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Health and education: An impact analysis applying propensity score matching

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Contents

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health, education, propensity score matching, PSE

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I00, I11, I18

Abstract · **Resumo**

In this paper, we estimated the effect of the School Health Program (PSE) on the total failure, total dropout, and total age/grade distortion rates based on microdata. Data was withdrawn from the School Census and Educational Indicators, published by INEP (Brazilian National Agency for Education and Research), and the list of public schools agreed in 2017 with the PSE, provided by the Ministry of Education (MEC). The Propensity Score Matching method applied sensitivity analyses developed by Ichino, Mealli, and Nannicini (2008) and Oster (2017) and heterogeneous tests to deepen questions intrinsic to the theme. The findings appoint to a fall in the total rates of failure, dropout, and age-grade distortion in schools under PSE compared to schools not participating in the Program. Such effects are significant and stand out in the total failure rate. In addition, it was noted that the PSE causes a more significant impact on the initial grades of middle school (1st to 5th grades) compared to the final years (6th to 9th grades). The sensitivity analyses proposed by Ichino et al. (2008) and Oster (2017) confirmed the result's robustness. Heterogeneous response tests applied in sample subgroups of teacher characteristics, class characteristics, and socioeconomic level of the school indicated a reduction in the analyzed rates, reinforcing the main result. All considered this study confirmed the hypothesis that schools with PSE agreements present a decrease in the total failure rate, total dropout rate, and total age/grade distortion rate.

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1. Introduction

In the contemporary world, health and education, among others, are playing a prominent role in the agenda of public managers. This is partly due to the modern political organization movement called the Welfare State, which took place from the 1980s, pushing nation-states to legally institute these areas as social rights.

Since then, globally representative institutions, such as the United Nations (UN), recognized the importance of these variables in economic development, including health and education indicators, besides income, as criteria of the Human Development Index (HDI), which brought resources for programs that promote social welfare to improve the life quality of the population and foster economic development.

In Brazil, in 1988, the Constituent Assembly included education and health in Chapter II of the Federal Constitution, which addresses Social Rights. These areas have become a priority for public policymakers, who have developed and implemented social projects focused on serving the population in these sectors. Such projects are implemented through actions and programs that direct large amounts of financial and human resources so states and municipalities may execute them.

In that context, in recent decades, the federal government has dedicated efforts to implement strategies aimed at developing proposals that integrate the areas of health and education to promote the development of citizenship and the qualification of Brazilian public policies. Consequently, Decree No. 6286 of 05 December 2007 was enacted by the Federal Government, creating the School Health Program – PSE (Planalto, 2007).

Invested in a significant social relevance, the main objective of the Program is to develop health preventive actions with schools and the Community besides promoting students' health. The fundamental feature of the PSE, which also stands out as a crucial strategy to perform its actions, is to bridge schools and the Health Centers of the Brazilian Unified Health System (SUS) found in every city of the country (Planalto, 2007). Likewise, the dynamics of PSE comprises intersectoral coordination between the Ministry of Health and the Ministry of Education, making it a relevant player in the integration of areas.

Supported by this framework, the present study is justified by its economic and social relevance given its contribution to an accountable society, revealing whether the Program's actions are practical in education. In addition, it is relevant for scientific research, given lacking studies of cause-effect analysis of health and education variables.

Arising from that scope, based on the School Health Program (PSE), this research aims at finding whether or not the actions promoting health and

education have any impact. Also, it is guided by the expectation that schools participating in the Program will have a lower rate of failure, total school dropout, and lower total distortion rates of age-grade than schools not joining the Program.

The primary objective of this paper is to estimate the PSE effect on failure, dropout, and age-grade distortion rates applying the Propensity Score Matching (PSM) method. The basic microdata is withdrawn from the School Census, Education Indicators—both published by INEP (National Agency for Education and Research)—and the list of public schools engaged in the Program in 2017, all provided by the Ministry of Education (MEC). Additionally, the specific objectives of this study are: (i) to demonstrate the characteristics of the School Health Program (PSE) from its legal aspects, objectives, and adhesion criteria, among others; (ii) to highlight the analysis method as a way to establish the causal relationship between health and education, considering the selected variables; and (iii) to demonstrate to what extent the PSE impacts on the total failure, total dropout, and total age/serial distortion rates.

The research provides a quantitative approach to the data treatment and results, explaining the objectives and classified as ex-post-fact. It analyzes the possible causal relationships from data collected previous to the study. For the execution of the results, we adopted cross-section data analysis and the non-parametric method Propensity Score Matching (PSM)—also known as propensity score matching—which allows estimating the average effect of treatment from the construction of a counterfactual (control group) with similar characteristics to the treatment group where and exogenous variables may consider to for the analysis.

Moreover, robustness tests are applied to ensure results reliability. This study used the test developed by Ichino et al. (2008) to assess Conditional Independence Assumption (CIA) sensitivity regarding unobservable variables and the methodology proposed by Emily Oster (2017). It is noteworthy that, to avoid regional factors invariant in space, fixed effects of State, Region, Mesoregion, and Microregion were employed to correct endogeneity problems. Finally, heterogeneous response tests were conducted to deepen issues inherent to the theme and strengthen the results.

When applying the statistical and econometric methods, the results indicated that the School Health Program led to a fall in total failure, total dropout, and total age/grade distortion rates, especially in the early years of middle school grades (1^{st} to 5^{th}) compared to the final grades (6^{th} to 9^{th}). The sensitivity analyses—Ichino et al. (2008) and Oster (2017)—and the heterogeneous response tests indicated the result's robustness.

Besides this brief introduction, this article is divided into five sections. The second section deals with the PSE characteristics. The third section presents

the data and descriptive statistics of the model variables. The fourth section demonstrates the empirical strategy used to develop the study. The fifth section contains the analysis of the results. Finally, the sixth section provides the final considerations.

2. The School Health Program

The PSE was established by Presidential Decree No. 6286 of 5 December 2007 and regulated by Ordinance No. 1055 ruling between Ministries, of 25 April 2017 (MS/MEC, 2017). It is a federal intersectoral public policy articulated between the Ministry of Health (MH) and the Ministry of Education (MEC) to foster actions to promote health and prevent diseases in the basic school system (MS, 2020).

The target audience is members of the school community, represented by teachers, students, managers, education and health professionals, and students from the Federal Program of Youth and Adult Education (EJA). To be assisted, the beneficiary must be linked to a school participating in the PSE and have the National Health Card, as explained in the Ministry of Health Portal (MS, 2020).

The PSE's initial design establishes that the Union regulates and monitors the program's actions, the municipalities implement and execute them, and finally, that the states articulate and support their schools. Thus, it is a shared management between federal institutions through the Intersectoral Working Groups – GTIs (MS, 2020). At the national level, the Program is managed by the GTI-F, comprising the Ministry of Education's teams and the Intersectoral Commission on Education and Health at School (CIESE), established in 2008 by the Ordinance No. 675, June 4, 2008, reaching different Ministries (MS/MEC, 2008). This level (GTI-E) comprises members of the Health State Office and the Education State Office. The municipal group (GTI-M) includes the Local Health Office and Local Education Office managers, representatives of the Family Health team, educators who will work in the PSE, schools, young people, and individuals from the local community (MS, 2011).

The Family Health Strategy holds the central coordination that defines PSE actions prepared by the Ministry of Health (Decree No. 6286, Planalto, 2007). Following that, a list of the territories covered by the program is created to allow better integration between public health and the school system. Based on that model, the PSE establishes the Territory according to strategies agreed between the school and the basic health centers, which is provided in the school's political-pedagogical project. The Territory determines the actions proposed that are part of activities to be carried out by municipalities, to be contracted through the Municipal Commitment Term (MS, 2020)

The effective implementation of the PSE takes place when the states, the Federal District, and the municipalities adhere to the goals and the guidelines provided. The program implementation is formalized when both municipalities and the Federal District fill out and sign the PSE Statement of Commitment, and the state signs the Statement of Adherence. The SUS Basic Care Teams and the schools benefiting from the PSE actions are appointed by the Municipalities and the Federal District in the Term of Commitment, always upon the consent of the health and education managers, complying with the Program priorities and targets, as provided in its Guiding Document (MS/MEC, 2017).

According to Ordinance No. 1055/2017 (MS/MEC, 2017), the above actions are as follows: develop actions to combat the *Aedes Aegypti* mosquito; foster physical activity practices and leisure at schools; prevent misuse and abuse of alcohol, tobacco, crack, and other drugs; promote the culture of peace, citizenship, and human rights; prevent violence and accidents; screen students possibly with aggravated diseases on disposal; evaluate dental health and apply fluoride; check and update immunization; advise on healthy eating, preventing childhood obesity; screen students to check hearing health, identifying possible hearing impairment; advise students on their sexual and reproductive rights, promoting STDs/AIDS preventive actions; promote eye health, identifying students with possible vision problems.

The Program covers twenty-four months (the quarters cycle), and the Statement of Commitment may be amended after twelve months from adhesion. During that cycle, the Municipalities and the Federal District should develop actions complying with the planning, considering local interests, and the twelve essential actions above. At the end of each year of the cycle, the federal management reports on the monitoring based on the records, which are forwarded and validated in the Health Information System for Basic Care (SISAB), reopening adherence for the next cycle (MS/MEC, 2017). Table 1 summarizes the membership and fund transfer criteria of the PSE established in the biennium 2017/2018.[1]

The Health Ministry transfers funds to the Municipalities joining the PSE—R$ 58,966,246.00 in 2017—after SISAB (Information System of Basic Health Care) issues the indicators for the program performance by adhered schools regarding (i) the number of actions implemented, (ii) action coverage in combating the *Aedes Aegypti* mosquito, and PSE coverage percentage.

[1] Ordinance MS nº 1861 of April 2008; Ordinance MS nº 2931 of December 2008; Ordinance MS nº 3918 of October 2010; Ordinance MS nº 3146 of December 2009; Ordinance MS nº 1537 of June 2010; Ordinance MS nº 3918 of October 2010; Ordinance MS/MEC nº 3696 of November 2010; Ordinance MS/MEC nº 1911 of August 2011; Ordinance MS/MEC nº 1910 of August 2011; Ordinance MS/GM nº 3014 of December 2011; Ordinance MS nº 357 of March 2012; Ordinance MS/GM nº 524 of March 2012; Ordinance MS nº 2693 of December 2012; Ordinance MS nº 297 of February 2013.

Table 1. Criteria of adhesion and fund transfer to the PSE – 2017/2018

Adhesion Criterium	Amount	Transfer
Brazilian Municipalities plus priority cities (high childhood obesity rates) – 1 two-year adhesion cycle.	Max. 600 students = R$ 5,676.00. For every 800 extra students = plus R$ 1,000.	A single payment at adhesion. The municipality becomes ineligible to receive the funding if: (i) accomplishes less than two actions; (ii) does not accomplish the 12th action (*Aedes Egypt*); (iii) accomplishes actions at only one school.

Source: MS/MEC (2017)

In summary, PSE establishes an essential program of the federal government that strengthens preventive actions and combats diseases making public schools' students vulnerable and compromising their full development.

3. Data

This paper was developed based on the data provided in the School Census Microdata and Basic School Indicators—from the INEP (National Agency for Education and Research). It also counted on data from public schools joining the PSE, provided by the Ministry of Health (MS) through the General Coordination of Physical Actions and Intersectional Activities of the SAPS (Primary Health Care Secretariat). We chose to use data from INEP for being the primary information source on basic education in Brazil, containing microdata covering school indicators for quantitative and qualitative characteristics and performance, enrolment, classes, and teachers of all the different stages and kinds of basic and vocational education.

The interest sample of this work regards information about 85,700 public schools in the PSE (treated group) and 22,896 schools not participating (the control group), totaling 108,596 schools located in the 5,510 Brazilian municipalities and the Federal District. From that, we withdrew socio-economical, school performance, and infrastructure data. Data were collected in 2019 and regard a period from January to December 2017, the analysis period.

We applied the total rate of failure, dropout, and age-grade distortion as independent variables. School adhesion to the PSE is taken as the independent variable. Control variables are data from schools surveyed in the School Census of Basic School of 2017. Table 2 shows a summary of the variables in this study.

In addition, this study applied heterogeneous response tests through sample subgroups to deepen issues inherent to the theme and strengthen the results. Table 3 shows the sample subgroups selected for that test.

Table 4 displays the means of the variables in the model of PSE's effect on the total failure rate, total dropout rate, and total age/grade distortion rate

Table 2. List of dependent, independent, and control variables of the model

VARIABLE	EXPLANATION
Dependent Variables	
Total failure rate	Percentage of students who did not earn a minimum passing grade at the end of the school year
Total dropout rate	Percentage of students who dropped out of school in the school year
Total age-grade distortion rate	Percentage of students who are two or more years older than recommended for a given school grade based on age established for admission in middle school, which is 6 years old
Independent Variables	
School Health Program (PSE)	Dummy = 1 indicates that the school is participating in the program and Dummy = 0 indicates otherwise
Control Variables	
Filtered water	Dummy = 1 indicates that the water provided to students is filtered, and Dummy = 0 shows otherwise
Electricity	Dummy = 1 indicates that the school is supplied with electric power, and Dummy = 0 shows otherwise
Garbage collection	Dummy = 1 indicates that there is a regular garbage collection, and Dummy = 0 shows otherwise
Kitchen	Dummy = 1 indicates that there is a kitchen in the school, and Dummy = 0 shows otherwise
Library	Dummy = 1 indicates that the school has a library, and Dummy = 0 shows otherwise
Bathroom	Dummy = 1 indicates that there are bathrooms in the school, and Dummy = 0 shows otherwise
PNE bathroom	Dummy = 1 indicates a bathroom for the disabled in the school, and Dummy = 0 shows otherwise
Copier machine	Dummy = 1 indicates that the school has a copier machine, and Dummy 0 indicates otherwise
Science lab	Dummy = 1 indicates that the school has a Science Lab, and Dummy = 0 shows otherwise
Student accommodation	Dummy = 1 indicates that the school has student accommodation, and Dummy = 0 shows otherwise
Teacher accommodation	Dummy = 1 indicates that the school has teacher accommodation, and Dummy = 0 shows otherwise
Meals	Dummy = 1 indicates that the school provides meals to students, and Dummy = 0 shows otherwise
Assistance	Dummy = 1 indicates that the school has a room dedicated to Assistance, and Dummy = 0 shows otherwise
Special material for *Quilombolas*[a]	Dummy = 1 indicates that the school uses pedagogical material specially developed for quilombola students, and Dummy = 0 shows otherwise
Special material for indigenous people	Dummy = 1 indicates the school uses pedagogical material specially developed for indigenous students, and Dummy = 0 shows otherwise

Note: Self-designated ethno-racial groups who have their own historical trajectory, specific territorial relations, and a presumed black ancestry related to the historical oppression they have suffered (Planalto, 2003).

Source: Table created by the author from information available on INEP webpage.

Table 3. List of sample subgroups comprising the heterogeneous tests

SUBGROUP	EXPLANATION
Teacher Characteristic	
Rate of school teachers holding a higher education degree (DSU)	Percentage of school teachers holding a higher education degree.
Rate of teachers whose subject matter is suitable to their training (AFD)	Percentage of school teachers holding a higher education degree or a bachelor's degree with additional training on the subject area they teach.
Teacher Effort Load (IED)	Percentage rate of teachers' effort regarding aspects of their practice that generate an overload.
Class Characteristics	
Student average per class (ATU)	The average number of students per middle school class.
Average daily class hour (HAD)	The average number of daily class hours per school in middle school.
Socioeconomic Level	
School Socioeconomic Level (INSE)	Dummy = 1 for very low level, and Dummy = 0 shows otherwise.
	Dummy = 1 for low level, and Dummy = 0 shows otherwise
	Dummy = 1 for a low medium level, and Dummy = 0 shows otherwise.
	Dummy = 1 for a medium level, and Dummy = 0 shows otherwise.
	Dummy = 1 for a high medium level, and Dummy = 0 shows otherwise.

Source: Table created by the author from information available on INEP webpage.

for the treated and the control groups. Such variables show differences in the means between the groups. The average total failure rate (8.22%) of schools in the treated group is 1.10% higher than that of the control group (7.11%). The average total dropout rate in the control group is 1.27%, while in the treated group, it is 1.82%, having a difference of 0.54%. The most significant difference is the average age/grade distortion rate (3.30%). Schools in the treated group report a 20.92% average for the total grade-age distortion rate, while the average is 17.61% in the control group.

On average, from schools that do not participate in the PSE, 53% have a library, while 49.9% have study facilities in the PSE group. It was also found that more schools not joining the Program have science labs (19.9%) compared to those in the PSE (10.3%). Moreover, it is observed that 48.8% of the school units covered by the PSE have a dedicated room to assist students, while 41.1% of those that are not attended have this environment in their school space.

In summary, this study found different means for treated and control groups, highlighting the need to apply a method for estimating the effect that creates a counterfactual, reducing selection bias. Therefore, it justifies applying

Table 4. Mean of model variables for the treated and the control groups

	Control		Treated		Difference	
	Mean	Standard Deviation	Mean	Standard Deviation	Diff	DP
Dependent Variables						
Total failure rate	7.11	0.047	8.22	0.392	−1.10	0.061
Total dropout rate	1.27	0.016	1.82	0.015	−0.54	0.023
Total age-grade distortion	17.61	0.093	20.92	0.749	−3.30	0.119
Control Variables						
Filtered Water	0.866	0.340	0.876	0.328	−0.010	0.002
Electricity	0.989	0.103	0.995	0.070	−0.005	0.000
Garbage Collection	0.010	0.099	0.010	0.103	0.000	0.000
Kitchen	0.980	0.139	0.984	0.124	−0.004	0.001
Library	0.530	0.499	0.499	0.500	0.030	0.004
Bathroom	0.149	0.356	0.169	0.375	−0.019	0.003
PNE Toilet	0.590	0.491	0.535	0.498	0.055	0.004
Copier machine	0.567	0.495	0.549	0.497	0.018	0.004
Science laboratory	0.199	0.399	0.103	0.305	0.095	0.002
Student accommodation	0.006	0.077	0.002	0.051	0.003	0.000
Teacher Accommodation	0.008	0.093	0.006	0.080	0.002	0.000
Meals	0.994	0.071	0.997	0.050	−0.002	0.000
Special assistance room	0.414	0.492	0.395	0.488	0.019	0.004
Special material for quilombolas	0.005	0.073	0.009	0.099	−0.004	0.000
Special material for indigenous people	0.003	0.056	0.003	0.556	0.000	0.004
N-Obs	21,110		33,039			

Source: Created by the author based on the Microdata of the Middle School Census, School Indicators of Middle School and Schools participating in the PSE.

the PSM method to estimate the PSE effects on school performance. This methodology will be detailed in the next section.

4. The empirical strategy

The econometric model of this paper is specified as follows:

$$Y_i = \beta_0 + \beta_1 PSE + \beta_n X_n + \delta_e + \delta_r + \delta_{\text{ma}} + \delta_{\text{mi}} + \varepsilon_i, \quad (1)$$

where Y_i is the total failure rate, total dropout rate, and total age-grade distortion rate of the school; β_1 is the School Health Program (PSE); $\beta_n X_n$ is a set of variables indicating infrastructure characteristics of each school that can influence school performance; the δs are fixed effects of state, region, macro-region and micro-region respectively, and finally, ε_i is the average random term.

The non-parametric PSM method—also known as propensity score matching—is used to verify the impact of PSE on the variables *total failure rate*, *total dropout rate*, and *total grade/age distortion rate*. This method allows estimating the average effect of a treatment based on the construction of a counterfactual (control group) whose characteristics are similar to the ones found in the treatment group, and which may consider observed exogenous variables for the analysis

Thus, the logic of the method consists in pairing the schools that participate in the PSE (treated group) with those that do not participate (control group) so that the paired groups do not present the same school in both groups, i.e., the treated group and the control group should not contain equal observations. It is also necessary that the schools in the groups that will be matched have similar characteristics, minimizing the endogeneity problem.

Specifically, the PSM estimates the school's probability of participate in the School Health Program (PSE) based on the selected control variables, simplifying the matching process. From this probability, one can gauge the causal effect of the PSE on the variables of interest since the treated and control groups that will be compared have similar observable characteristics.

According to Rosenbaum and Runbin (1983), the causal effect is obtained using the ATT (Average Treatment Effect on the Treated) represented by the following function:

$$ATT(x) = E\left[\frac{Y_i(1)}{T_i = 1}, X_i = x\right] - E\left[\frac{Y_i(0)}{T_i = 1}, X_i = x\right], \tag{2}$$

where

$ATT(x)$ is the casual effect;

$E\left[\frac{Y_i(1)}{T_i=1}, X_i = x\right]$ is the mean of treated groups; and

$E\left[\frac{Y_i(0)}{T_i=1}, X_i = x\right]$ is the mean if treated groups had not been treated, considering the characteristics observed.

The application of PSM requires fulfilling two assumptions: Conditional Independence Assumption (CIA) and Common Support Hypothesis (Rosenbaum & Runbin, 1983; Becker & Ichino, 2002).

The Conditional Independence Hypothesis (CIA) assumes that the binary treatment Variable ($T_i = 1$ and $T_i = 0$), represented in this research by PSE, does not interfere with potential outcomes when conditional on the observable variables (X_i) of school characteristics. It is assumed that unobservable factors are not sources of bias. Thus, we have:

$$Y_i(0), Y_i \perp T_i, X_i\,. \tag{3}$$

Thus, equation (2), applying the CIA, would be rewritten as follows:

$$ATT(x) = E\left[\frac{Y_i(1)}{T_i = 1}, X_i = x\right] - E\left[\frac{Y_i(0)}{T_i = 0}, X_i = x\right]. \tag{4}$$

The Common Support Hypothesis assumes that the treated and control groups have observations that can be compared for characteristics X_i. Thus, we have:

$$0 < \Pr\left[\frac{T_i = 1}{X_i}\right] < 1. \tag{5}$$

Once the previous hypotheses are satisfied, the propensity score is estimated by applying the parametric Probit and Logit model. Thus, we have:

$$P(x) = \text{Probability}\left[\frac{T = 1}{X}\right] = E\left[\frac{T}{X}\right], \tag{6}$$

where X is the vector of individual characteristics; and T indicates the treatment.

Finally, function (2), which represents ATT (Average Treatment Effect on the Treated) or the average effect of PSE on schools, will be defined by

$$ATT(x) = E\left[\frac{Y_i(1)}{T_i = 1}, P(X)\right] - E\left[\frac{Y_i(0)}{T_i = 0}, P(X)\right]. \tag{7}$$

Once the previous steps are fulfilled, algorithms are applied to match schools that participate in the PSE (treated group) with those that do not participate (control group). To perform the matching, the following algorithms were used:

Nearest Neighbor Matching (NN): This algorithm selects elements of the control group for each element of the closest treated group, considering the propensity score. In this work, the nearest neighbor variant is used with or without replacement. In this case, an untreated element can be used more than once as a match allowing the better average quality of the match and reducing selection bias (Caliendo & Kopeinig, 2008).

Kernel Matching (KM) and *Local Linear Marching (LLM):* Non-parametric matching estimators using weighted averages of all individuals in the control group to build the counterfactual result. These algorithms match each element of the treated group with "n" observations of the control group considering weights inversely proportional to the *propensity score* distance (Santos & Jacinto, 2017; and Salvini, Pontes, Rodrigues, & Silva, 2019). The advantage of these approaches is the use of more information, which allows the achievement of lower variance. The disadvantage is the possible use of observations that do not match; therefore, the proper imposition of the common support condition is essential (Caliendo & Kopeinig, 2008).

Despite being appropriate to assess the causal effect for allowing matching treated and control groups, the PSM is limited in minimizing the selection bias issue since the conditional independence hypothesis (CIA) cannot be fully guaranteed (Caliendo & Kopeinig, 2008).

In this step, the literature recommends that, after the adoption of the PSM, robustness tests should e applied to confirm the results. Thus, the choice in this work was using the test of Ichino et al. (2008) to assess the sensitivity of the CIA about unobservable variables and the methodology proposed by Oster (2017). It is noteworthy that, to avoid regional factors invariant in space, fixed effects of State, Region, Mesoregion, and Microregion to correct endogeneity problems.

Briefly, the Ichino et al. (2008) test suggests no conditional independence between the dependent Variable and the treatment, given the observed variables (X_i). Therefore, according to this model, CIA is guaranteed, having an unobserved binary Variable (U), in addition to the observed variables (X). Therefore, we have:

$$E\left(\frac{Y_0}{T=1}, X, U\right) = E\left(\frac{Y_0}{T=0}, X, U\right). \tag{8}$$

And the central inference in the method proposed by Oster (2017) is the proportional selection assumptions, which the following equation can translate:

$$\delta \frac{\sigma_{XT}}{\sigma_X} = \frac{\sigma_{UT}}{\sigma_U}, \tag{9}$$

where $\sigma_{XT} = \text{Cov}(X, T)$; $\sigma_{UT} = \text{Cov}(U, T)$; $\sigma_X = \text{Var}(X)$; $\sigma_U = \text{Var}(U)$; and δ is the ratio coefficient of proportionality.

This approach proposes three regression models: (i) the first considers as independent Variable only the treatment (PSE), the estimated coefficient of the treatment represented by β' and $\dot{R}$ and the regression represented by R^2; (ii) the second considers all the observed independent variables (T and X) and β'' and $\bar{\dot{R}}$ as the estimated coefficient of the treatment (PSE) and the regression; (iii) and the third considers as independent Variable the treatment (T), the observables (X) and the unobservable (U), while β and R_{max} represent the estimated coefficient of the treatment and the regression.

Considering the proportionality hypothesis, $\delta = 1$ is an equal selection between observables and unobservable occurs. The expression below represents an approximation for the bias when δ is close to 1:

$$\beta^* = \beta'' - \frac{\delta(\beta' - \beta'')\left(R_{\text{max}} - \bar{\dot{R}}\right)}{\bar{\dot{R}} - \dot{R}}. \tag{10}$$

Thus, the degree of selection is calculated according to the following expression:

$$\delta' \approx \frac{(\beta'' - \beta''')\left(\bar{R} - \dot{R}\right)}{(\beta' - \beta'')\left(R_{\max} - \bar{R}\right)}, \tag{11}$$

where δ' is the approximate value of the selection degree when β is equal to the predicted value (β''') and equal to zero. This model demonstrates the degree of selection on the unobservable variables concerning the observable ones, showing a lack of impact on treatment impact.

5. Results

The methodology adopted (PSM) assumes that, after the matching, the differences between the characteristics of schools that received the treatment (PSE) and those that did not are substantially reduced. Table 5 shows the result after matching, considering this assumption.

A significant fall is noticed in Pseudo R^2 and the values of mean and median biases, confirming that, after applying PSM, there was a good matching.

In Table 6, we find the results of the PSE effect estimate on failure, dropout, and age-grade distortion total rates taking all methods into account.

To better analyze the results, we also estimated the PSE effect on failure, dropout, and age-grade distortion rates in all phases of middle school, divided into the initial grades (1^{st} to 5^{th}) and the final grades (6^{th} to 9^{th}).

A significance of the PSE effect is found for all failure, dropout, and age-grade distortion total rates in all methods, where the highest total rate lies on failure. Such outcome becomes evidence that schools receiving PSE actions showed failure, dropout, and age-grade distortion than those not covered by the Program.

Table 5. *Balance* before and after PSE matching

Variable		Pseudo R2	Mean Bias	Median Bias
Total failure rate	Not matched	0.227	4.5	3.5
	Matched	0.18	1	0.6
Total dropout rate	Not matched	0.233	4.5	3.5
	Matched	0.017	1.1	0.6
Total age-grade distortion rate	Not matched	0.233	4.5	3.5
	Matched	0.017	1.1	0.6

Source: Created by the author based on the Microdata of the Middle School Census, School Indicators of Middle School and Schools participating in the PSE.

Table 6. PSE effect on failure, dropout, and age-grade distortion total rates

	Total failure rate			Total dropout rate			Total age-grade distortion rate		
	Total	Initial grades	Final grades	Total	Initial grades	Final grades	Total	Initial grades	Final grades
Probit Method									
NN(1)	−5.62***	−11.78***	−2.44**	−4.45***	−10.39***	−4.39***	−5.58***	−9.21***	−3.18***
	(0.014)	(0.013)	(0.012)	(0.012)	(0.013)	(0.011)	(0.013)	(0.013)	(0.010)
NN(2)	−6.98***	−14.00***	−3.30***	−5.90***	−12.57***	−5.18***	−6.99***	−11.63***	−3.21***
	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)	(0.009)	(0.010)	(0.010)	(0.008)
Kernel	−9.87***	−20.97***	−4.17***	−7.59***	−17.91***	−5.15***	−8.55***	−16.95***	−2.77***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.005)
LLR	−4.97***	−11.47***	−2.19**	−4.46***	−9.85***	−2.93***	−5.10***	−9.34***	−1.83*
	(0.014)	(0.013)	(0.012)	(0.012)	(0.013)	(0.011)	(0.013)	(0.013)	(0.010)
Logit Method									
NN(1)	−5.71***	−12.77***	−2.01**	−4.09***	−11.22***	−3.96***	−5.40***	−10.17***	−2.52**
	(0.014)	(0.012)	(0.012)	(0.122)	(0.012)	(0.011)	(0.012)	(0.012)	(0.010)
NN(2)	−6.71***	−15.23***	−3.19***	−5.52***	−13.43***	−4.78***	−6.56***	−12.62***	−2.76***
	(0.011)	(0.010)	(0.009)	(0.009)	(0.010)	(0.009)	(0.010)	(0.010)	(0.008)
Kernel	−9.98***	−21.16***	−4.24***	−7.76***	−18.08***	−5.17***	−8.66***	−17.10***	−2.77***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.005)
LLR	−5.00***	−11.87***	−2.29**	−4.72***	−10.21	−3.01***	−5.32***	−9.65***	−1.87*
	(0.014)	(0.012)	(0.012)	(0.012)	(0.012)	(0.011)	(0.012)	(0.012)	(0.010)
N. Obs.	56,745								

Note: *Significant to 10%; **Significant to 5%; ***Significant to 1%.

Source: Created by the author based on the Microdata of the Middle School Census, School Indicators of Middle School and Schools participating in the PSE.

Furthermore, the effect is more relevant at the initial school grades, a meaningful result confirmed regardless of the method. It is noticed that, applying the nearest neighbor-based approach not replacing NN(1) at the said grades, the proportional failure rate is 1.178 percentual points (pp) lower at schools under the PSE compared to schools not covered by the Program (not participating). By applying the matching method, ATT estimate for dropout rates is 1.039 pp lower than its control group (schools not participating in the PSE) at the initial Middle school grades.

Such a finding reveals the PSE relevance as a positive tool in the selected variables impacting mainly school performance at the initial Middle school grades, typically characterized by the high cognitive potential of children for learning (Cunha, Heckman, Lochner, & Masterov, 2006; Currie & Stabile, 2008; Case, Paxson, & Fertig, 2005; Hass & Fosse, 2008).

In a broader analysis, the positive results of the PSE effect at the initial Middle school grades may, to a certain extent, be related to Program actions that promote healthy eating habits and prevention of childhood obesity, requiring further research to confirm this hypothesis.[2] Studies demonstrate a statistically significant relationship between low school performance and overweight (Izidoro, Santos, Oliveira, & Martins-Reis, 2014).[3]

Having the effect analysis complete, robustness is now evaluated to confirm the findings. To do so, we applied the test developed by Ichino et al. (2008) to investigate the Conditional Independence Assumption (CIA) and the Oster approach (2017) to ensure that observable variables (control) explain the model is not inferring in the treatment effect (control), confirming the not having a Variable bias omitted. Following, the heterogeneous responses to the model are assessed, taking the sample subgroups described in Table 3.

Table 7 shows the results of CIA sensitivity as proposed by Ichino et al. (2008) for failure, dropout, and age-grade distortion total rates. Despite a sharp fall in ATT, the outcomes appoint a decrease in all rates analyzed for all simulations, strengthening the main results.

The Oster test (2017) is presented in Table 8 based on the Probit model of Table 5. This approach assumes that observable variables influence the treatment effect as much as unobservable variables when δ (proportionality coefficient) is less than 1 ($\delta < 1$). Thus, if $\delta \geq 1$, there will be no impact of unobservable on the treatment effect.

[2] It is suggested a deepening in the analysis of the selection criteria (adherence) to the PSE of high schools with a view to a possible endogeneity in the adherence to the program.

[3] Children's performance was evaluated based on the test scores in reading, writing, and arithmetic through the Test for School Achievement – TDE (Izidoro et al., 2014). The Author used Pearson chi-square test for an inferential analysis with a 5% significance level.

Table 7. Sensitivity analysis by Ichino et al. (2008), PSE, Total failure rate, Total dropout rate, and age-grade distortion total rate

	p_{11}	p_{10}	p_{01}	p_{00}	Γ	Λ	ATT	SE
Total failure rate								
In confouder	0.000	0.000	0.000	0.000	–	–	−0.084	0.025
Filtered water	0.840	0.900	0.870	0.820	1.444	0.999	−0.088	0.027
Electricity	1.000	1.000	0.990	0.980	3.943	3.641	−0.083	0.026
Garbage collection	0.010	0.030	0.010	0.010	0.766	1.483	−0.081	0.026
Kitchen	0.990	0.980	0.980	0.990	0.729	1.664	−0.080	0.027
Library	0.460	0.490	0.530	0.590	0.774	0.755	−0.089	0.028
Bathroom	0.140	0.210	0.150	0.180	0.810	1.025	−0.073	0.027
PNE bathroom	0.490	0.560	0.590	0.620	0.890	0.705	−0.088	0.029
Copier equipment	0.540	0.550	0.560	0.610	0.813	0.887	−0.084	0.028
Science laboratory	0.100	0.050	0.190	0.190	0.995	0.418	−0.082	0.027
Student accommodation	0.000	0.000	0.000	0.000	0.801	0.973	−0.080	0.026
Teacher accommodation	0.000	0.020	0.010	0.020	0.550	0.694	−0.080	0.027
Meals	1.000	1.000	1.000	1.000	1.753	0.000	−0.081	0.027
Special assistance room	0.390	0.400	0.390	0.500	0.633	0.935	−0.089	0.028
Special material for *quilombolas*	0.010	0.010	0.000	0.00	0.684	3.270	−0.078	0.027
Special material for indigenous people	0.000	0.000	0.000	0.000	0.395	1.819	−0.079	0.026
Total dropout rate								
No confouder	0.000	0.000	0.000	0.000	–	–	−0.036	0.028
Filtered water	0.850	0.870	0.870	0.860	1.095	1.025	−0.041	0.031
Electricity	0.990	1.000	0.970	1.000	0.090	4.419	−0.032	0.030
Garbage collection	0.020	0.010	0.010	0.010	1.677	1.377	−0.035	0.030
Kitchen	0.980	0.990	0.960	0.990	0.250	1.748	−0.026	0.030
Library	0.430	0.490	0.570	0.520	1.254	0.736	−0.044	0.033
Bathroom	0.110	0.180	0.080	0.190	0.337	1.102	−0.040	0.031
PNE bathroom	0.520	0.490	0.530	0.620	0.713	0.706	−0.044	0.033
Copier equipment	0.520	0.550	0.550	0.580	0.885	0.907	−0.045	0.030
Science laboratory	0.140	0.060	0.270	0.150	2.092	0.382	−0.032	0.032
Student accommodation	0.010	0.000	0.000	0.000	1.854	0.851	−0.028	0.030
Teacher accommodation	0.010	0.010	0.030	0.010	5.257	0.581	−0.039	0.030
Meals	1.000	1.000	0.990	1.000	0.331	0.000	−0.030	0.030
Special assistance room	0.330	0.420	0.310	0.450	0.532	0.976	−0.050	0.032
Special material for *quilombolas*	0.010	0.010	0.010	0.000	3.763	2.876	−0.024	0.030
Special material for indigenous people	0.000	0.010	0.000	0.000	1.575	2.227	−0.024	0.030
Total age-grade distortion rate								
In confouder	0.000	0.000	0.000	0.000	–	–	−0.086	0.029
Filtered water	0.850	0.870	0.820	0.890	0.575	1.101	−0.077	0.032
Electricity	0.990	1.000	0.980	1.000	0.073	4.554	−0.083	0.032
Kitchen	0.980	0.990	0.970	0.990	0.216	1.901	−0.076	0.032
Library	0.430	0.510	0.610	0.490	1.672	0.712	−0.070	0.035
Bathroom	0.120	0.190	0.120	0.180	0.649	1.108	−0.073	0.032
PNE bathroom	0.530	0.480	0.550	0.620	0.764	0.708	−0.078	0.033
Copier equipment	0.540	0.540	0.600	0.540	1.321	0.867	−0.074	0.032
Student accommodation	0.010	0.000	0.010	0.000	2.940	0.807	−0.077	0.031
Teacher accommodation	0.010	0.000	0.020	0.000	13.796	0.505	−0.082	0.032
Meals	1.000	1.000	0.990	1.000	0.360	0.000	−0.075	0.032
Special assistance room	0.360	0.420	0.370	0.440	0.754	0.961	−0.081	0.033
Special material for *quilombolas*	0.010	0.010	0.010	0.000	3.809	2.945	−0.071	0.032
Special material for indigenous people	0.000	0.010	0.000	0.000	3.661	2.150	−0.081	0.032

Note: Columns p_{11}, p_{10}, p_{01}, and p_{00} show the p_{ij} values used to simulate the binary confouder variable (U) for each case; Γ is the odds ratio of the Variable of interest (outcome) for the untreated, considering the effect of U and controlling for the observed covariates (X); Γ represents the treatment odds ratios (T), considering the observed covariates (X). ATT was generated based on the nearest neighbor method (NN1), using U as a covariate. The statistic represents the effect mean in a process repeated 100 times. The SE is the standard error in this statistic (Ichino et al., 2008).

Source: Created by the author based on the Microdata of the Middle School Census, School Indicators of Middle School and Schools participating in the PSE.

Table 8. Oster approach (2017) for PSE effect

Max. R	0.6	0.7	0.8	0.9	1
Total failure rate					
δ for $\beta = 0$	3.33	2.84	2.48	2.19	1.97
Set, Id. ($\delta = 1$)	[0.108; 0.134]	[0.103; 0.134]	[0.097; 0.134]	[0.091; 0.134]	[0.085; 0.134]
total dropout rate					
δ for $\beta = 0$	2.40	2.04	1.78	1.58	1.42
Set, Id. ($\delta = 1$)	[0.132; 0.149]	[0.127; 0.149]	[0.121; 0.149]	[0.113; 0.149]	[0.103; 0.149]
Total age-grade distortion rate					
δ for $\beta = 0$	6.71	5.73	5.00	4.43	4.43
Set, Id. ($\delta = 1$)	[0.222; 0.178]	[0.235; 0.178]	[0.250; 0.178]	[0.269; 0.178]	[0.292; 0.178]

Source: Created by the author based on the Microdata of the Middle School Census, School Indicators of Middle School and Schools participating in the PSE.

It is found that all δ values are more significant than 1, revealing that the control variables have opposite correlations regarding the treatment (PSE) and the outcome variables (failure, dropout, and age-grade distortion rates). This can be observed, for example, for the Variable age-grade distortion total rate, which showed a $R_{\max}$ of 0.6 and a proportionality coefficient of 6.71, denoting that the unobservable variables would have to be 6.71 times more robust than the observable variables to explain the effect of PSE on school performance.

It is also found that, even when increasing $R_{\max}$ to 1, the results remain significant, being the proportionality coefficient of total failure rate 197, total dropout rate 142, and total age-grade distortion rate 443.

The tests of heterogenous response were applied taken subgroup samples[4] of (i) teacher's characteristics, (ii) class characteristics, and (iii) school socioeconomic level. The first subgroup is represented by the rate of teachers holding higher education degree teaching at schools (DSU), teacher effort load (IED), rate of teachers whose training—Full teaching License and BA's—is adequate to the subject they teach (AFD). The second subgroup is represented by the mean of students per class (ATU) and the mean daily class hour (HAD). Finally, the last subgroup is represented by the school socioeconomic level (INSE), subdivided into seven classifications: Very Low, Low, Medium Low, Medium, Medium High, and Very High.

The outcome for all tested subgroups shows that the PSE effect lowers total rates of failure, dropout, and age-grade distortion in schools that adhered

[4] According to Table 3.

to the program compared to those out of the program, confirming the main result.[5]

Analyzing the result of the subgroup "teacher characteristics" (Table 9, Table 10, and Table 11), for instance, it is noticed that the PSE effect is significant in reducing failure rate in all methods.

In Table 9, the estimated ATT for the total failure rate by the nearest neighbor of the Probit Method replacing NN(2) is 658 pp, a number close to the estimate generated by the same method shown in Table 6, −698 pp.

Additionally, Table 10 shows that applying the nearest neighbor method without replacement NN(1), the ratio of failure rate is 714 pp lower in schools participating in the PSE than in schools that did not adhere to the Program, regarding the teacher effort load.

In Table 11, a reduction is found in all rates for schools under the PSE regarding the rate of teachers whose training (full teaching license and BA's degree) to the subjects they teach. It is observed a significant reduction of

Table 9. Heterogeneous Response to PSE effect considering different methods and teachers holding a higher education degree

	Rate of school's teachers holding a higher education degree (DSU)		
	Total failure rate	Total dropout rate	total age-grade distortion rate
Probit Method			
NN(1)	−5.00***	−3.70***	−3.67***
	(0.012)	(0.011)	(0.020)
NN(2)	−6.58***	−3.74***	−5.44***
	(0.009)	(0.009)	(0.015)
Kernel	−8.25***	−4.17***	−7.37***
	(0.006)	(0.006)	(0.007)
LLR	−4.48***	−2.80***	−3.18***
	(0.012)	(0.011)	(0.020)
Logit Method			
NN(1)	−5.46***	−3.89***	−3.80***
	(0.012)	(0.011)	(0.020)
NN(2)	−6.67***	−4.31***	−5.25***
	(0.009)	(0.009)	(0.015)
Kernel	−8.27***	−4.18***	−7.37***
	(0.006)	(0.006)	(0.007)
LLR	−4.49***	−2.81***	−3.19***
	0.012	(0.011)	(0.020)

Note * Significant to 10%; **significant to 5%; *** significant to 1%.

Source: Created by the author based on the Microdata of the Middle School Census, School Indicators of Middle School and Schools participating in the PSE.

[5] Table 6—PSE effect on total rates of failure, dropout, and age-grade distortion.

Table 10. Heterogeneous Response to PSE effect considering different methods and teacher effort

	Teacher effort load (IED)		
	Total failure rate	Total dropout rate	total age–grade distortion rate
Probit Method			
NN(1)	−7.14***	−3.28***	−2.53**
	(0.014)	(0.014)	(0.023)
NN(2)	−7.56***	−3.43***	−3.87***
	(0.011)	(0.012)	(0.017)
Kernel	−9.79***	−5.56***	−6.18***
	(0.008)	(0.008)	(0.010)
LLR	−5.85***	−3.56***	−2.81***
	(0.014)	(0.014)	(0.023)
Logit Method			
NN(1)	−6.81***	−4.23***	−2.71***
	(0.014)	(0.014)	(0.022)
NN(2)	−7.94***	−4.67***	−3.48***
	(0.011)	(0.011)	(0.017)
Kernel	−9.8***	−5.58***	−6.2***
	(0.008)	(0.008)	(0.010)
LLR	−5.79***	−3.54***	−2.84***
	(0.014)	(0.014)	(0.022)

Note * Significant to 10%; **significant to 5%; *** significant to 1%.

Source: Created by the author based on the Microdata of the Middle School Census, School Indicators of Middle School and Schools participating in the PSE.

799 pp in the rate of failure when applying the Kernel method in the sample AFD–bachelor degree.

By applying the Logit Method–Kernel regarding the average student per class rate (ATU), results of the "class characteristic" subgroup (Table 12) show that the ATT for the total age-grade distortion rate estimated for this subgroup is −854 pp, confirming the estimate of the main result (Table 6) by the same method, which is 866 pp.

Results for the "socioeconomic level" subgroup shown in Table 13 show that the ATT has a sharp drop. However, the main result shown in Table 6 for the total age-grade distortion rate generated by the Logit Method-Kernel was −866 pp, a number close to that estimated by the same method for the average socioeconomic level, reported in Table 13, −772 pp.

In addition, the same Table shows that, when the Probit-Kernel method is applied, the PSE effect is significant on the age-grade distortion rate in schools classified in the medium-low socioeconomic level, 969 pp.

Table 11. Heterogeneous Response to PSE effect considering different methods and adequacy of teacher

	Rate of teachers trained for the subject they teach (AFD) – Full Teaching License			Rate of teachers trained for the subject they teach (AFD) – BA degree		
	Total failure rate	Total dropout rate	Total age-grade distortion rate	Total failure rate	Total dropout rate	Total age-grade distortion rate
Probit Method						
NN(1)	−3.80***	−2.12**	−4.79***	−6.44***	−3.73***	−2.42**
	(0.013)	(0.012)	(0.021)	(0.018)	(0.017)	(0.027)
NN(2)	−3.96***	−2.15**	−5.16***	−6.80***	−3.11***	−2.90***
	(0.010)	(0.010)	(0.016)	(0.015)	(0.014)	(0.021)
Kernel	−3.71***	−1.71*	−8.12***	−7.99***	−3.56***	−4.31***
	(0.006)	(0.006)	(0.007)	(0.011)	(0.011)	(0.014)
LLR	−1.98**	−1.12*	−3.04***	−4.80***	−2.28**	−2.06**
	(0.013)	(0.012)	(0.021)	(0.018)	(0.017)	(0.027)
Logit Method						
NN(1)	−3.37***	−1.75*	−4.55***	−6.62***	−2.99***	−2.61***
	(0.013)	(0.012)	(0.021)	(0.018)	(0.017)	(0.027)
NN(2)	−3.61***	−1.82*	−4.89***	−7.18***	−2.38	−3.03***
	(0.010)	(0.010)	(0.016)	(0.015)	(0.014)	(0.021)
Kernel	−3.71***	−1.70*	−8.13***	−8.00***	−3.59***	−4.30***
	(0.006)	(0.006)	(0.007)	(0.011)	(0.011)	(0.013)
LLR	−2.00**	−1.15*	−3.08***	−4.83***	−2.30**	−2.09**
	(0.013)	(0.012)	(0.021)	(0.018)	(0.017)	(0.027)

Note * Significant to 10%; **significant to 5%; *** significant to 1%.

Source: Created by the author based on the Microdata of the Middle School Census, School Indicators of Middle School and Schools participating in the PSE.

Table 12. Heterogeneous Response to PSE effect considering different methods and class characteristics

	Average of student per class (ATU)			Average of daily class hour (HAD)		
	Total failure rate	Total dropout rate	Total age-grade distortion rate	Total failure rate	Total dropout rate	Total age-grade distortion rate
Probit Method						
NN(1)	−6.71***	−4.99***	−4.80***	−9.29***	−3.51***	−3.84***
	(0.014)	(0.013)	(0.019)	(0.014)	(0.015)	−0.033
NN(2)	−8.32***	−5.59***	−6.61***	−10.41***	−4.84***	−4.98***
	(0.011)	(0.010)	(0.015)	(0.012)	(0.012)	−0.025
Kernel	−12.03***	−7.03***	−8.56***	−11.19***	−5.37***	−6.83***
	(0.007)	(0.007)	(0.009)	(0.009)	(0.009)	−0.013
LLR	−6.03***	−4.02***	−4.14***	−7.17***	−3.38***	−2.61***
	(0.014)	(0.013)	(0.019)	(0.014)	(0.015)	−0.033
Logit Method						
NN(1)	−6.85***	−5.08***	−4.90***	−8.88***	−2.66***	−2.85***
	(0.014)	(0.013)	(0.019)	(0.015)	(0.015)	(0.033)
NN(2)	−8.52***	−5.96***	−6.58***	−10.44***	−3.90***	−3.93***
	(0.011)	(0.010)	(0.015)	(0.012)	(0.012)	(0.025)
Kernel	−12.03***	−7.03***	−8.54***	−11.16***	−5.35***	−6.80***
	(0.007)	(0.007)	(0.009)	(0.009)	(0.009)	(0.012)
LLR	−6.01***	−3.96***	−4.13***	−7.08***	−3.37***	−2.61***
	(0.014)	(0.013)	(0.019)	(0.015)	(0.015)	(0.033)

Note * Significant to 10%; **significant to 5%; *** significant to 1%.

Source: Created by the author based on the Microdata of the Middle School Census, School Indicators of Middle School and Schools participating in the PSE.

Table 13. Heterogeneous Response to PSE effect considering different methods and school socioeconomic level (NSCE)

	Total Failure Rate					Total Dropout Rate					Age-Grade Distortion Total Rate				
NSCE	Very Low	Low	Medium Low	Medium	High Medium	Very Low	Low	Medium Low	Medium	High Medium	Very Low	Low	Medium Low	Medium	High Medium
Probit Method															
NN(1)	−3.48***	−2.09**	−2.89***	−4.35***	−2.13**	−2.10**	−2.10**	−2.94***	−2.27**	−2.10**	−2.10**	−2.08**	−3.82***	−3.49***	−2.08**
	(0.033)	(0.024)	(0.015)	(0.022)	(0.042)	(0.033)	(0.033)	(0.017)	(0.016)	(0.024)	(0.032)	(0.029)	(0.026)	(0.034)	(0.038)
NN(2)	−3.75***	−3.11***	−3.37***	−4.51***	−1.55*	−3.19***	−2.01**	−2.59***	−3.01***	−2.49***	−2.00**	−2.73**	−5.63***	−4.32***	−2.37**
	(0.029)	(0.021)	(0.012)	(0.017)	(0.035)	(0.033)	(0.028)	(0.014)	(0.013)	(0.018)	(0.028)	(0.024)	(0.019)	(0.024)	(0.028)
Kernel	−3.93***	−4.32***	−4.51***	−5.88***	−2.28**	−4.53***	−2.22**	−3.56***	−3.62***	−2.46**	−2.10**	−2.52**	−9.69***	−7.66***	−2.97***
	(0.025)	(0.016)	(0.008)	(0.010)	(0.026)	(0.027)	(0.021)	(0.010)	(0.009)	(0.013)	(0.023)	(0.018)	(0.010)	(0.010)	(0.016)
LLR	−2.88***	−2.96***	−2.39**	−2.82***	−1.50*	−3.28***	−1.87*	−1.98**	−1.85*	−1.27*	−1.60*	−1.98**	−3.84***	−2.36**	−1.30*
	(0.033)	(0.024)	(0.015)	(0.022)	(0.042)	(0.038)	(0.033)	(0.017)	(0.016)	(0.024)	(0.032)	(0.029)	(0.026)	(0.034)	(0.038)
Logit Method															
NN(1)	−3.25***	−2.02**	−2.21**	−4.35***	−2.61***	−2.69***	−2.07**	−2.38**	−2.52**	−2.64***	−2.28**	−1.89*	−3.93***	−3.37***	−2.13**
	(0.034)	(0.023)	(0.015)	(0.022)	(0.042)	(0.039)	(0.031)	(0.016)	(0.017)	(0.025)	(0.031)	−0.030	(0.026)	(0.034)	(0.038)
NN(2)	−3.8***	−2.97***	−3.06***	−4.79***	−1.58*	−3.39***	−1.90*	−3.45***	−3.13***	−2.04**	−1.95**	−2.08**	−5.91***	−4.48***	−2.61***
	(0.029)	(0.020)	(0.012)	(0.017)	(0.034)	(0.033)	(0.027)	(0.014)	(0.013)	(0.018)	(0.028)	(0.025)	(0.019)	(0.024)	(0.028)
Kernel	−3.92***	−4.23***	−4.49***	−5.89***	−2.14**	−4.44***	−2.15**	−3.62***	−3.63***	−2.41**	−2.05**	−2.50**	−9.67***	−7.72***	−2.90***
	(0.025)	(0.016)	(0.008)	(0.010)	(0.026)	(0.027)	(0.021)	(0.010)	(0.009)	(0.013)	(0.023)	(0.018)	(0.010)	(0.009)	(0.016)
LLR	−2.78***	−3.05***	−2.40**	−2.84***	−1.42*	−3.14***	−1.93*	−2.12**	−1.79*	−1.20*	−1.62*	−1.93*	−3.87***	−2.36**	−1.30*
	(0.034)	(0.023)	(0.015)	(0.022)	(0.042)	(0.039)	(0.031)	(0.016)	(0.017)	(0.025)	(0.031)	(0.030)	(0.026)	(0.034)	(0.038)

Note * Significant to 10%; **significant to 5%; *** significant to 1%.

Source: Created by the author based on the Microdata of the Middle School Census, School Indicators of Middle School and Schools participating in the PSE.

In summary, after applying the PSM method with different algorithms, the results showed that the PSE reduces total rates of failure, dropout, and age-grade distortion. Such results were confirmed by applying the ASD sensitivity approaches created by Ichino et al. (2008) and Oster (2017). Further, the heterogeneous response tests showed a reduction in all rates, regardless of the sample subgroup, reinforcing the main result.

6. Conclusions

This study estimated the effect of the School Health Program (PSE) on the total rates of failure, dropout, and age-grade distortion based on microdata from the School Census and Educational Indicators, published by the National Agency for Education and Research (INEP, 2019), and the list of public schools agreed in 2017 with the PSE, provided by the Ministry of Education (MEC, 2019). The Propensity Score Matching (PSE) method was used, applying sensitivity analyses proposed by Ichino et al. (2008) and Oster (2017), in addition to heterogeneous responses tests using sample subgroups. In addition, fixed effects of State, Region, Mesoregion, and Microregion were included in the model to correct endogeneity issues.

It was observed that the PSE impacts the reduction of failure, dropout, and age-grade distortion rates, which are significant and stand out with greater intensity in the total failure rate. Furthermore, it was noted that the magnitude of the effect is more critical in the initial grades of middle school (1^{st} to 5^{th}) compared to the final grades (6^{th} to 9^{th}). The findings regarding the initial grades may be related, to some extent, with the implementation of the Program's actions to promote healthy eating and prevention of childhood obesity in the school environment, lacking further research to confirm this hypothesis.

The ASD sensitivity approach proposed by Ichino et al. (2008) indicated robust results for the PSE effect on total rates of failure, dropout, age-grade distortion. In the approach of Oster (2017), it was found that the model control variables have an opposite correlation with the treatment (PSE) and with the result variables, reinforcing the robustness of the results.

The heterogeneity analysis covering sample subgroups of teacher characteristics, class characteristics, and school socioeconomic level showed a reduction in the total rates of failure, dropout, and age-grade distortion in schools that adhered to the PSE for all simulations, reinforcing the main result. This analysis observed a shar in the Average Treatment Effect on the Treated (ATT) of the "socioeconomic level" subgroup. However, the result for total drop age-grade distortion rate, estimated in the main result by the Logit Method-Kernel, was close to the one estimated by the same method for the medium socioeconomic level.

Finally, it should be underlined that the present study is based on the PSE effect at school level. Therefore, it is suggested to deepen the effect analysis considering the Program's actions on student performance since such analyzes may be relevant for future research.

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