Apuntes 88, 141-178
ISSN: 0252-1865
eISSN: 2223-1757
doi:

Article received on
Final version approved for publication on

Impact of the Qali Warma school feeding program on chronic child malnutrition[1]

PEDRO FRANCKE
Pontificia Universidad Católica del Perú
pfranck@pucp.edu.pe

GUSTAVO ACOSTA
Duke University
gustavo.acosta@duke.edu

Abstract. This article provides evidence of the impact of the Qali Warma school feeding program on anemia and chronic malnutrition in children between 3 and 5 years of age in Peru. Drawing on data from the 2014 to 2017 Peruvian Demographic and Health Survey, empirical results were obtained through a quantitative two-step evaluation. First, entropy balancing and machine learning techniques were used to achieve a comparable control group that allowed for robust estimates. Then, employing regressions, the program's effect on the variables of interest were estimated. The results indicate that Qali Warma has no effect on anemia or on chronic malnutrition in the age range studied.

Keywords: children, Peru, nutrition programs and policies, anemia, child nutrition disorders.

---

[1] This study received funding from the Instituto Nacional de Estadística e Informática.

1. INTRODUCTION

Reducing anemia and chronic child malnutrition (CCM) are health policy priorities in Peru. This is reflected in the Ministry of Health's (MINSA) *Plan Nacional para la Reducción y Control de la Anemia Materno Infantil y la Desnutrición Crónica Infantil en el Perú: 2017-2021*[2] (2017), which sets the target for reducing the incidence of these diseases at 19% and 6.4%, respectively, by the 200th anniversary of Peru's independence in 2021. However, progress has been slow; between 2014, when the Peruvian government launched its first national anemia plan, and 2018, the prevalence of this disease fell from 46.8% to 43.5%. If the decline were to continue at this rate, the target figure of 19% would not be reached until 2048. While child anemia fell at a rate of one percentage point per year between 2000 and 2014, the following four years saw this figure drop to 0.88% per year. Meanwhile, CCM has dwindled more slowly still: in 2018 it stood at 12.2%, only 2.4% less than in 2014, according to Peru's National Institute of Statistics and Informatics (Instituto Nacional de Estadística e Informática, INEI) in 2019.

The data are concerning, since these diseases limit the physical and cognitive development of children, which conditions their functioning in adulthood. As Buttenheim, Alderman and Friedman (2011) point out, "previous work has confirmed that children suffering from micronutrient deficiencies do poorly in school. Anemia in particular is a widespread problem with clear health and educational attainment implications" (Beard & Connor, 2003; World Health Organization [WHO]/Center for Disease Control and Prevention [CDC], 2004). Moreover, the costs of education, health, and comprehensive development can be very high; for anemia alone, Alcázar (2012) calculates that these costs equate to 0.62% of gross domestic product (GDP).

In this context, it is important to evaluate whether social and food programs contribute to the attainment of these nutritional goals. Though there have been assessments of the impact of programs such as Vaso de Leche (Gajate & Inurrétegui, 2001) and Juntos (Jaramillo & Sánchez, 2011) on chronic malnutrition, Alcazár (2016) stresses that "one of the most significant problems is that the monitoring and assessment of the programs is very limited" [3] (p. 227). It is important to determine whether the Qali Warma program is contributing to these targets; the program reaches an estimated

---

[2] National Plan for the Reduction and Control of Maternal and Child Anemia and Chronic Child Malnutrition in Peru,

[3] All translations from sources originally published in Spanish are by *Apuntes*.

38.4% of Peruvian 3 to 5 year olds and it assigns an annual budget of 300 million soles to this age group.

In Peru, anemia and chronic malnutrition have prevalences of 20.1% and 11.1% among children aged 3 to 5, respectively. The goals of Qali Warma are to improve school attendance and attention in class, and to promote better dietary habits. Accordingly, the Qali Warma Restructuring Committee (Comisión de Reestructuración de Qali Warma, 2018) recommended the inclusion of explicit nutritional targets for children in this age range.

Buttenheim et al. (2011) note that successful school feeding programs can achieve three objectives: increase school enrollment and attendance, raise learning achievement, and improve nutritional status. Along the same lines, the National Strategy for Social Development and Inclusion "Incluir para Crecer" (Ministerio de Desarrollo e Inclusión Social [MIDIS], 2013) has set the reduction of chronic malnutrition as an intermediate outcome (anemia is not included even though its effects are well-known). In addition, according to Barrón and MIDIS, "most studies find that participation in school feeding programs improves the nutritional results of direct program beneficiaries" (2011, p. 11).

Students are undergoing a dynamic, complex, and varied nutritional transition, which means that highly marked extremes, such as widespread malnutrition alongside rising obesity, are being recorded. This double burden of malnutrition (DBM) is the subject of current international debate, and involves "the coexistence of both undernutrition and overnutrition in the same population across the life course" (Shrimpton & Rokx, 2012, p. IX). The reality of the DBM gives rise to a need for "double-duty actions" that tackle both problems; that is, "actions that promote healthy growth in early life and nutritious diets throughout the life course, combined with healthy food environments, adequate income and education, and the knowledge and skills that support these goals have the potential to benefit multiple forms of malnutrition" (Hawkes, Ruel, Sinclair, & Branca, 2019, p. 143).

In this context, the present study entails a two-stage quantitative impact assessment of the Qali Warma program. First, we use advanced entropy balancing and machine learning techniques to achieve a comparable control group that allows us to obtain statistically robust estimations. Then we proceed to regressions in order to estimate the program's effect on the variables of interest. We employ data from Peru's Demographic and Family Health Survey (Encuesta Demográfica y de Salud Familiar, ENDES) from 2014 to 2017. The application of statistical methods to balance and compare two groups (treatment and control) with similar characteristics is widely used in econometrics. They make it possible to analyze social programs that are not subject to randomization, and to obtain results that elucidate their impact. We seek to answer the following questions: Does the Qali Warma (QW) school feeding program have an impact on anemia reduction, and, if so, what factors strengthen or weaken this impact? We analyze the impact on children aged 3 to 5, because QW is not targeted at children any younger, and because ENDES only measures anemia and malnutrition in children up to the latter age.

The study takes into account the heterogeneity of the food service, which entails two different modalities: a "portions" modality in which the school receives pre-prepared meals to give out to the students; and a "products" modality whereby the school is given non-perishable or processed products for preparation locally. Moreover, at some schools only breakfast is provided, while at others (in districts classified as "very poor") students receive breakfast as well as lunch. Our estimation of the impact of QW controls for these differences in the treatment.

It should be noted that Peru's National Health Institute (Instituto Nacional de Salud, INS), through Administrative Resolution No 355-2017, set the subject studied here as one of its public health research priorities for 2018-2021, stressing the importance of "the development and assessment of effective interventions for the prevention and control of malnutrition, anemia, and non-transmissible diseases at different life-stages through an intercultural approach in the context of the population" (2017).

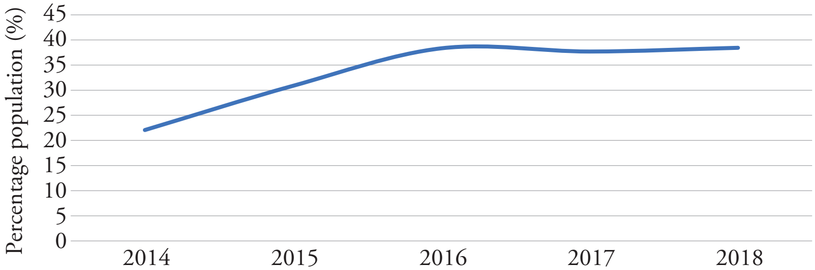
2. CONCEPTUAL FRAMEWORK

2.1 The Qali Warma program

The MIDIS Qali Warma National School Feeding Program (Programa Nacional de Alimentación Escolar Qali Warma) provides a feeding service every school day to pre- and primary-school students in all regions of Peru, and to secondary-school students from indigenous communities in Amazonia.

The program's budget has increased from year to year. In 2014, its allocation was 1,021 million soles; by 2018, the figure had risen to 1,525 million soles. Positive results are evident in terms of budgetary execution (which increased from 93.9% in 2014 to 99.5% in 2018) and coverage (the proportion of recipients aged between 36 and 59 months rose from 22.07% in 2014 to 38.44% in 2018).

Figure 1
Coverage of Qali Warma among infants between 36 and 59 months, 2014--2018



Source: compiled by authors using ENDES data (2014-2018)

The program utilizes a “co-management” model in which various actors from civil society participate, representing the private and public sectors. The co-management process is divided into three stages: school menu planning, the purchase process, and management of the feeding service.

The first stage consists in studying, evaluating, and validating local recipes and diets. This task is overseen by the program centrally. In turn, the procurement committees (which operate at the regional level) are tasked with acquisition of the products to be distributed via the feeding service. Each of these committees is responsible for around 25 thousand students distributed among several schools, and is composed of the following members: the social development manager of the provincial municipality; a representative of the health network; the sub-prefect of the province; one parent representative at the primary level; and one parent representative at the pre-school level. Finally, the school feeding committees (SFCs) receive, store, and deliver the food to the beneficiaries. A SFC is established at each school where QW is administered, and is comprised of the following members: the school principal, and two parents of the children served.

As noted earlier, QW has two provision modalities: “portions” and “products.” The MIDIS designed the portions modality for urban schools that have fewer than 200 students and at which parents’ participation in the SFCs is considered to be low. It entails the distribution of pre-packaged ready-to-eat breakfasts (or breakfasts and lunches, where applicable), which do not require advance preparation by the SFC. In turn, the products modality was designed for poorly connected rural areas with under-provisioned markets and a limited number of suppliers. This modality entails the delivery to schools of non-perishable processed, industrialized, or commodity products, which the SFC uses to prepare breakfast (or breakfast and lunch).

The food provided varies from locality to locality and, sometimes, from one school to another, based on local availability. However, the QW technical specifications and recipe designs stipulate that the food distributed cover between 55% and 65% of the children's daily energy requirements, 60%--85% of their daily protein requirements, and 45%--60% of their daily iron requirements. Thus, QW provision is largely standardized in terms of nutritional content, as confirmed by previous impact assessments. It should be noted that the program only provides food on school days, and thus does not cover children's dietary needs on school holidays, public holidays, or weekends.

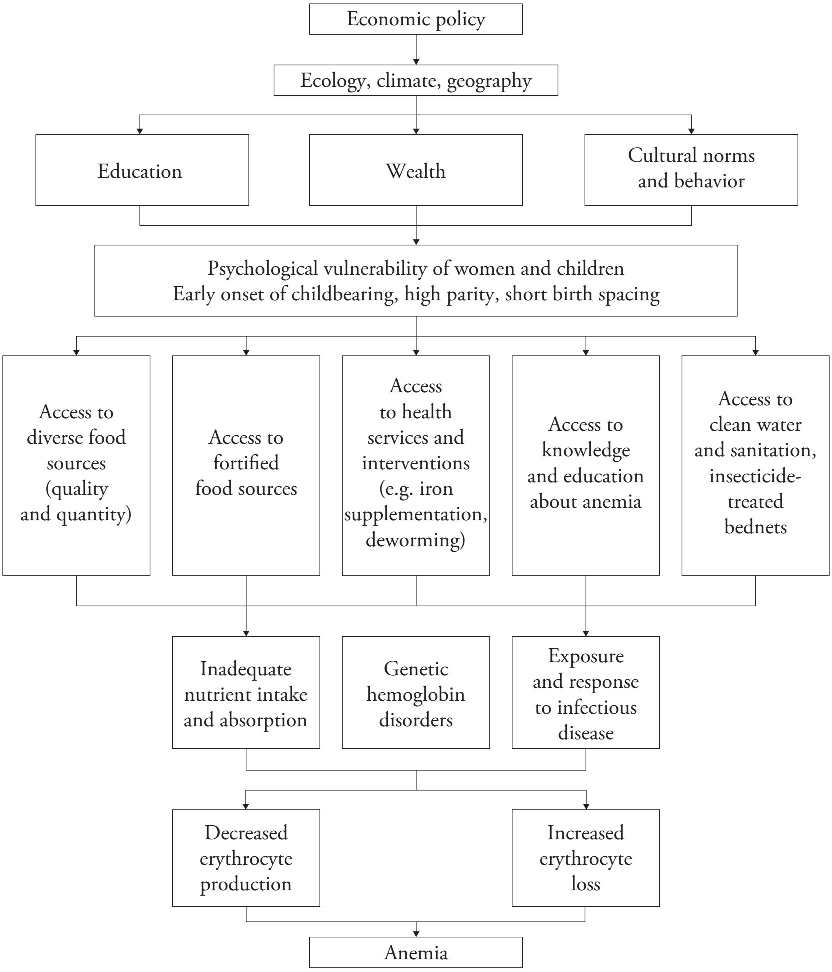
In 2018, the Qali Warma Program Reorganization Committee published its *Informe Final (*Comisión Reorganización del Programa Qali Warma, 2018); the report's recommendations focused on the need to explicitly address nutritional problems such as anemia, overweight, obesity, and malnutrition, and were subsumed into the general aims of the program.

2.2 Anemia and CCM

The World Health Organization (WHO) defines anemia as "a condition in which the number of red blood cells (and consequently their oxygen-carrying capacity) is insufficient to meet the body's physiologic needs" (2011). On the immediate causes, the WHO notes that "iron deficiency is thought to be the most common cause of anaemia globally, but other nutritional deficiencies (including folate, vitamin B12 and vitamin A), acute and chronic inflammation, parasitic infections, and inherited or acquired disorders that affect haemoglobin synthesis, red blood cell production or red blood cell survival, can all cause anaemia" (2011).

Meanwhile, in their conceptual model of the determinants of anemia, Balarajan, Ramakrishnan, Ozaltin, Shankar, and Subramanian observe that "anaemia has multifactorial causes involving complex interaction between nutrition, infectious diseases, and other factors, and this complexity presents a challenge to effectively address the population determinants of anaemia" (2011, p. 2123). Specifically, they cite "access to diverse food sources (quantity and quality)" (p. 2123) and "access to fortified food sources" (p. 2123) as important determinants of this condition. Thus, Qali Warma might be expected to have an impact on childhood anemia.

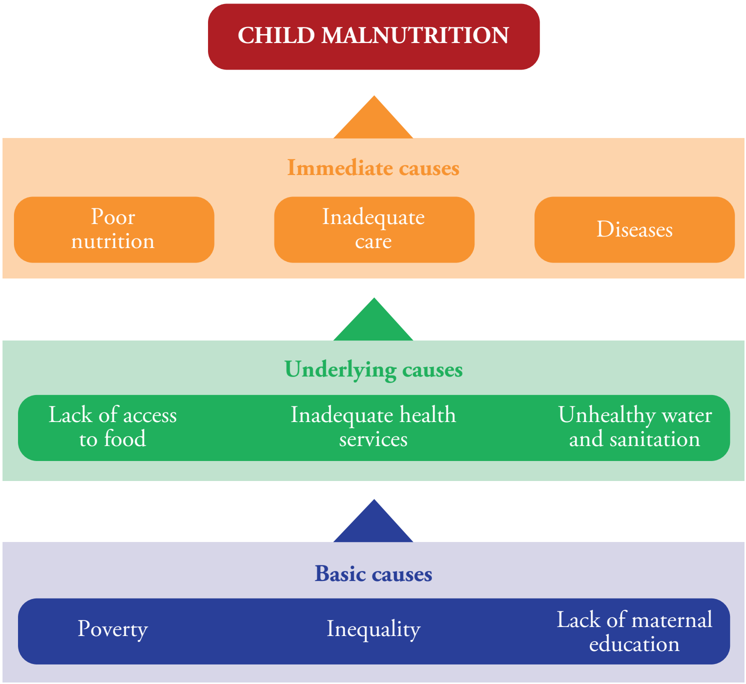
Figure 2
Conceptual model of anemia



Source: Balarajan et al. (2011, pp. 2123-35)

Chronic child malnutrition is defined by the WHO as a lack of nutrients that stunts child development (2011). Wisbaum (2011) presents a causal model of child malnutrition with three levels of determinants; first, there are the so-called “immediate” causes: inadequate dietary intake, and childhood diseases. These are followed by underlying causes: lack of access to food, inadequate health services for children and mothers, and unhealthy water and sanitation. Finally, the so-called basic (or structural) causes are multiple and include poverty, inequality, and inadequate maternal education, as well as the factors that cause them. Following this model, the intention is that the QW program combat dietary insufficiency, and in turn, reduce child malnutrition, by providing access to food.

Figure 3
Conceptual model of child malnutrition



Source: Adapted from Wisbaum (2011)

2.3 Qali Warma, anemia and CCM

The basic microeconomic framework holds that consumers maximize their utility and, subject to budget and price constraints, select a basket of food and services (Bitler & Wide, 2011; Babu, Gajanan, & Hallam, 2016). That is, rational individual consumers can only improve their nutritional status if a budget constraint is lifted (for instance, if their real income improves) or if policy-makers prioritize nutritional status over well-being and consumers (individuals and families) modify their behavior in line with relative prices, choosing certain goods (see, for example, Smith & Haddad, 2000).

A broader theoretical framework could also take into account the time that families take both to generate income and to prepare food. This provides scope for taking into account demand for food prepared at restaurants, as well as the necessary balance between energy intake and energy expended through work (Bitler & Wide, 2011). However, there are various "market failures" that expose potential limitations in such a theoretical framework (Bitler & Wide, 2011). A first limitation is that infants and children do not have the capability to make rational decisions to optimize their well-being. Second, imperfect information means that not all information about the attributes of goods, such as their nutritional content, can be discerned. Third, externalities related to child malnutrition can arise, in that future health problems caused by early nutritional deficiencies must be addressed by third-party actors. For instance, the state may be able to remedy nutrition-related market failures, particularly as far as they affect infants and children.

Buttenheim et al. propose that one objective of school feeding programs is "to improve children's long-run macro- and micronutritional status through the provision of additional calories and fortified foods, reducing malnutrition and its attendant negative impact on future health and productivity" (2011, p. 522).

In her synthesis of the academic debate about feeding programs in Peru, Alcázar (2016) argues that school feeding programs can be classified as assistance- or nutrition-driven, but are best regarded as a category in their own right: "School feeding programs [...] consist in the provision of food at school to promote attendance, alleviate hunger in the short run, and thus contribute to student learning (Buhl, 2010; Miller, 1999; *World Food Programme*, 2004)." In many cases these programs have nutritional aims, which they attempt to fulfill by giving out fortified foods and nutritional supplements.

In their pioneering study on Peru, Pollit, Jacoby, and Cueto (1996) confirm that this aim is pursued by fortifying school breakfasts with iron; these authors detect nutritional effects, especially on anemia. Despite their findings, there is ongoing international scientific debate about the extent to which school feeding programs do have a nutritional impact, and about what type of program has the greatest effect. According to Alderman and Bundy, "school meal programs can also be a vehicle for improved micronutrient status if the meals or rations are fortified or if they contribute to an increase of diet diversity. While studies often—but not universally—find benefits from the inclusion of meat in school meal programs (Whaley and others 2003), such meals are often impractical or too expensive for low income settings" (2011, p. 210). In the specific case of QW in Peru, we have found no studies on the program's impact on 3--5 year old pre-schoolers; this may be partly because extensive coverage at the pre-school level has only been achieved in the last decade. Nor has the literature discussed differentiated effects based on program modality or form of food delivery.

3. METHODOLOGY AND DATABASE

3.1 Database and variables

The main data source for this study is the ENDES survey. This survey is administered annually and is representative at the national, departmental, and area (rural/urban) levels. Employing the ENDES database, it is possible to identify QW recipients and observe their individual and household characteristics, including information about their health status—such as whether they suffer from anemia or chronic child malnutrition, which is determined through anthropometric and blood-hemoglobin measurements.

Moreover, we use the administrative data provided to us by MIDIS for the period 2014-2017. These data pertain to the schools that take part in the program, modality of provision, whether breakfast only or breakfast and lunch is provided, and the poverty index, among other variables.

As noted earlier, QW provision typically involves one of two different modalities: products or portions. In addition, QW provides both breakfast and lunch in certain districts only. Thus, whether a child receives the food service in one way or another will depend on the location of the school he or she attends. On this basis, we assume that all children attend a school within the district where they live, and not one outside it. If a child lives in a district where both modalities are received, he or she is withdrawn from the sample in the interests of comparability.

The total sample contains 15,334 children aged 3 to 5 for the period 2014--2017, and who are distributed by years and type of modality as shown in Table 1.

Table 1
Size of samples of Qali Warma recipients by modality

Children from schools in districts with both modalities				Children from schools in districts with portions modality only			Children from schools in districts with products modality only			
Year	**User**	**Non-user**	**Total**	**User**	**Non-user**	**Total**	**User**	**Non-user**	**Total**	**Total**
2014	157	177	334	239	67	306	413	905	1,318	**1,958**
2015	315	388	703	404	275	679	713	2,893	3,606	**4,988**
2016	137	677	814	241	218	459	287	3,092	3,379	**4,652**
2017	127	559	686	204	195	399	258	2,393	2,651	**3,736**
Total	**736**	**1,801**	**2,537**	**1,088**	**755**	**1,843**	**1,671**	**9,283**	**10,954**	**15,334**

Source: ENDES (INEI)-MIDIS. Compiled by authors.

To balance the treatment group with the control group, it is also necessary to define the set of variables related to the probability of being classified as a potential QW user. Thus, using the *Metodología para la Determinación de la Clasificación Socioeconómica4* (MIDIS, 2015), we used the following variables: number of devices in the household, whether the household has a gas cooker, whether the household uses a polluting fuel for cooking, whether the household has a blender, whether the house has access to the public sewer system, whether the house has rudimentary flooring (dirt or another material such as marble or stone), whether the household has a refrigerator or freezer, whether the house has rudimentary roofing, whether the house has access to the power grid, number of household members, year, and department.

Our sample delimitation does not need an additional filter to ensure that only children who attend a state school are included; this is because in the ENDES survey, from which we draw our data, all children in our age range go to a public school.

The sample balancing allows comparable groups to be established. The variables for estimating the impact of QW on anemia and CCM are presented in Table 2.[5]

Table 2
Study variables

VARIABLES	Description	Source
Dependent variables		
Anemia	Defines the presence of anemia in the child. Takes two values: 1 if the child has less than 110 g/L of hemoglobin; 0 otherwise	ENDES
Hemoglobin	Presence of hemoglobin in the blood in grams per deciliter (g/L), adjusted for altitude	ENDES
CCM	Defines the presence of chronic child malnutrition Takes two values: 1 if the child has a score below -2Z in the indicator according to the WHO definition; 0 otherwise	ENDES
Z-score	Nutritional level in standard deviations according to height/age	ENDES
Independent variables on Qali Warma		
Receives Qali Warma.	Describes intervention via Qali Warma Takes two values: 1 if the child received; and 0 if the child did not receive	ENDES

---

4 "Methodology for Determination of Socioeconomic Classification."

5 We do not include variables related to diseases such as diarrhea or respiratory tract infections, since these are affected in turn by the level of anemia and CCM of the children and are affected by other control variables that we include, as well as by program intervention itself. Thus, our estimation includes both direct effects and possible indirect effects of QW as a result of the reduction of these diseases.

Number of months receiving	Describes the number of months that Qali Warma has been received.[6]	ENDES
Control variables		
Maternal education	Describes the age of the mother in years	ENDES
Antenatal checks	1: if the child received antenatal checks, and 0: if the child did not receive antenatal checks	ENDES
Birth weight	Describes the weight of the child at birth	ENDES
Iron supplements during pregnancy	1: if the mother took during pregnancy, and 0: if the mother did not take	ENDES
Number of GDCs	Describes the number of growth and development checks	ENDES
Child's age	Describes the age of the child in months	ENDES
Breastfeeding during first 6 months	1: if the child was breastfed in the first 6 months, and 0: if the child was not breastfed in the first 6 months	ENDES
Breastfeeding from 7 to 12 months	1: if the child was breastfed from 7 to 12 months, and 0: if the child was not breastfed from 7 to 12 months	ENDES
Child's sex	1: female, and 0:male	ENDES
Breakfast and lunch	Takes two values: 1: if the child received breakfast and lunch, and 0: if the child received only breakfast- At the district level.	MIDIS
Products modality	Describes whether the modality is "products." Takes two values: 1: if the modality is "products," and 0: otherwise. At the district level.	MIDIS
Products and portions modality	Describes whether the modality is "products and portions." Takes two values: 1: if the modality is "products and portions," and 0: otherwise. At the district level	MIDIS

Source: compiled by authors.

The appendix includes a brief description of these variables, and is available upon request. It would have been useful to also control for the possibility of a child's involvement in Cuna Más or another social or family program before starting school, but the database does not provide this information.

3.2 Methodology

The present study is explanatory; it uses a deductive methodology and applies quantitative econometric techniques. It is divided into two stages. First, we balance the sample using two different methods: entropy balancing (EB) and

---

[6] The program gives out food every school day; the variable takes different values based on age and the time of the survey.

machine learning (ML). Then, we apply differences by way of a regression to estimate the impact of QW on the variables of interest.

Sample balancing

Given that the treatment and control groups are not identified by random assignment, we can employ non-experimental methods. These allow us generate counterfactuals that are comparable. To this end, we use two different methods; first entropy balancing and then machine learning.

Entropy balancing7 has an advantage over other methods such as propensity score matching, in that the latter always requires a common support between the treatment and control groups and so loses the observations that fall outside that common support. Moreover, entropy balancing uses not only the first statistical moment (the mean) but also two additional moments (the variance and the asymmetry).

Another advantage of entropy balancing is that it retains important information, in that it adjusts the weights directly using the known moments from the sample. This allows the weights to vary smoothly around the variables until the variances of the weights cannot be reduced without losing the balancing. In addition, after the weights have been obtained, they can be used for almost all regressions of treatment effect estimation (Hainmueller, 2012).

In turn, machine learning[8] is a more efficient, precise, computationally potent, and robust model in statistical terms when it comes to generating counterfactuals, as it creates complex decision trees that can even function in the case of "missings." We apply this method using a gradient boosting model (GBM) via the TWANG statistical package (Ridgeway, McCaffrey, Ann, & Burgette, 2014).

The TWANG estimation entails an iterative process using multiple decision trees to capture complex and non-linear relationships between assignment to the treatment and the covariables without over-adjusting the data (Ridgeway et al., 2014) Moreover, it functions with continuous and discrete pre-treatment variables. For the iterative process, McCaffrey, Griffin, Almirall, Slaughter, Ramchand, and Burgette (2013) formulate four stopping rules. These rules are based on two descriptive statistics: maximum values and absolute standardized bias, which compares the means or the

---

7 A good presentation of the mathematical formulation, assumptions, and advantages of entropy balancing can be found in Hainmueller (2012).

8 A good presentation of the mathematical formulation, the assumptions and the advantages of machine learning can be read in Athey and Imbens (2017).

distributions of the covariances between the treatment and control groups. Therefore, in the results we present the "esmean" and the "ksmax" balancing, which refer to those points where the iteration process is stopped.

Although we cannot rule out the possibility that there may be unobservable variables that are no longer taken into consideration, we include variables of stratification and years, and the MIDIS targeting methodology allows us to affirm that most variables are observable.

Estimation of impact

Once the sample has been balanced and the weights assigned to the control and treatment groups, we estimate the impact using the method of differences and the variables presented in Table 2.

The condition of a child having anemia or not is a dichotomous variable; thus, we apply probit estimations. In addition, we evaluate the possibility that Qali Warma has effects on the hemoglobin levels of children with anemia. This level is a continuous variable, and so we employ ordinary least squares (OLS). In the case of CCM, as with anemia we estimate whether or not the child suffers from this condition (score below -2Z) using probit; in addition, we carry out Z-score estimations of height/age as a continuous variable using OLS.

Below, we specify the regression to assess the impact of QW:

$$Y_i = \varphi + \beta T_i + n_1 F_t + + \delta X_i + \varepsilon_i$$

Where Y_i is any of the endogenous variables of interest for our study for individual "i." φ denotes the intercept, which represents the mean value of the untreated group. T_i is a variable that takes the value of 1 if individual "i" is a program beneficiary, and 0 otherwise. F_t represents the frequency of receipt of the program for individual "i."[9] In addition, we control for variables that appear in ENDES and are included in the vector as the child's birth weight, maternal education level, attendance of growth and development checks (GDCs), mother's iron intake during gestation, and mother's attendance of antenatal checks, among others. This estimation allows us to interpret the mean effect of QM on children who participate in the program.

---

[9] The program provides food every school day to all students at registered schools; there is no targeting or prioritization of the most vulnerable individuals. The variable we use to measure frequency is "months receiving," which takes different values given the time at which the survey was conducted, which is not correlated with the nutritional status or needs of each child.

4. RESULTS

4.1 Results of sample balancing

Entropy Balancing

Table 3 shows the entropy balancing results for the QW sample. We carry out the balancing three times: once for the probit, again for the Z-score, and finally for hemoglobin level. The covariables used in this regression are outlined in Table 2. As can be observed, the treatments and the counterfactuals are initially different in the variables used. For instance, in the case of the balancing for the probit, the average number of devices in the household for the treatments is 7.68, while for the counterfactuals it is 9.75. Applying entropy balancing allows us to assign weights to the observations, such that the mean, the variance, and the asymmetry of the counterfactuals are similar to those of the treatments. This is also achieved for the other covariables employed, which ensures that we have adequate counterfactual.

Table 3[10]
Results of entropy balancing for Qali Warma

	Before weighting						After weighting					
	Treated			Counterfactuals			Treated			Counterfactuals		
propensity score covariables	Mean	Variance	Asymmetry	Mean	Variance	Asymmetry	Mean	Variance	Asymmetry	Mean	Variance	Asymmetry
Qali Warma- probit												
Number of devices	7.678	18.02	0.5774	9.746	21.16	0.08798	7.678	18.02	0.5774	7.678	18.02	0.5772
Household has a refrigerator	0.3397	0.2243	0.6769	0.5325	0.249	-0.1302	0.3397	0.2243	0.6769	0.3397	0.2244	0.6772
Household has a gas cooker	0.7952	0.1628	-1.463	0.8813	0.1047	-2.358	0.7952	0.1628	-1.463	0.7953	0.1629	-1.464
Household has blender	0.5172	0.2497	-0.06892	0.6609	0.2242	-0.6797	0.5172	0.2497	-0.06892	0.5172	0.2498	-0.06898
Polluting fuel	0.3942	0.2388	0.433	0.2081	0.1648	1.438	0.3942	0.2388	0.433	0.3941	0.2389	0.4333
Rudimentary flooring	0.4163	0.243	0.3396	0.2692	0.1968	1.041	0.4163	0.243	0.3396	0.4163	0.2431	0.3398
Rudimentary roofing	0.08328	0.07635	3.016	0.09962	0.08972	2.674	0.08328	0.07635	3.016	0.08327	0.07635	3.017
Lack of access to public sewerage network	0.5054	0.25	-0.02159	0.3465	0.2265	0.6453	0.5054	0.25	-0.02159	0.5054	0.25	-0.02159
Lack of access to power grid	0.8969	0.09245	-2.611	0.9215	0.07233	-3.135	0.8969	0.09245	-2.611	0.897	0.09245	-2.611
Urban/rural	0.5577	0.2467	-0.2322	0.7743	0.1748	-1.312	0.5577	0.2467	-0.2322	0.5577	0.2467	-0.2323

---

[10] For ease of readability, the table does not present the dummy variables by years or departments.

Qali Warma- Z-score												
Number of devices	5.233	11.07	0.974	6.415	17.89	0.6622	5.233	11.07	0.974	5.236	11.07	0.9712
Household has a refrigerator	0.1351	0.1169	2.135	0.26	0.1929	1.094	0.1351	0.1169	2.135	0.1348	0.1169	2.138
Household has a gas cooker	0.6176	0.2363	-0.4841	0.685	0.2163	-0.7965	0.6176	0.2363	-0.4841	0.6181	0.2366	-0.4861
Household has a blender	0.3008	0.2104	0.8687	0.39	0.2385	0.4511	0.3008	0.2104	0.8687	0.3003	0.2106	0.8713
Polluting fuel	0.6612	0.2241	-0.681	0.4875	0.2505	0.05002	0.6612	0.2241	-0.681	0.6617	0.2244	-0.6834
Precarious flooring	0.6476	0.2283	-0.6182	0.5625	0.2467	-0.252	0.6476	0.2283	-0.6182	0.6481	0.2286	-0.6205
Precarious roofing	0.1156	0.1023	2.404	0.17	0.1415	1.757	0.1156	0.1023	2.404	0.1153	0.1023	2.408
Lack of access to public sewerage network	0.7292	0.1976	-1.032	0.63	0.2337	-0.5385	0.7292	0.1976	-1.032	0.7298	0.1977	-1.035
Lack of access to power grid	0.7973	0.1617	-1.479	0.775	0.1748	-1.317	0.7973	0.1617	-1.479	0.7978	0.1617	-1.483
Urban/rural	0.3248	0.2194	0.7481	0.495	0.2506	0.02	0.3248	0.2194	0.7481	0.3243	0.2197	0.7505
Qali Warma - Hemoglobin												
Number of devices	6.785	16.59	0.7041	8.73	22.09	0.2113	6.785	16.59	0.7041	6.786	16.6	0.7029
Household has a refrigerator	0.2542	0.1897	1.129	0.4487	0.2477	0.2063	0.2542	0.1897	1.129	0.2539	0.1897	1.131
Household has a gas cooker	0.7439	0.1906	-1.117	0.8331	0.1393	-1.786	0.7439	0.1906	-1.117	0.7442	0.1907	-1.119
Household has a blender	0.4362	0.246	0.2575	0.5804	0.2439	-0.3258	0.4362	0.246	0.2575	0.436	0.2463	0.2581
Polluting fuel	0.4667	0.249	0.1336	0.2864	0.2047	0.9451	0.4667	0.249	0.1336	0.4666	0.2493	0.1339

Rudimentary flooring	0.4855	0.2499	0.05803	0.3384	0.2242	0.6829	0.4855	0.2499	0.05803	0.4855	0.2502	0.05821
Rudimentary roofing	0.1062	0.09497	2.556	0.1026	0.09222	2.619	0.1062	0.09497	2.556	0.1061	0.09497	2.558
Lack of access to public sewerage network	0.5872	0.2425	-0.3542	0.4671	0.2493	0.132	0.5872	0.2425	-0.3542	0.5874	0.2427	-0.3551
Lack of access to power grid	0.8437	0.1319	-1.893	0.8744	0.11	-2.26	0.8437	0.1319	-1.893	0.8439	0.1319	-1.895
Urban/rural	0.4893	0.25	0.04295	0.6769	0.2191	-0.7564	0.4893	0.25	0.04295	0.4892	0.2503	0.04306

Source: compiled by authors.

Machine learning

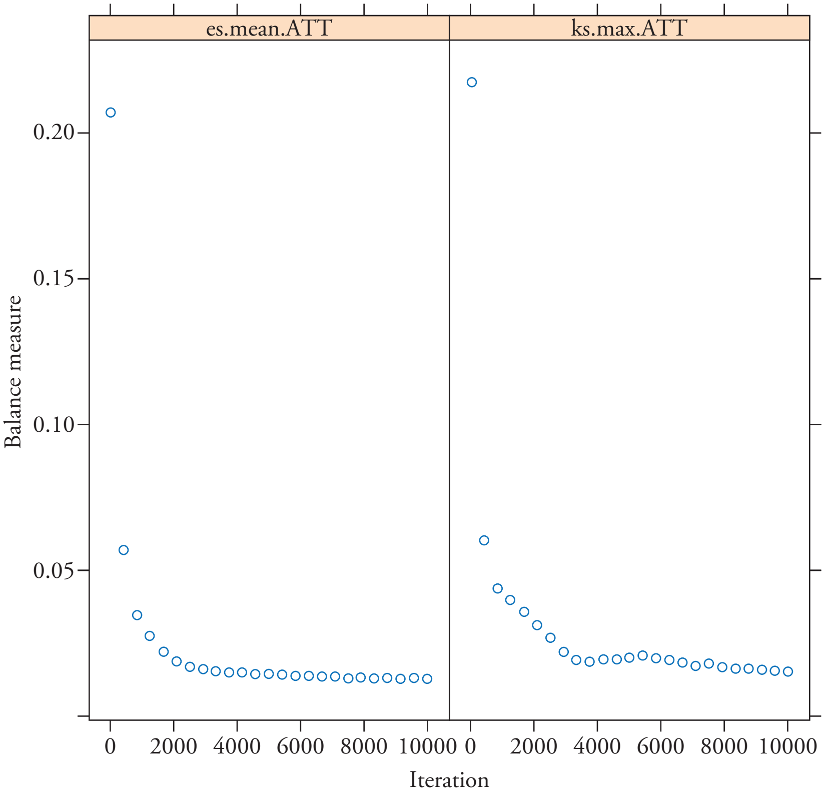
We present the results of the balancing with machine learning in three graphs corresponding, respectively, to the sample weights for the probit, the Z-score, and hemoglobin level. As mentioned in the methodology section, we must observe three situations: before balancing, with “esmean” balancing, and with “ksmax” balancing.

Each graph is divided into three “plots.” The first exhibits the balancing process (“esmean” and “ksmax” optimization) throughout the iterations, which results in convergence of the models. In all cases, it can be confirmed that the sample was initially unbalanced for most variables, but was ultimately balanced after application of the TWANG. In the second “plot” the black points denote the initially unbalanced covariables with a p-value below 0.05; after balancing, the white points indicate that the covariables approach the diagonal that represents the “gold standard” of the impact assessments; that is, we achieve an adequate sample for estimating the impacts. Finally, the third “plot” shows the extent of the propensity scores estimated in the treatment and control groups; after testing the new weights in the sample, we note that the treatment and control groups are now much more similar than before applying the TWANG.

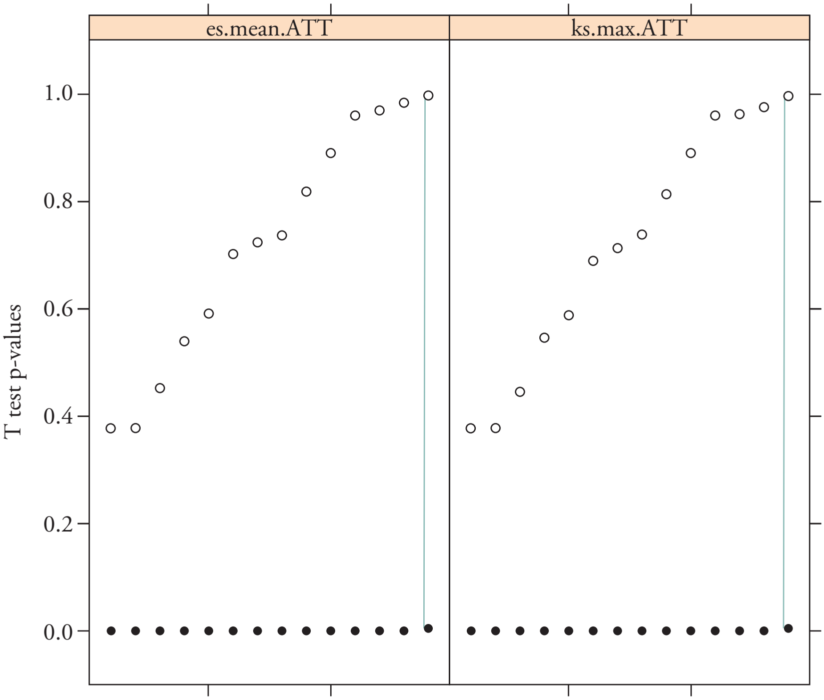
With both entropy balancing and machine learning, we are able to weight the control and treatment groups so that they are comparable to each other. This allows us to conduct unbiased, reliable, and robust QW impact estimations in the next stage.

Figure 4
Results of machine learning balancing for the probit

Plot 1 (optimized): GBM Optimization

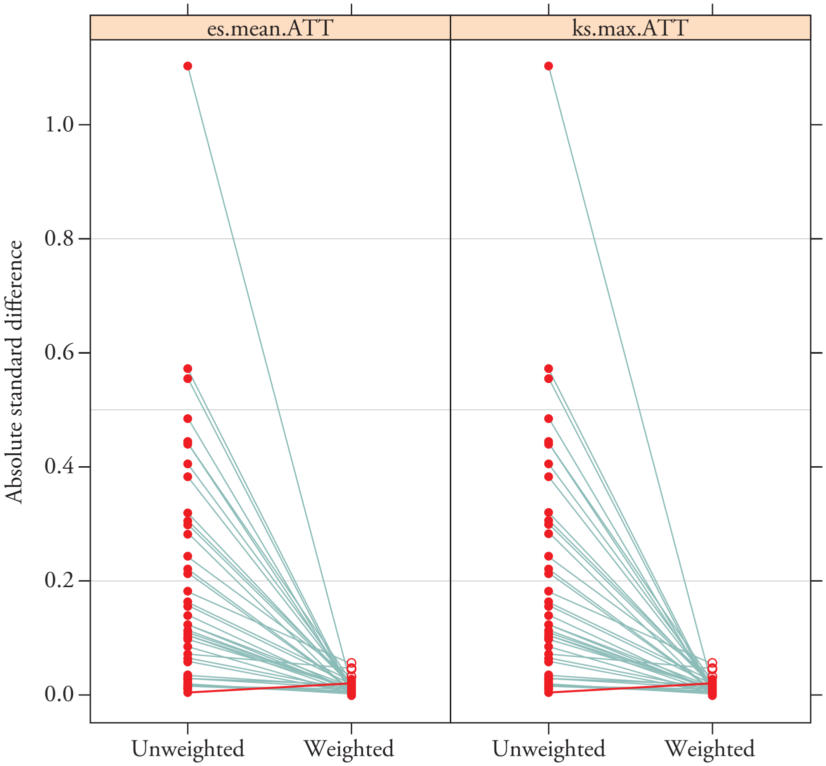


Plot 2 (t): T-test P-values of Group Means of Covariates



Rank of p-value for pretreatment variables
(hollow is weighted, solid is unweighted)

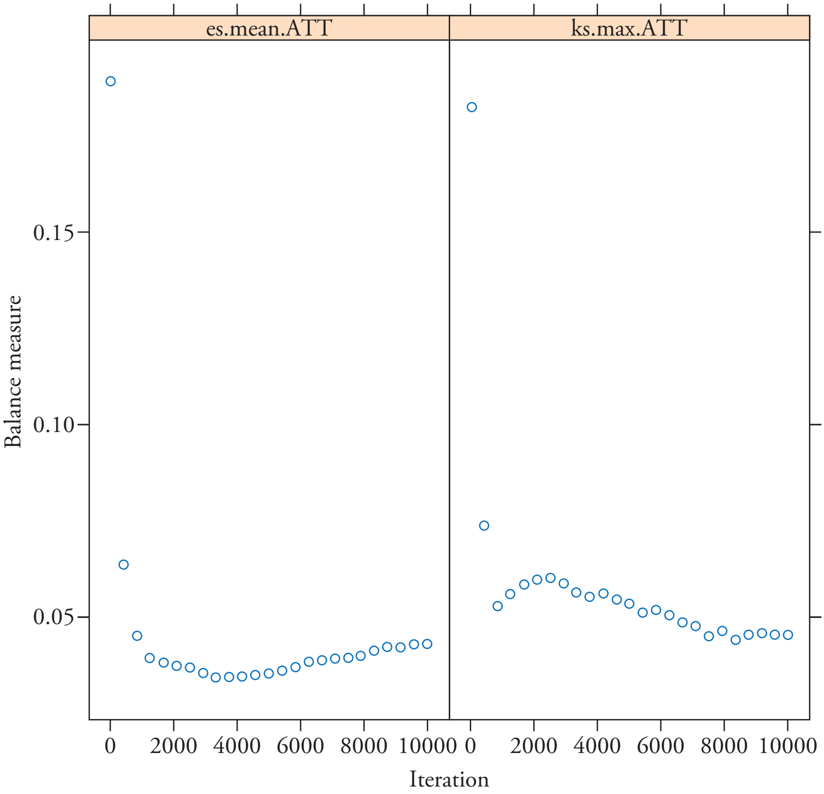
Plot 3 (es): Standardized Effect Sizes Pre/Post Weighting



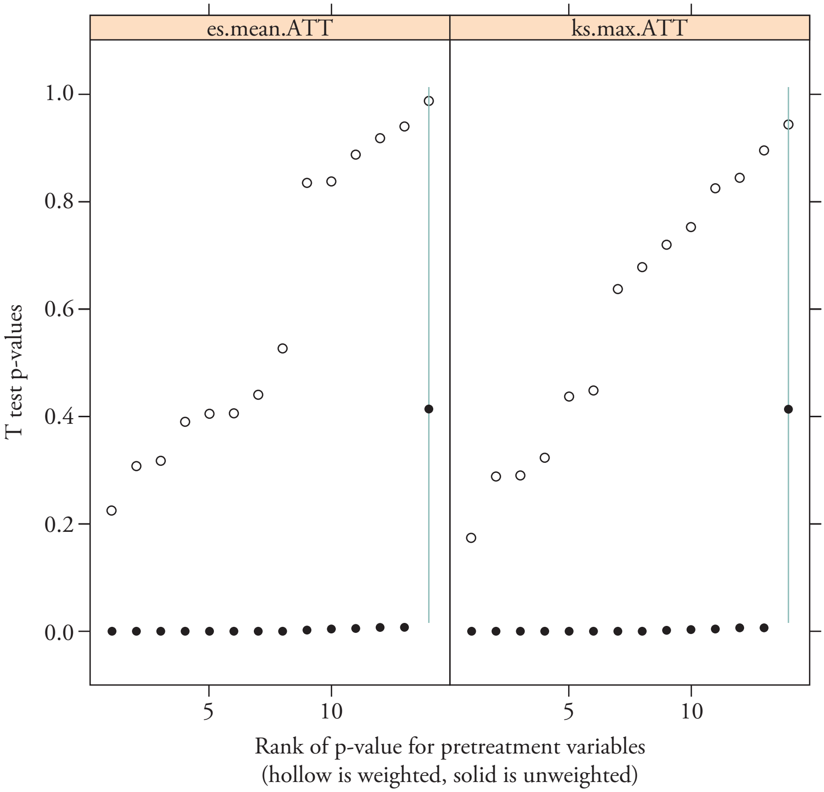
Source: compiled by authors.

Figure 5
Results of machine learning balancing for the Z-score

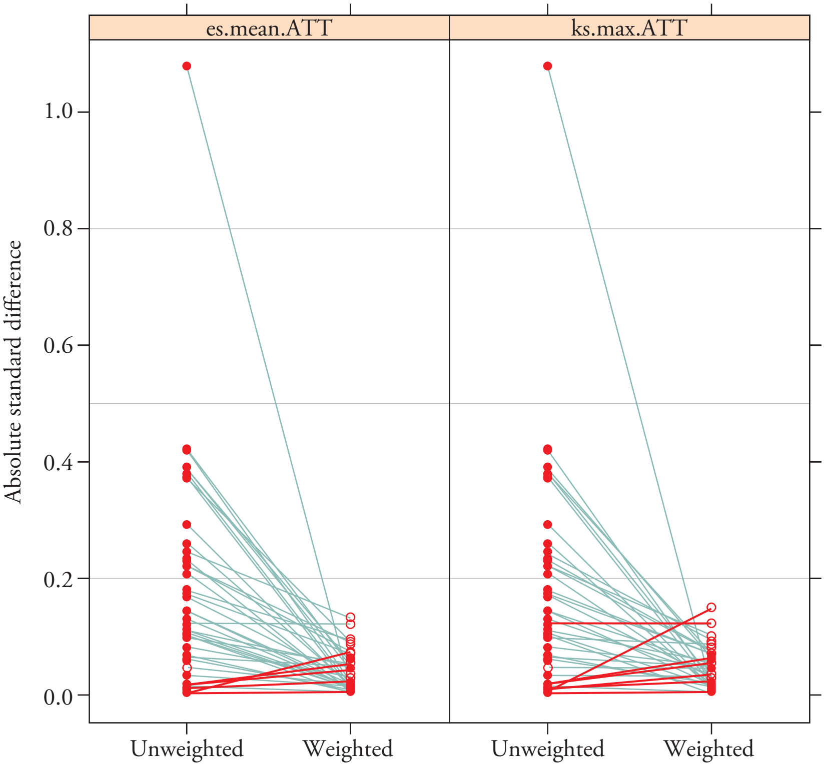
Plot 1 (optimized): GBM Optimization



Plot 2 (t): T-test P-values of Group Means of Covariates

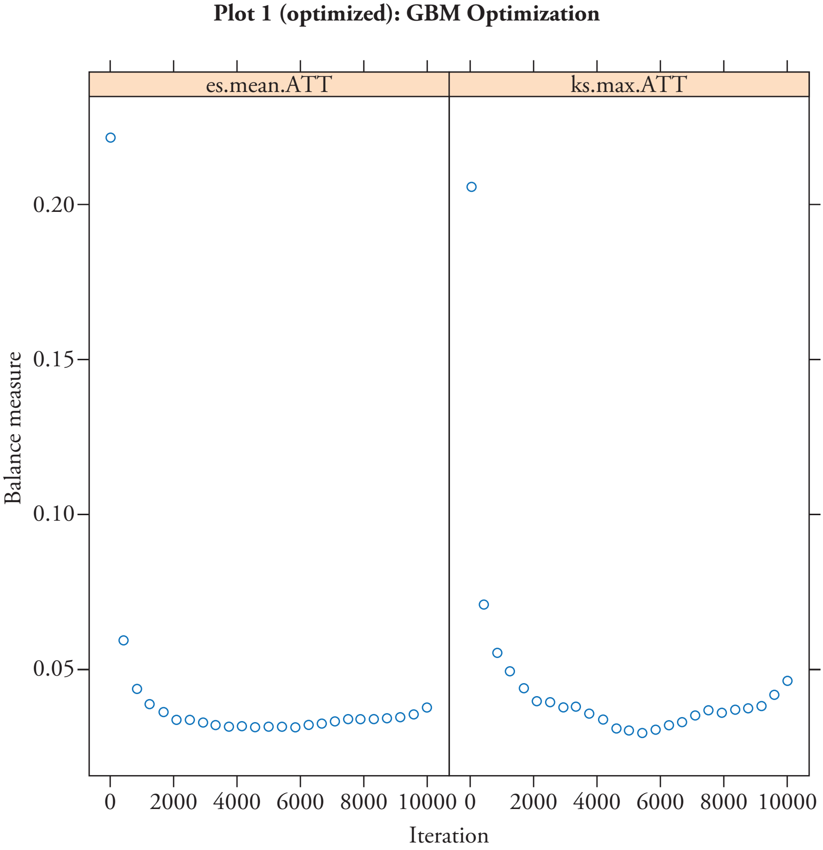


Plot 3 (es): Standardized Effect Sizes Pre/Post Weighting

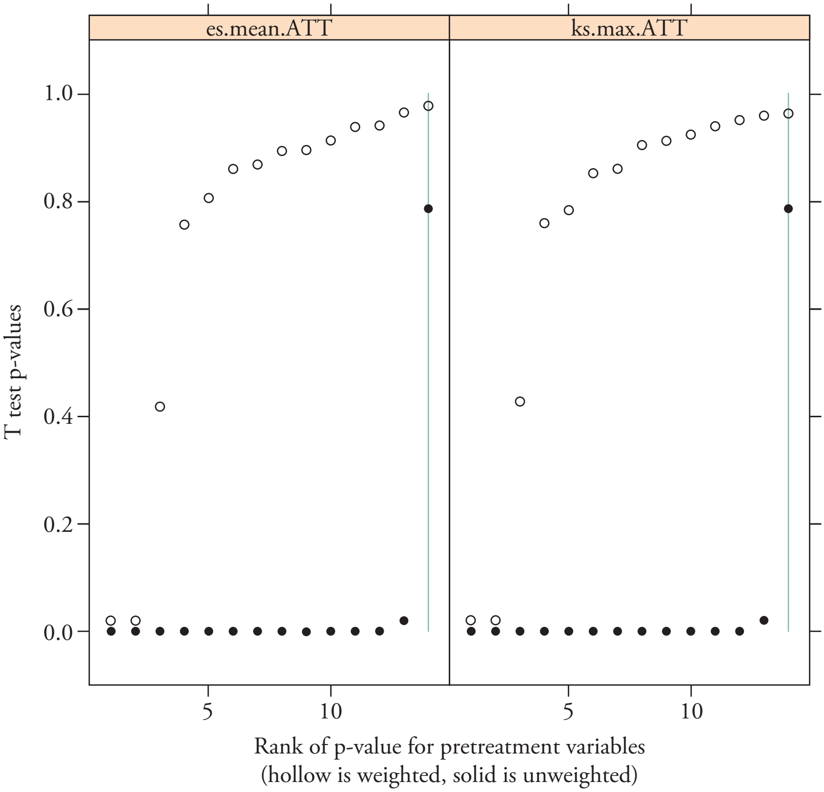


Source: compiled by authors.

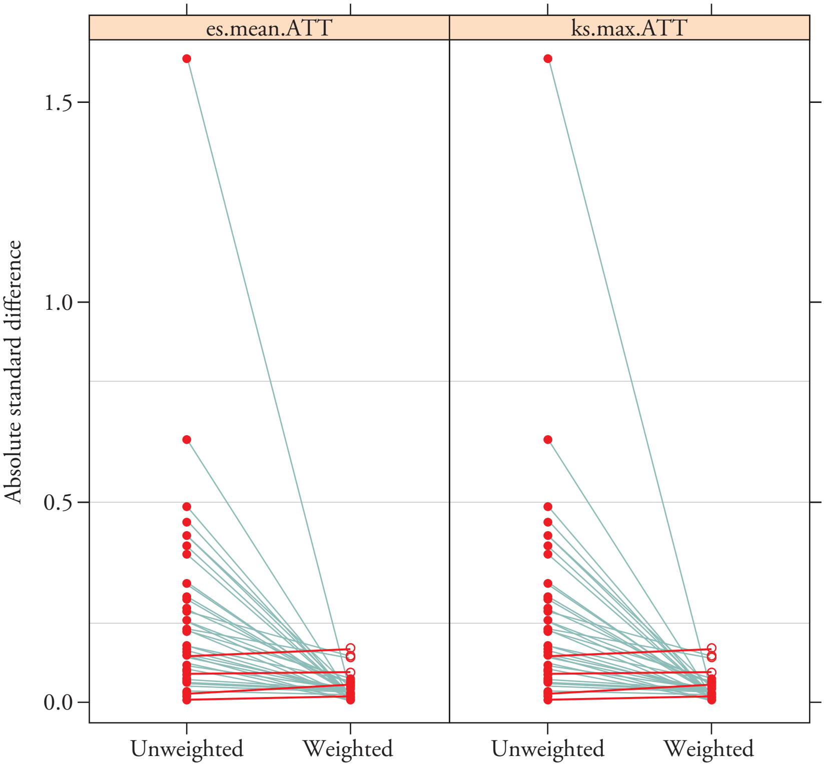
Figure 6
Results of machine learning balancing for hemoglobin level



Plot 2 (t): T-test P-values of Group Means of Covariates



Plot 3 (es): Standardized Effect Sizes Pre/Post Weighting



Source: compiled by authors.

4.2 Estimation of the impact of Qali Warma on anemia and CCM[11]

Next we present the results of the estimation of QW's impact on anemia and CCM. Table 4 reveals the marginal effects of the regressions on the probability of a child having anemia; columns 1 and 2 correspond to entropy balancing, while columns 3 and 4 correspond to balancing with machine learning. We present the results with and without controls.

---

[11] In response to suggestions that we gratefully received from anonymous peer reviewers that we test the validity of the results, we also performed OLS estimations and divided the sample randomly into two parts. We obtained results consistent with our OLS estimations; following estimation using a random variable we found that the treatment is not similar, which confirms the validity of the result.

Table 4
Estimation of the impact of Qali Warma on anemia

	(1)	(2)	(3)	(4)
VARIABLES	Anemia	Anemia	Anemia	Anemia
Receives Qali Warma	0.000	0.012	0.007	0.018
	(0.014)	(0.015)	(0.014)	(0.015)
Maternal education		-0.016		-0.010
		(0.013)		(0.013)
Breakfast and lunch		0.040*		0.039*
		(0.021)		(0.022)
Products modality		0.062**		0.051*
		(0.031)		(0.031)
Products and portions modality		0.004		-0.005
		(0.036)		(0.035)
Products modality *Months		-0.003		-0.003
		(0.003)		(0.003)
Products and portions modality *Months		0.001		0.000
		(0.001)		(0.001)
Number of months receiving		0.002		0.002
		(0.003)		(0.003)
Antenatal checks		-0.013		-0.005
		(0.025)		(0.025)
Birth weight		0.017		0.017
		(0.011)		(0.012)
Iron supplements during pregnancy		0.008		-0.000
		(0.023)		(0.023)
Number of GDCs		-0.003***		-0.004***
		(0.001)		(0.001)
Child's age		-0.063***		-0.048***
		(0.015)		(0.015)
Breastfeeding during first 6 months		-0.013		0.013
		(0.026)		(0.028)
Breastfeeding from 7 to 12 months		0.006		-0.039***
		(0.016)		(0.013)
Child's sex		-0.032**		0.000
		(0.013)		(0.016)

Observations	14,879	13,614	15,201	13,614
Balancing method[1]	EB	EB	ML	ML
Fixed effects	NO	YES	NO	YES

[1] EB=entropy balancing, ML=machine learning
Standard errors in parentheses.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$
Source: compiled by authors.

The estimations without controls show that QW does not have effects on the probability of a child having anemia. After including the controls, the coefficient of impact increases the magnitude but the result is still not significant.

As to the variables that do contribute to reducing the probability of suffering from anemia, we identify as statistically significant the number of GDCs, the child's age, breastfeeding from 6 to 12 months, and the child's sex.

It should be noted that of the controls, we take into account the heterogeneity of program modalities (products or rations) and the meals provided (breakfast or breakfast and lunch) with the aim of achieving more robust estimations.

Having found no effects, whether positive or negative, on any of the children in the sample, we analyze only children diagnosed with anemia to determine whether QW has any effect on their hemoglobin levels. Thus, we explore the possibility that there are effects on the tail of the distribution of the "hemoglobin level" variable, adjusted for altitude, to increase the robustness of the previous result. The estimations of OLS regressions on hemoglobin level are presented in Table 5, for which in all cases we use the two balancing methods and estimations with and without controls. In no case does the effect of receiving the program appear to improve or worsen children's hemoglobin levels. None of the control variables prove significant under either balancing method.

Table 5
Estimation of the impact of Qali Warma on hemoglobin in children with anemia

	(1)	(2)	(3)	(4)
VARIABLES	Hemoglobin	Hemoglobin	Hemoglobin	Hemoglobin
Receives Qali Warma	0.416	0.109	0.188	0.018
	(0.388)	(0.404)	(0.403)	(0.409)
Maternal education		-0.252		0.316
		(0.393)		(0.376)

Breakfast and lunch		-0.383		0.084
		(0.515)		(0.538)
Products modality		0.473		-0.152
		(1.058)		(0.856)
Products and portions modality		-0.780		-0.272
		(1.261)		(0.976)
Products modality *Months		-0.041		-0.024
		(0.078)		(0.071)
Products and portions modality *Months		0.040		0.018
		(0.036)		(0.028)
Number of months receiving		0.052		0.057
		(0.081)		(0.071)
Antenatal checks		0.052		-0.118
		(0.713)		(0.560)
Birth weight		0.133		0.226
		(0.308)		(0.294)
Iron supplements during pregnancy		-0.351		-0.045
		(0.668)		(0.539)
Number of GDCs		0.012		-0.000
		(0.022)		(0.019)
Child's age		0.176		0.042
		(0.364)		(0.338)
Breastfeeding during first 6 months		0.613		-0.073
		(0.715)		(0.547)
Breastfeeding from 7 to 12 months		0.511		0.437
		(0.375)		(0.306)
Child's sex		0.342		0.055
		(0.323)		(0.309)
Constant	103.461***	102.958***	103.707***	102.259***
	(0.373)	(2.131)	(0.389)	(2.340)
Observations	3,308	2,943	3,365	2,943
Balancing method[1]	EB	EB	ML	ML
Fixed effects	NO	YES	NO	YES

[1] EB=entropy balancing, ML=machine learning
Standard errors in parentheses.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$
Source: compiled by authors.

To verify the robustness of the results, we estimate similar regressions to those presented in Tables 4 and 5, which include, as controls, only the QW provision modalities. Table 6 presents the summarized results for machine learning estimations with fixed effects.[12]

Table 6
Impact of different Qali Warma provision modalities on anemia and hemoglobin

	(1)	(2)	(3)	(4)
VARIABLES	Anemia	Anemia	Hemoglobin	Hemoglobin
Breakfast and lunch	0.012		0.052	
	(0.016)		(0.389)	
Only portions		0.002		0.268
		(0.014)		(0.378)
Portions and products		0.004		0.981*
		(0.020)		(0.580)
Observations	14,816	14,816	3,299	3,299

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: compiled by authors.

As can be seen, only in the case of the receipt of both products and portions modalities is there a significant effect on children with anemia. Table 7 presents data on the marginal effects of regressions on the probability of a child having CCM. Columns 1 and 2 correspond to entropy balancing; and columns 3 and 4 to balancing by way of machine learning. In turn, columns 1 and 3 do not include controls, while 2 and 4 do.

Table 7
Estimation of the impact of Qali Warma on CCM

	(1)	(2)	(3)	(4)
VARIABLES	CCM	CCM	CCM	CCM
Receives Qali Warma	-0.002	0.004	-0.002	0.005
	(0.014)	(0.012)	(0.014)	(0.012)
Maternal education		-0.047***		-0.047***
		(0.010)		(0.010)
Breakfast and lunch		0.023*		0.013
		(0.014)		(0.015)

---

[12] In the case of the probit estimations of anemia, we report the marginal effects. Estimations without fixed effects do not yield any additional data of value.

Products modality		0.040		0.026
		(0.025)		(0.026)
Products and portions modality		0.045		0.060*
		(0.032)		(0.035)
Products modality *Months		-0.003		-0.002
		(0.003)		(0.003)
Products and portions modality *Months		-0.002*		-0.002**
		(0.001)		(0.001)
Number of months receiving		0.003		0.003
		(0.003)		(0.003)
Antenatal checks		-0.046**		-0.051**
		(0.020)		(0.020)
Birth weight		-0.099***		-0.096***
		(0.008)		(0.008)
Iron supplements during pregnancy		0.023		0.027
		(0.020)		(0.020)
Number of GDCs		-0.001**		-0.002**
		(0.001)		(0.001)
Child's age		-0.029***		-0.029**
		(0.011)		(0.012)
Breastfeeding during first 6 months		-0.062***		-0.066***
		(0.019)		(0.021)
Breastfeeding from 7 to 12 months		-0.020*		0.003
		(0.012)		(0.010)
Child's sex		0.008		-0.013
		(0.010)		(0.012)
Observations	14,888	13,621	15,209	13,621
Balancing method[1]	ML	EB	ML	ML
Fixed effects	NO	YES	NO	YES

[1] EB=entropy balancing, ML=machine learning
Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1
Source: compiled by authors.

No significant impacts on the probability of having CCM are identified in any case. With regard to the control variables, maternal education, number of GDCs, birth weight, breastfeeding until 6 months and, to a lesser extent, until 12 months reduce the probability of experiencing CCM.

In Table 8, we present only children with CCM and estimate whether receiving QW has an impact on the Z-score.

Table 8
Estimation of the impact of Qali Warma on the Z-score among children with CCM

	(1)	(2)	(3)	(4)
VARIABLES	Z-score	Z-score	Z-score	Z-score
Receives Qali Warma.	-2.910	-4.110	-2.381	-5.560
	(3.815)	(3.537)	(3.706)	(3.465)
Maternal education		8.135***		5.870**
Breakfast and lunch		4.522		0.874
		(3.749)		(3.664)
Products modality		1.754		6.878
		(6.864)		(7.535)
Products and portions modality		13.219*		18.327**
		(6.747)		(7.887)
Products modality *Months		-0.121		-0.653
		(0.635)		(0.667)
Products and portions modality *Months		-0.040		-0.221
		(0.251)		(0.260)
Number of months receiving		-0.265		0.416
		(0.647)		(0.661)
Antenatal checks		-1.518		-0.890
		(4.158)		(4.263)
Birth weight		2.395		2.158
		(2.651)		(2.548)
Iron supplements during pregnancy		2.189		2.042
		(3.883)		(4.035)
Number of GDCs		-0.007		0.193
		(0.184)		(0.177)
Child's age		12.386***		7.813**
		(3.645)		(3.168)
Breastfeeding during first 6 months		-1.151		-4.234
		(5.842)		(6.182)
Breastfeeding from 7 to 12 months		9.685***		-1.917
		(2.944)		(2.731)

Child's sex		-2.247		7.718***
		(3.084)		(2.949)
Constant	-245.810***	-320.104***	-246.276***	-293.076***
	(3.697)	(21.288)	(3.586)	(19.484)
Observations	2,398	2,023	2,423	2,023
Balancing method[1]	EB	EB	ML	ML
Fixed effects	NO	YES	NO	YES

[1] EB=entropy balancing, ML=machine learning
Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1
Source: compiled by authors.

As Table 8 shows, we do not identify effects in any of the four regressions presented. Maternal education, child's age, and breastfeeding from 7 to 12 months appears to have the expected positive effects on the Z-score of height/age.

As with anemia and hemoglobin in Table 6, to ensure the robustness of the results we estimate regressions that include, as controls, only QW modalities. In Table 9 we present an overview of the results, none of which prove significant.

Table 9
Impact of different Qali Warma modalities on chronic child malnutrition

	(1)	(2)	(3)	(4)
VARIABLES	MALNUTRITION	MALNUTRITION	Z-score	Z-score
Breakfast and lunch	0.005		-4.043	
	(0.013)		(3.419)	
Only portions		0.004		-3.312
		(0.012)		(3.634)
Portions and products		-0.023		-1.052
		(0.015)		(4.254)
Observations	14,825	14,825	2,391	2,391

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: compiled by authors.

In sum, for most estimations we find that the QW program has no effects, whether positive or negative, on anemia. Likewise, we are unable to identify effects on CCM and the Z-score of the height/age indicator. Only in the estimation without controls for the child and the mother did we discern that joint receipt of products and portions has a positive impact on the hemoglobin levels of children with anemia.

5. CONCLUSIONS

We applied a quasi-experimental method to assess the nutritional impact of Qali Warma on children aged 3 to 5, based on the use of data from the ENDES survey for four consecutive years. The results obtained through the use of entropy balancing and machine learning were robust.

The evidence presented in this study indicate that no effects on anemia or on chronic child malnutrition can be attributed to the program. In addition, the number of months that a child has been a program recipient is not significant in any estimation; that is, the intensity of treatment likewise has no effect in terms of reducing anemia or CCM. A possible explanation for this is food substitution between the school and the home, possibly because, as Lavado and Barrón (2019) find, breakfast at home tends to contain more iron and proteins than the QW breakfast.

One question that we have not been able to answer given the characteristics of the available data, and which therefore remains outstanding for future studies, is whether children who previously received Cuna-Más, Juntos, SIS, or other social programs are experiencing nutritional benefits from QW through sustained improvements in their dietary habits, health conditions, or parental care between 3 and 5 years of age.

We suggest that the program be revised in order to meet its aim of tackling nutritional problems such as chronic child malnutrition and anemia, which, as international and national studies have found, are important factors in learning attainment. There is a clear need to carefully evaluate the food provided and its actual nutritional content, particularly considering Lavado and Barrón's (2019) finding that QW food consumed only accounts for 16.7% of a child's iron intake, and that 93% of recipients ingest less iron than expected. This is related to the program's operation and implementation, provision modalities, continuity throughout the year, relationships with families, and effects on children's consumption.

REFERENCES

Alcázar, L (2012). *Impacto económico de la anemia en el Perú*. Lima: Grupo de Análisis para el Desarrollo.

Alcázar, L. (2016). Algunas reflexiones sobre los programas alimentarios y nutricionales: cambios y retos durante la última década. In *Investigación para el desarrollo en el Perú. Once balances* (pp. 251-296). Lima: Grupo de Análisis para el Desarrollo.

Alderman, H., & Bundy, D. (2011). School feeding programs and development: are we framing the question correctly? *The World Bank Research Observer*, *27*(2), 204-221.

Athey, S., & Imbens, G. W. (2017). The State of Applied Econometrics: Causality and Policy Evaluation. *The Journal of Economic Perspectives*, *31*(2), 3-32.

Babu, S., Gajanan, S. N., & Hallam, J. A. (2016). *Nutrition economics: Principles and policy applications*. London: Academic Press.

Balarajan, Y., Ramakrishnan, U., Ozaltin, E., Shankar, A.H., & Subramanian. S.V. (2011). Anaemia in low-income and middle-income countries. *Lancet*, *378* (9809), 2123-35.

Barrón, M., & Ministerio de Desarrollo e Inclusión Social. (2017). *Evaluación de Impacto del Programa Nacional de Alimentación Escolar Qali Warma-Nota Metodológica*. Lima: MIDIS.

Beard, J. L., & Connor, J. R. (2003). Iron status and neural functioning. *Annual review of nutrition*, *23*(1), 41-58.

Bitler, M., & Wilde, P. (2011). Economics of Nutrition. In A. J. Culyer. *Encyclopedia of Health*. Elsevier. Retrieved from https://www.economics.uci.edu/files/docs/faculty_review/bitler-wilde-book-chaper-working-paper-2011.pdf

Buhl, A. (2010). *Meeting nutritional needs through school feeding: a snapshot of four African nations*. Washington, D.C: Global Child Nutrition Foundation.

Buttenheim, A., Alderman, H., & Friedman, J. (2011). Impact evaluation of school feeding programmes in Lao People´s Democratic Republic. *Journal of Development Effectiveness*, *3*(4), 520-542.

Comisión de Reorganización administrativa de Qali Warma (2018). *Informe Final*. Lima: MIDIS.

Gajate, G., & Inurrétegui, M. (2001). *El impacto de los programas alimentarios sobre el nivel de nutrición infantil: una aproximación a partir de la metodología del "Propensity Score Matching*." Lima: Consorcio de Investigación Económica y Social. Mimeo.

Hainmueller, J. (2012). Entropy balancing for causal effects: A multivariate reweighting method to produce balanced samples in observational studies. *Political Analysis*, *20*(1), 25-46.

Hawkes, C., Ruel, M., Salm, T., Sinclair, L.B., & Branca, F. (2019). Double-duty actions: seizing programme and policy opportunities to address malnutrition in all its forms. *Lancet*, *395*(10218), 142-155.

Instituto Nacional de Salud. (2017). *Prioridades de investigación del Instituto Nacional de Salud 2018-202 RJ N° 355-2017/OPE/INS*. Lima: INS.

Instituto Nacional de Estadística e Informática. (2019). *Series anuales de indicadores principales de la ENDES 1986-2018*. Lima: INEI.

Jaramillo, M., & Sánchez, A. (2011). *Impacto del programa Juntos sobre nutrición temprana* (Documento de Investigación 61). Lima: Grupo de Análisis para el Desarrollo.

Lavado, P., & Barrón, M. (2019). *Evaluación de Impacto del Programa Nacional de Alimentación Escolar Qali Warma*. Lima: Ministerio de Desarrollo e Inclusión Social.

McCaffrey, D., Griffin, B., Almirall, D., Slaughter, M., Ramchand, R., & Burgette, L. (2013). A tutorial on propensity score estimation for multiple treatments using generalized boosted models. *Statistics in medicine*, *32*(19), 3388-3414.

Miller, J. (1999). *School Feeding Programs: improving effectiveness and increasing the benefit to education, a guide for program managers*. Oxford: The Partnership for Child Development.

Ministerio de Desarrollo e Inclusión Social. (2013). *Política Nacional "Incluir Para Crecer*." Lima: MIDIS.

Ministerio de Desarrollo e Inclusión Social. (2015). *Metodología para la Determinación de la Clasificación Socioeconómica. RM* Nº 151-2016-MIDIS. Lima: MIDIS.

Ministerio de Salud. (2014). *Plan Nacional para la Reducción de la Desnutrición Crónica Infantil y la Prevención de la Anemia en el país: 2014-2016. RM N° 258-2014/ MINSA*. Lima: Minsa.

Ministerio de Salud. (2017). *Plan Nacional para la Reducción y Control de la Anemia Materno Infantil y la Desnutrición Crónica Infantil en el Perú: 2017-2021. RM N° 249-2017/MINSA*. Lima: Minsa.

Pollitt, E., Jacoby, E., & Cueto, S. (1996). *Desayuno escolar y rendimiento: a propósito del Programa de Desayunos Escolares de Foncodes en el Perú*. Lima: Editorial Apoyo.

Ridgeway, G., Mccaffrey, D., Ann, B., & Burgette, L. (2014). *Twang: Toolkit for weighting and analysis of non-equivalent groups*. Santa Monica, CA: RAND Corporation. Retrieved from Http://Cran.Rproject.Org/Web/Packages/Twang/Vignettes/Twang.Pdf

Shrimpton, R., & Rokx, C. (2012). *The double burden of malnutrition: a review of global evidence*. Washington, D.C: World Bank.

Smith, L., & Haddad, L. (2000). *Explaining Child Malnutrition in Developing Countries. A Cross-Country Analysis.* Washington, D.C: International Food Policy Research Institute.

Wisbaum, W. (2011). *La desnutrición infantil: causas, consecuencias y estrategias para su prevención y tratamiento*. Madrid: Fondo de las Naciones Unidas para la Infancia.

World Food Programme. (2004). *School Feeding Programs: why they should be scaled up now*. Rome: WFP.

World Health Organization & Center for Disease Control and Prevention. (2004). *Assessing the Iron Status of Populations*. Geneva: WHO.

World Health Organization. (2011). *Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity*. Geneva: WHO (WHO/NMH/NHD/ MNM/11.1). Retrieved from https://www.who.int/vmnis/indicators/haemoglobin.pdf