural households who are in poverty and marginalization. Therefore, a comprehensive approach to food and nutrition security policy is necessary, which considers the provision of a safe food intake through SPBs. Furthermore, it is required to complement this food policy program with other community strategies, such as promoting fresh food products (cultivated in safe and quality conditions); and implementing educational designs to acquire healthy eating habits, involving the whole family, not just school-age children.

The EIASADC as the guide strategy of the most recent version of the SBP constitutes a significant advance in this sense. However, the success of a food policy depends not only on a good design but on being appropriately implemented. For this reason, adequate monitoring of the different stages, complementary policies of the program, and more and better external evaluations are essential to improve its results.

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