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Miora Rakotonirainy,
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By

Miora Rakotonirainy,

Olivier Ramiandrisoa

and
Marilys Razakamanana

Centre de Recherche pour le Développement,
Catholic University of Madagascar

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Abstract

Implementing a school feeding programme to support education is common practice in most States, particularly in developing countries. One of the aims of the programme is to help improve educational outcomes for pupils. Although there is a relationship between the school feeding programme and educational outcomes, the programme does not necessarily lead to its effectiveness. This paper therefore aims to shed more light on the factors that explain the performance of the school feeding programme and its effects on pupils' learning outcomes at the end of primary school by studying the case of Madagascar. The results reveal the limited impact of the school canteen programme on pupils' and mathematics scores. Analyses revealed that while school feeding improves pupils' reading skills, it has no significant effect on their mathematical skills. It was also noted that although the impact of the programme was not palpable for public primary schools, a modest improvement in school results was observed for pupils in private schools. This research work concludes that the effectiveness of the school canteen programme also depends on multiple criteria linked to the environment of the target pupils. It will be difficult for the programme to achieve its full effectiveness in terms of school performance as long as the socio-economic context of the pupils remains critical and the quality of teaching remains low.

Key words: *Madagascar, school canteen programme, school performance*

1. Introduction

A number of governments and organisations are opting for a policy of supporting school feeding to improve children's nutritional status, health and educational performance, particularly in developing countries. Yet malnutrition remains a major public health problem among children, particularly in developing countries. A balanced diet during childhood is not only important for healthy growth, but is also considered to be a major factor in future success at school, (Glewwe, 2002).

However, developing countries, particularly those in Sub-Saharan Africa, are marked by child malnutrition and food insecurity (UNICEF, 2019). In terms of education, pupils in developing countries tend to perform poorly academically (Glewwe and Kremer 2006, Hanushek and Woessmann, 2008). To support primary school pupils by helping to improve their nutritional situation and their performance at school, several states have implemented school food support programmes.

The literature on the evaluation of school food support programmes in terms of educational performance is quite extensive, but the effects are still mixed. Some studies have shown that the provision of free school meals leads to better academic performance (McEwan (2013), Rothbart et al. (2020)). While others have pointed to the absence of any significant effect of school meal programmes on pupils' academic results (Hinrichs (2010), Imberman and Kugler (2014)). Although the school nutrition programme increases the food consumption and nutritional intake of beneficiary children, its effect on school results does not necessarily correspond to an improvement in the latter (Schanzenbach and Zaki (2014), Gundersen and Kreider (2009)).

Other factors also influence brain development and affect educational outcomes, such as education and household standard of living (Nyaradi et al., 2013) (Akubuilo et al., 2020), the quality of education (Glewwe, 2013), and the socio-economic environment of households (Glick et al. 2011). Some studies point out that the effect of the school feeding programme on returns to education varies according to the socio-economic environment, with the impact more apparent in rural areas (Fang & Zhu, 2022). Other studies mention the positive impact of the programme on school performance among pupils living in disadvantaged socio-economic situations or in low-income households (Dahl & Lochner, 2012). There are also studies that have pointed out that the impact of the programme varies according to the school environment (Dotter (2013); Imberman and Kugler (2014)).

It is in this context that this paper seeks to analyse the extent to which the implementation of the school canteen programme promotes the academic success of pupils in primary schools in Madagascar. This paper contributes to the development of the literature on the school canteen programme by attempting to provide more explanation on the effectiveness of the programme according to the context and the socio-economic environment of the pupils.

2. Primary education and the school canteen programme in Madagascar

Primary education in Madagascar

Education is at the heart of the country's concerns. It is one of its greatest challenges. This can be seen from the fact that education is commonly highlighted in the various national development plans, besides the implementation of different education plans. These include the Educational Sector Plan (Plan Sectoriel de l'Education ou PSE) (2018-2023), which is being implemented by the education Ministry and aims above all to improve quality (learning), access and governance; and the Basic Education Support Project (Projet d'Appui à l'Education de Base - PAEB), which is an extract from the PSE, and which contains the priorities and outlines the main educational policy guidelines for achieving the main objective of raising the primary school completion rate, while focusing on improving early learning.

In Madagascar's education system, formal education up to the baccalauréat constitutes basic education: 1 (primary), basic education 2 (collège) and secondary education (lycée). Primary education takes five years, collège four years, and secondary education or lycée, three years. Since the school canteen programme is implemented at primary school level, our study focuses on the primary education levels.

In primary schools, pupil numbers have grown more or less steadily, with an average annual growth rate of 0.04% between the 2013/2014 and 2017/2018 school years. A decrease in the gross enrolment rate was noted during the three years of 2017, 2018 and 2019, ranging from 150% to 115% (MEN, 2019). In 2019, the primary gross enrolment rate was 142.5% and the net enrolment rate is 95.6%. Although the school attendance rate is 76% (MICS, 2018), the average completion rate is 56%, varying from 82% to 25%, depending on the region (INSTAT, 2019).[4]

The number of public school teachers represents around 76% of all teaching staff at primary level, and public school classrooms around 73% of the total for all sectors combined (public and private). Pupil-teacher ratios for the public sector are well above the norm (45), while pupil-teacher ratios for the private sector have stabilised at around 33 (MEN, 2022).

Access to education in Madagascar remains a major challenge, given the various difficulties encountered, such as the lack of human and financial resources, and limited school equipment and infrastructure.

The school canteen programme in Madagascar

Although most people live in low- or middle-income countries, including Sub-Saharan Africa (UNICEF, 2021)[5], Madagascar is one of the four (4) countries most affected by hunger in the world (von Grebmer et al., 2019). The country's population suffers in particular, from chronic malnutrition and ranks 3rd in sub-Saharan Africa (UNICEF, 2019). To provide food assistance to pre-school and primary school pupils during school days, the school canteen programme has been implemented by the state, as in most countries around the world. The importance attached to this school feeding support programme is justified by its inclusion in the country's various policies, namely the Educational Sector Plan (2018-2022) and the National Nutrition Plan (2017-2021).

In November 2017, the National Assembly adopted the National School Feeding Policy 2016-2021 (PNAS), one of whose specific objectives was to contribute to improving learning capacity and indicators of school access and performance with reference to the objectives of the Educational Sector Plan (PSE), by reducing hunger among pupils in public primary schools. Since 2017, several changes and updates have been made to the PNAS: the National Nutrition Action Plan (PNAN) including the nutrition dimension, then the National Nutrition Action Plan (PNAN III 2016-2021), and finally the National School Food, Nutrition and Health Programme (PNANSS) with, in particular, the introduction of a school health record for each child including monitoring of deworming, oral health, weight and cognitive status (WFP, 2019).

The school feeding programme is implemented by the Ministry of Education with the support of technical and financial partners, in particular the World Food Programme (WFP)[6]. The programme is based on the fact that school feeding is the 3rd most effective interventions for increasing school enrolment in Africa and improving learning outcomes[7]. The school canteen programme aims to contribute to the improvement of three sectors: education, nutrition and social protection. In terms of education, the programme aims to improve the attendance rate of school-age children, reduce the drop-out rate and contribute to improving the school success and completion rate, and finally to improve the concentration and learning capacity of pupils in assisted schools, by reducing so-called immediate or temporary hunger (WFP, 2019). The canteen's aim to cover one-third of pupils' daily macronutrient and micronutrient requirements. The expected impact is measured on children's school life through an increase in the duration and quality of education, as well as on their productivity.

In 2018, 6% of Malagasy primary schools had a canteen, covering 9% of pupils enrolled (WFP, 2019). This corresponds to 1,373 primary schools with a canteen, or 354,000 pupils out of the 4 million primary school children throughout the country who benefiting from one meal a day at school (WFP, 2019)[8]. The levels of education covered by the school canteen programme are pre-school, for children aged 3 to 5, and primary, for children aged 6 and over.

There are also community-run canteens, the number of which is yet to be established by the Ministry of National Education's School Canteen Project Coordination Unit (WFP, 2019). School canteens aim to cover a third of daily requirements in macronutrients (protein, carbohydrates, lipids) and 50% in micronutrients (vitamins and minerals). Every primary school pupil, and pre-school pupil since 2018, receives a hot meal, served 5 days out of 5 throughout the school year. The ration partly remedies the child's nutritional deficiencies and helps to improve his or her development. This programme not only provides a safety net for families, but also encourages pupils to attend school, especially in areas of high food insecurity.

3. Literature review

Nutrition, school food and performance

Studies have been carried out to determine the relationship between nutritional status and children's performance at school (e.g. Glewwe et al., 2001; Victora et al., 2008) (Abebe et al., 2017) (Nyaradi et al., 2013) (Akubuilo et al., 2020). They have shown that children with a healthy diet perform better at school. Some studies have highlighted the significant and direct impact of diet on pupils' behaviour, cognitive abilities and ability to attend school (Lambert et al., 2004; Sorhaindo and Feinstein, 2006). Nyaradi et al (2017), examining the link between nutritional intake and neurocognitive development during childhood, found that malnutrition can adversely affect cognitive development. In fact, nutrition plays an important role in brain development throughout life (Akubuilo et al., 2020) and these interventions early in life are indeed optimally effective (Wu et al., 2020).

Abebe el at. (2017) worked on the determinants of school performance with a focus on malnutrition among primary school pupils. The authors highlight the existence of a correlation between school performance and malnutrition. Pupils who were stunted and underweight were less likely to perform well at school compared with pupils who did not have these characteristics. Shree and Murthy (2021) have shown that increasing children's nutritional status in turn increases their success at school. In contrast, the work of Akubuilo et al (2020) found no negative effect of malnutrition on the academic performance of pupils in Nigerian primary schools.

Although nutritional status plays an important role in students' cognitive development, other factors also affect their performance at school, including the socio-economic characteristics of households, the school environment and the quality of teaching (Glewwe and Kremer (2006), Dahl and Lochner (2012) Glick et al. (2011)). Students whose parents were educated were more likely to perform well in school than those whose parents were not educated and students from households with high monthly income were more likely to perform well in school than students from households with low monthly income (Abebe et al.,2017)

The literature on the school feeding programme shows different results regarding the effectiveness of the programme on educational outcomes. Some studies have found some improvement in educational attainment and academic performance for disadvantaged populations as a result of the school feeding support programme

(Schwartz and Rothbart, 2017). Dotter (2013) shows that the school breakfast programme improves achievement scores in maths and reading. Frisvold (2015) found that participation in the school feeding programme improved students' test scores in maths, reading and science. Fang and Zhu (2022), studying the effect of school feeding on education and health outcomes in rural China, found that the programme has an effect on the long-term benefits to the education of pupils.

According to the literature, the programme's effectiveness on school results can be explained by the improvement in pupils' nutrition, which in turn contributes to brain improvement (Bryan et al., 2004; Victora et al., 2008; Wu et al., 2020). And if the school meal improves the brain, this in turn helps to increase the completion rate. The availability of canteens in schools can also reduce pupils' absenteeism or being late to school. In fact, pupils arrive earlier and are always present at school for the free meal. Hinrichs (2010) found an improvement in the completion rate of pupils participating in the canteen programme due to increased attendance. Bhattacharya et al. (2006) note that school canteens for pupils is similar to the increase in income for households with children benefiting from the programme. And the increase in household income improves school results, particularly for pupils from disadvantaged backgrounds (Dahl and Lochner (2012), Fang and Zhu (2022)).

However, other studies have found little or no effect of the programme on pupils' outcomes. Hinrichs (2010), investigating the effect of participation in the National School Meal Programme on health and education, found that the programme had no effect on long-term health and no palpable effect on educational outcomes. Bartlett et al. (2014), and Schanzenbach and Zaki (2014) found no effect of breakfast on school results. Alongside this, other authors find that test scores of pupils in groups eligible for the free school meal scheme are relatively low, means-tested (Gordon et al., 2018). Bhattacharya, et al. (2006) point out that school meals do not have a significant effect on results in terms of nutritional intake and reading test results in general, despite the existence of a positive effect on nutritional intake during breakfast. In fact, the availability of school meals improves nutrition (Bhattacharya et al., 2006), but there is very little evidence on the relationship between the school feeding programme and the academic performance (Fox et al., 2004). Fang and Zhu (2022) found an improvement in long-term school performance as a result of the school feeding programme in rural China, while the authors found no effect of the programme in urban areas. Furthermore, even if the school canteen programme is intended to support pupils' diets during school days, it is possible that these children with access to the programme eat less at home (Imberman & Kugler, 2014).

To assess the impact of the school feeding programme on educational outcomes, most of the literature compares the effect of the programme on academic achievement for eligible and non-eligible programme participants before and after the implementation of the programme (Fang and Zhu (2022), Frisvold (2015), McEwan (2013)) using the double difference method. Glewwe and Maïga (2011), to assess the impact of the school management reform programme in Madagascar

used simple regression for cross-sectional data. They found that the programme was ineffective on pupils' test scores and that test scores did not vary according to teacher type.

Other determinants of educational success

Educational success is a complex phenomenon, and this has been demonstrated in the literature. Although pupils' performance is primarily influenced by individual characteristics, the impact of the socio-economic and cultural environment is also fundamental (Bakker et al., 2007; Marks 2006; Teodorovic 2012). The socio-economic conditions of the area are essential for understanding pupils' results, as they influence the family context. This effect is reciprocal: a country's educational results influence the country's development. Several studies have shown that socio-economic inequality tends to increase the presence of inequality in educational outcomes (Checchi and Peragine, 2010). Rodriguez-Posè and Tselios (2009) have shown that education can have an impact on economic inequality at regional level.

Many studies in the field of education have recognised the importance of economic, social and cultural status as a determinant of the learning process (Schutz et al.2008; Giambona and Porcu, 2015). Agasisti and Vittadini (2012) have shown that great variability in student outcomes can be explained by contextual and regional factors. In particular, the composition of the school's student body, in terms of socio-economic and cultural background, matters more than the school's resources. Several studies have acknowledged that the impact of socio-economic and cultural situation of households (e.g. parents' occupation, parents' education, mother's work, number of children in the family, educational practices, etc.) on school performance varies according to region (Matteucci and Mignani, 2014).

At school level, several factors can explain the disparities in performance. These include teacher quality, class size and school environment. According to Basque (2018), school success is explained by students' previous results, the quality of teaching and their socio-economic status. School success is also determined by the quality of teaching and pupils' motivation and commitment. Other studies also suggest that the relationship between teacher and pupils has an impact on educational success (Roorda, Koomen, Spilt, & Oort, 2011, Hajovsky et al. (2017). With regard to class size, the literature is not unanimous about its effects on results. Some studies have shown that pupils' performance decreases as class size increases (Lee and Loeb 2000; Wasley et al., 2000); while others have asserted a positive effect (Luyten, 2014; Victora et al., 2014). However, the heterogeneity of the effects of small schools on pupils' performance and engagement is demonstrated in several studies (Leithwood and Jantzi 2009; Weiss et al., 2010; Schwartz et al., 2013); Thomas et al., (2020).

4. Methodology

We estimate the impact of schools' participation in the school canteen programme on pupils' maths and reading scores.

Model

Based on the models used by Frisvold (2015) and Glewwe and Maïga (2011), the following regression is used to measure the effect of the school canteen programme on pupils' academic results:

$$Y_{ij} = \beta T_{ij} + \delta X_{ij} + u_{ij} \quad (1)$$

Where Y_{ij} is the results of the pupil *i* in the school *j,* i.e. the pupil's maths and language test scores. T_j is a binary variable indicating the status of the school, i.e. whether the pupil *i* is in school *j* that benefits from the school canteen programme or not. X_{ij} is the vector of control variables which group together the pupil's individual data, the characteristics of the school and those of the household. In this regression, β is the coefficient of interest in this specification, representing the impact of the programme on pupils' test scores. u_{ij} is the error term.

Given that the outcome variables of the school canteen programme in this paper are the mathematics and reading scores of the pupils, the decomposition of equation (1) is as follows:

$$Math\_score_{ij} = \sigma T_{ij} + \theta X_{ij} + u_{ij} \quad (2)$$

$$Language\_score_{ij} = \alpha T_{ij} + \gamma X_{ij} + \varepsilon_{ij} \quad (3)$$

Data description

To estimate the impact of the school canteen programme on pupils' academic results, individual data from the CONFEMEN Education System Analysis Programme (Programme d'Analyse du Système Educatif de la CONFEMEN[9] (PASEC) database for 2019 were used. PASEC is a grouped evaluation of the CONFEMEN Education System Analysis Programme. It involves collecting data in randomly selected schools from

pupils at the beginning of primary school (grade 2) and the end of primary school (grade 6) using tests measuring language and mathematical skills. Data was also collected from teachers and school headmasters using contextual questionnaires relating to school management. In the case of Madagascar, the sample is made up of 265 schools selected at random from different regions of the country. Then, 25 pupils were randomly selected in one school. In total, the survey sample is made up of 1,883 pupils in grade 2; 4,758 pupils in grade 6; 1,390 teachers and 263 school headmasters (PASEC, 2019).

Treatment and control groups

The treatment group is made up of pupils from schools that have taken part in the school canteen programme, i.e. that have a free canteen. These schools are located in 9 of the country's 22 regions[10]. The control group is made up of pupils from schools that have not benefited from the programme (i.e. do not have a free canteen) in the same regions concerned and which are located in the same geographical areas as the treatment (city, suburb, large village or small village). In other words, the schools in the control group are selected so that they are located in the same areas as the treated schools in the same Region or in another Region with the same geographical and climatic characteristics as the treated Region concerned.

The pupils concerned are those in grade 6, i.e. at the end of primary school. The treatment group consisted of 356 pupils in 22 schools, and the control group of 770 pupils in 39 schools. In total, the sample comprised 1,126 observations.

Estimation method

This paper attempts to estimate the impact of school participation in the school canteen programme on scores through the Average Treatment Effects (ATEs) of the intervention. To balance the observable criteria of the covariates of the treatment and control groups, the Propensity score Kernel matching is used.

In estimating the Average Treatment Effects (ATE) or the Intention to treat (ITT), all pupils enrolled in the schools selected for the school canteen programme are treated as having benefited from the programme, defined as follows :

$$ITT = Moyenne[Y(i,1) - Y(i,0)];$$

where $Y(i,0)$ is the counterfactual scenario or control group. A diagnosis of the balance on the observed factors or covariates between the treatment group and the control group is made using the kernel density plot which compares the Propensity scores before and after matching.

Given that each impact estimation technique provides different results on the impact of the evaluation, we conducted a sensitivity analysis, as a robustness check, to show that even if different procedures were used, the results of the intervention impact evaluation remain the same. The following sensitivity analyses will be used: Mahanobis Nearest-Neighbor Matching and propensity score matching. The choice of combining these two methods stems from the structure of this evaluation. In fact, the present evaluation of the school canteen programme in this paper is not a pre-post intervention approach. In other words, there is no baseline or pre-intervention data. As a result, we have opted for more rigorous statistical impact evaluation methods to better quantify the impact of the intervention in the absence of pre-intervention baseline data.

An Ordinary Least Squares estimate will also serve as a benchmark for the programme's impact results.

Description of variables

Variables of results : To capture the effect of participation in the school canteen programme on academic achievement, the test results of pupils at the end of primary school, i.e. Grade 6, were used. The tests have two components: mathematics and languages. The test scores used are obtained from the arithmetic mean of the scores of five different tests in mathematics and languages. Apart from the overall scores, the PASEC data defined hierarchical levels of student performance for each subject, making it possible to understand the tasks that pupils are capable of achieving or doing at a given 'level' on the skills scale. These levels are hierarchised in such a way that a pupil who performs at one level is also capable of succeeding at tasks at lower levels. In other words, the lower levels of the scale for a subject require less complex tasks than the higher levels. (PASEC, 2019).

Our variable of interest is the participation of schools in the school canteen programme. To do this, the data provides information on schools with a free canteen. For such schools, all pupils receive a free meal, regardless of level. This is a binary variable, with 1 being the schools that have a free canteen and 0 being the schools that do not.

The control variables are made up of individual pupils information, household characteristics (Nazmul and Riddhi (2018), Dahl and Lochner (2012), school characteristics including individual teachers and headmasters informations (Glewwe and Kremer (2006), Glick et al., (2011)) (see Table 1). A classroom equipment index was used for any teaching equipment and resources available in the classroom. With regard to household characteristics, the socio-economic index summarising the socio-economic situation of households for each pupil was used. These indices were already provided in the survey database.

Table 1: Details of control variables used

Control variables	Questionnaire response procedures
Individual pupil information	
Age	
Gender	1.Boy, 2.Girl
Having completed pre-primary school	1.Yes, 2.No
School features	
Number of years' teaching experience before becoming headmaster	
Teacher training as a headmaster in the last two years	1.Yes, 2.No
Teacher's gender	1.Male, 2.Female
Teacher's level of academic training	Primary, Lower secondary, Upper secondary, Baccalaureate and above. Categorised from 1 to 12 according to level
Number of years of teaching experience	
Length of initial teacher training	1.No initial professional training, 2.Less than six months, 3.One year, 4.Two years, 5.Three years, 6.More than three years
School status	1 Public, 2 Private
School with double-flow or double-shift classrooms	1.Yes, 2.No
School location	Your school is located in a :
1.City, 2. City suburbs, 3. Large village, 4 small village	
Class equipment index	
Family features	
Socio-economic index of households	

Source: Authors.

5. Results

Descriptive analysis

Table 2 summarises the descriptive statistics on individual data for pupils at the end of primary school. In our sample, 356 pupils attended schools with free canteens and 770 pupils attended schools without free canteens. The average age of these pupils at the end of primary school was 12.5 years, and most of them were boys. On average, the pupils had not attended pre-primary school, whether they were enrolled in schools with or without a canteen.

The average mathematics test score of pupils in schools selected for the school canteen is lower than that of pupils in non-beneficiary schools (443.6 compared with 465.6 respectively). The average language scores are almost the same for beneficiary schools (451.2) and non-beneficiary schools (450.7), although those for schools with canteens are slightly higher. Most primary schools are more disadvantaged in terms of school facilities. In addition, the pupils live in households with a disadvantaged socio-economic environment.

School headmasters have an average of 11.5 years of teaching experience before becoming a headmaster. Most of them had not received any teacher training in the previous two years (average=1.5). The teachers in these primary schools had a high school education on average, both for schools with canteens and those without (average=4.5). However, on average, these teachers had not undergone any initial teacher training. Most of the teachers in all the schools were men. In terms of experience, teachers in schools with a canteen had on average more years of experience (13.2) than those in schools without a canteen (9.8).

Table 2: Summary of descriptive statistics for variables

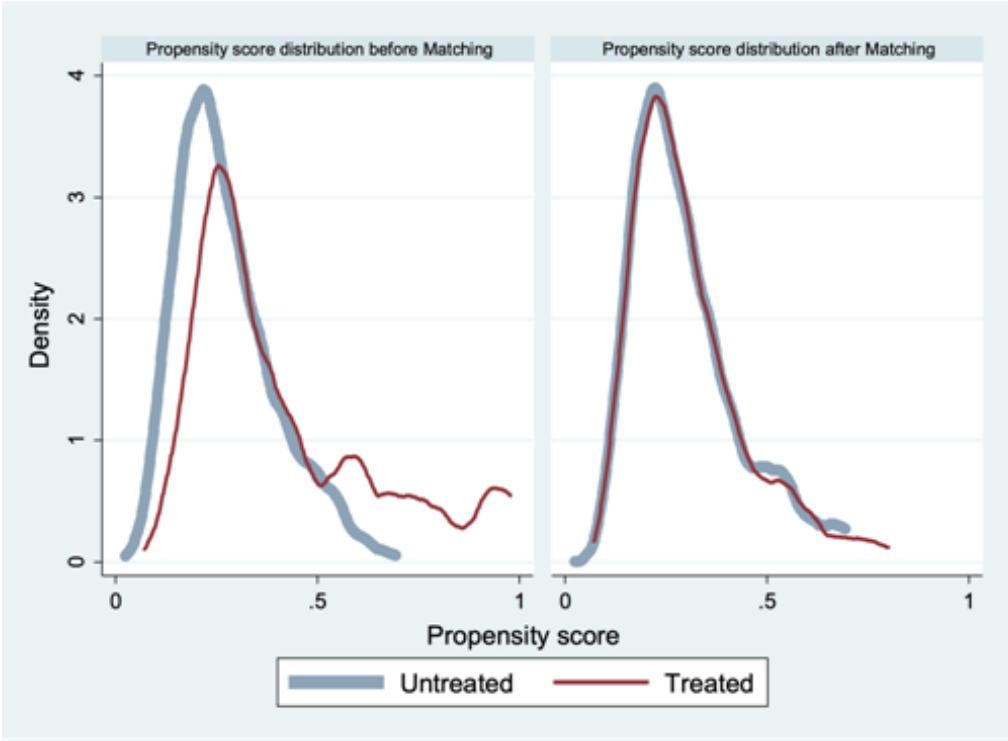
	All schools (1)		Schools with free canteen (2)		Schools without free canteen (3)	
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
Scores in maths	458.6	72.4	443.6	78.6	465.6	68.2
Scores for languages	450.9	61.0	451.2	70.9	450.7	55.8
Individual student details						
Age of pupil	12.5	2.9	13.2	4.5	12.2	1.5
Gender (boy)	1.5	0.5	1.5	0.6	1.5	0.4
Having completed pre-primary school	2.1	1.8	2.2	1.9	2.0	1.7
School features						
Number of years' experience of the school Headmaster	11.5	9.0	12.2	9.7	11.2	8.6
Headmaster with pedagogical training	1.5	1.0	1.4	0.5	1.6	1.1
Gender of the teacher (male)	1.8	1.0	1.8	1.0	1.8	1.1
Teacher's level of education	4.5	1.8	4.6	2.1	4.4	1.7
Number of years' experience of the teacher	10.9	7.5	13.2	9.6	9.8	6.0
Teacher training	1.7	1.1	1.6	0.9	1.8	0.9
School status	1,2	1.2	1.5	1.7	1.1	0.3
Double flow or double vacation classrooms	1,6	0.47	1.65	0.4	1.6	0.4
Location	3.3	0.8	3.1	0.9	3.4	0.8
Class equipment index	49.9	9.2	49.6	9.7	50.0	9.0
Socio-economic features of households						
Socio-economic index	44.21	7.2	43.1	7.1	44.4	7.2
Number of observations	1 126		356		770	

Source : Authors

Result of balancing the treatment and control groups (matching)

After balancing the socio-economic characteristics between the treatment and control groups, the sample is composed of 676 individuals, including 157 students in the treatment group and 519 in the control group. The results of the matching are presented in Figure 1.

Figure 1: Kernel density propensity score before and after matching of treatment and control groups.



Source : Authors

Estimation results

- **Impact of the school canteen programme on pupils' learning skills**

Table 3 presents the results of specifications (2) and (3) on the impact of the school canteen programme using the regression adjustment based on the propensity score, as well as the results of the sensitivity analysis. The values in brackets are the standard errors.

Table 4 shows the impact of the school canteen programme on pupils' test scores at the end of primary school, using the OLS estimator which will be used for benchmarking in our analysis. The coefficients of the variable of interest in columns (1) and (2) all show a negative and significant relationship between participation in the free canteen and mathematics test scores, while a positive and significant effect is noted on reading score results.

In table 3, based on the results of the regression adjusted on the propensity score, the school canteen programme improves pupils' results in reading by 0.20 percentage points, but does not improve scores in mathematics, with a reduction in scores of -0.12 percentage points (Table 4). In other words, pupils who receive a free canteen at school tend to have lower maths test results than pupils in schools without a canteen.

Table 3: Results of the impact of the school canteen programme using regression adjustment based on the propensity score and sensitivity analyses

Method for estimating impact	Scores in maths	Scores for languages
	ATE (p-value)	ATE (p-value)
Regression Adjustment based on propensity score	-0.12*	0.20***
	(0.054)	(0.005)
Sensitivity analysis		
Regression Adjustment based on the Mahalanobis distance	-0.11*	0.17***
	(0.060)	(0.006)
Propensity score matching (PSM)	-0.34***	0.05
	(0.002)	(0.430)
PSM with Nearest-Neighbor Matching 1:3	-0.29***	0.003
	(0.002)	(0.862)
PSM with Nearest-Neighbor Matching 1:5	-0.28**	0.017
	(0.009)	(0.878)
Mahalanobis distance with Nearest-Neighbor Matching 1:1	-0.15**	0.12**
	(0.019)	(0.029)
Mahalanobis distance with Nearest-Neighbor Matching 1:3	-0.17**	0.13*
	(0.012)	(0.053)

Note: Standard errors are shown in brackets. Significance level of ***1%, **5% and*10%.

The same impacts with the same signs of the coefficients were found in the results of the OLS regression (see Table 4). As regards the results of the sensitivity analysis, the coefficients remained the same for the different types of regression, i.e. the positive and significant impact of the programme on reading scores and the absence of effect with a negative and significant coefficient on pupils' maths scores (cf. table 3). This justifies the validity and robustness of the coefficients on the effect of the programme on school results, as discussed in the methodology section.

Table 4: Effect of participation in the school canteen programme on test scores in mathematics and language using the OLS estimator

Variables	OLS Scores in maths (1)	OLS Scores in reading (2)
School canteen programme	-0.18***	0.12**
	(0.000)	(0.008)
Pupil's age	-0.033***	-0.012
	(0.011)	(0.288)
Gender (girl)	-0.18	0.074**
	(0.669)	(0.000)
Having completed pre-primary school	-0.217***	-0.169***
	(0.000)	(0.000)
Number of years' experience of the school Headmaster	0.001	-0.009***
	(0.727)	(0.000)
Headmaster with pedagogical training	0.314***	0.251***
	(0.000)	(0.000)
Gender of the teacher (female)	0.160***	0.038
	(0.010)	(0.494)
Teacher's level of education	-0.024***	0.018**
	(0.003)	(0.013)
Number of years' experience of the teacher	0.040	0.002
	(0.526)	(0.436)
Teacher training	-0.001	0.278***
	(0.929)	(0.000)
Scholl status	0.251***	0.315***
	(0.001)	(0.00)
Double flow or double vacation classrooms	0.293***	0.223***
	(0.000)	(0.000)
Class equipment index	0.028***	0.012***
	(0.000)	(0.000)
Socio-economic index	0.012***	0.024***
	(0.000)	(0.000)
Location	-0.141	-0.115***
	(0.021)	(0.018)
Constant	1.8	1.68
Observations	666	666

Note: Each column reports the coefficients from the OLS regression whose dependent variables are the maths and language test scores. Standard errors are shown in brackets. Significance level of ***1%, **5% and*10%.

- **Interaction with control variables**

For the control variables, the coefficients on the individual pupil variables (see Table 4) show that the older they are at the end of primary school, the lower their test results in both mathematics and language. Pupil gender affects reading skills but has no effect on mathematical skills. irls tend to score higher in reading than boys. Attending pre-primary schools improves test scores in both maths and reading. In other words, not attending pre-primary school reduces test scores by -0.21 points in maths and -0.169 points in languages.

With regard to the characteristics of the school, it was the experience and training of the teachers that affected the students' scores and not those of the school headmaster. The experience and training of the teachers thus improved the test scores of the pupils in languages, whereas it did not affect the mathematics scores. The same was true for teachers' level of education, which only affected language scores (0.018) but reduced maths scores. The coefficient for the gender of the teacher was positive. Female teachers had a positive and significant effect on students' test scores in mathematics (0.160). In double-shift or double-flow classes, pupils scored higher in mathematics and language. Classroom equipment also had a positive and significant effect on pupils' results in both maths and language.

The coefficient of school status is positive and significant. Pupils enrolled in private schools obtain higher scores in mathematics and language than students in public schools. The coefficient for the location of the school shows that the more rural the school, the lower the test scores of the pupils.

The socio-economic environment of households has a positive and significant effect on pupils' mathematical and language skills. Pupils living in a more advantaged socio-economic environment obtain higher test results.

- **Impact of the school canteen programme according to the status of the school: public or private**

A disaggregation of the results by school status, public or private, is provided in Table 5. The average impact of the programme on the pupils who benefited from the intervention according to the status of the school is positive for pupils in private schools; while for public schools, a positive effect of the programme is noted, although it is not significant, and the programme has no effect on maths scores. The significance of the ATE coefficients differed according to the type of regression adopted, but their signs remained the same. This difference is due to the reduction in sample size in the treatment and control groups by dividing the initial sample into sub-samples according to school status.

For private schools, the school canteen improves pupils' learning skills in mathematics by 0.81 percentage points and in reading by 0.82 percentage points, according to the Propensity score matching (PSM) method. In public schools, the

school feeding programme improved pupils' reading scores by 0.15 percentage points, according to the Regression Adjustment based on the Mahalanobis distance. However, the programme had no effect on pupils' maths scores in public schools. This implies that pupils who benefit from a free canteen in public schools have lower results in mathematics than pupils who do not benefit from a canteen at school.

Table 5: Impact of the school canteen programme on pupils' test scores by school status: public OR private

Method for estimating impact	Scores in maths ATE (p-value)		Scores for languages ATE (p-value)	
	Public	Private	Public	Private
Regression Adjustment based on propensity score	-0.25**	0.27	0.13	0.12
	(0.004)	(0.821)	(0.158)	(0.903)
Sensitivity analysis				
Regression Adjustment based on the Mahalanobis distance	-0.17	0.52*	0.15*	0.42
	(0.298)	(0.051)	(0.062)	(0.138)
Propensity score matching (PSM)1 :1	-0.19***	0.81***	0.11	0.82***
	(0.028)	(0.002)	(0.203)	(0.008)
OLS	-0.34***	0.60***	0.002	0.59***
	(0.000)	(0.002)	(0.958)	(0.006)

Source: Author; Note: Significance level ***1%, **5% and*10%.

6. Discussion

School canteen intervention is a fairly common programme in both developed and developing countries to improve, among other things, pupils' educational outcomes (Jomaa et al., 2011). The results obtained showedA limited effect of the programme on the educational results of pupils in general. This lack of effect in part of the programme is in line with some literature that found no effect of the school feeding support programme and educational outcomes in primary schools, such as McEwan (2013), Leos-Urbel et al., (2013); Imberman and Kugler (2014) , Gordon, et al., (2018).

Disaggregation of the results reinforced the existence of this limited effect of the programme. The results according to the status of the school, public or private, showed the existence of a positive and significant effect of the programme on language and maths scores in private schools. In public schools, disaggregation showed, albeit modestly, a positive effect of the programme on pupils' language scores, even though the effect of the programme on maths scores remained negative. All this implies that in private schools, the free canteen programme enabled pupils to achieve better academic results than pupils who did not benefit from free school meals; and that in public schools, school meals improved pupils' academic results, although this was modest and limited solely to reading skills.

To explain the limited effect of the programme on learning skills, apart from the actual impact of the programme on nutrition, health, nutrients and calories consumed (McEwan, 2013), the literature further suggests that it is also necessary to know the quality of education (Glewwe 2013), and the household standard of living (Dahl & Lochner, 2012), (Akubuilo et al., 2020). Taking into account the information available in our database, the explanation of our result will focus on the quality of education and the standard of living of households.

Pupils in schools benefiting from free canteens are in fact in a household with a more disadvantaged socio-economic environment than pupils attending schools without canteens. Even though these pupils take a free meal a day during school days, because of their socio-economic situation, their academic results are still lower than those of pupils in schools without canteens who are in a better situation. Moreover, even if the pupils benefiting from the programme have access to a free meal on school days, it is possible that they do not eat enough or do not eat at home, given that they live in poor households (Waehrer (2008), Imberman and Kugler (2014)).

This is the case for the positive impact of the programme in public schools because the effect of the programme is conditioned and reinforced by the more favourable socio-economic situation of households in these private schools.

The lower academic results of pupils benefiting from the canteen compared with those not benefiting from it, particularly in mathematics, can also be explained by the fact that the majority of pupils in schools with a free canteen did not attend pre-primary school compared with pupils in schools without a canteen.

With regard to the quality of teaching, the results showed in particular the positive contribution of teacher training on pupils' test results in relation to the teacher's level of education and experience, even if the value of the coefficient is modest. This can be explained by the fact that the majority of teachers have not received any training. However, according to the results, whatever the teacher's level of education, it is the teacher's professional training that most improves the students' level of competence. The results of the PASEC (2019) tests of teachers' knowledge and skills also confirm the importance of teacher training. In fact, only 17.65% of teachers showed a relatively satisfactory level of mastery of the subject content (reading comprehension and mathematics) taught at primary level, 40.5% of teachers had a good knowledge of the subject content taught, and 35.9% of teachers were at level 1 on the reading comprehension and mathematics competency scales. The teacher's level of education cannot make an effective contribution to improving pupil results, since the majority of teachers only have a level 2 basic education (collège). Most of them are less qualified but are motivated by getting their contracts renewed in the future (Glewwe & Maïga 2011).

Teaching and learning conditions also play an important role in pupils' academic performance. The school infrastructure index makes a positive contribution to pupils' test scores, albeit a modest one. The schools selected for the canteen programme suffer from a shortage of school equipment compared with schools not benefiting from the programme. This lack of equipment is also apparent in public schools (PASEC, 2019).

These results suggest that the school canteen programme cannot be fully effective in terms of academic success in a disadvantaged socio-economic context and where the quality of teaching is low.

Conclusion and recommendations

In view of the results found, it can be deduced that although the school feeding support programme improves pupils' reading skills, it cannot achieve the objective of improving school results on its own. Its effectiveness depends on the quality of teaching and the socio-economic environment of households.

The following recommendations are made :

- To continue and strengthen the school canteen programme, giving priority

to pupils living in disadvantaged socio-economic situations or in low-income households. Continue to extend the programme to pupils in disadvantaged schools, particularly public schools, as they are the ones most in need of nutritional and educational support.

- To prioritise in-service teacher training, and more specifically to strengthen teacher training in public primary schools. This is to overcome the problem of the low educational level of most teachers, with a view to improving their teaching skills and enabling them to master the content of the subjects taught in primary schools.

- To improve the teaching and learning conditions of pupils by providing primary schools with the necessary classroom infrastructure, enabling them to guarantee the quality of education given to pupils, given that public primary schools suffer from a lack of school equipment.

- Ensure the effectiveness of development policies on household living standards. Improving the socio-economic situation of households would support the effectiveness of the school canteen policy. The programme will remain ineffective in terms of pupils' learning skills as long as households live in disadvantaged socio-economic conditions.

Notes

1. Centre de Recherche pour le Développement, Catholic University of Madagascar

2. Centre de Recherche pour le Développement, Catholic University of Madagascar

3. Centre de Recherche pour le Développement, Catholic University of Madagascar

4. 27% for lower secondary education and 13% for upper tertiary education.

5. https://www.unicef.fr/dossier/nutrition, Consulted on August 18, 2021.

6. Other technical and financial partners include ADRA, the Office National de la Nutrition and JICA. But it is the WFP that covers most of the beneficiaries (85% in 2019).

7. Source : World Bank. 2018. Facing Forward: Schooling for Learning in Africa. *Africa Development Forum* series. Washington, DC: World Bank. Page 109. doi:10.1596/978-1-46481260-6

8. The impact of school canteens in Madagascar. Cost-benefit analysis. WFP, 2019.

9. CONFEMEN: Conference of Ministers of Education of the States and Governments of the Francophonie

10. Analamanga, Vakinankaratra, Amoron'i Mania, Haute Matsiatra, Analanjirofo, Antsinanana, Androy, Anosy and Atsimo Andrefana regions.

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communications@aercafrica.org