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Attainments and limitations of an early childhood programme in Colombia

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The Growth and Development Monitoring Programme is a longstanding early childhood social intervention in Colombia. The programme's goal is the prevention and early identification of problems affecting children's health and nutrition. To achieve this aim, the programme's basic strategy is to educate parents about the overall health care of infants. The objective of this study is to measure the impact of this programme on children's nutrition and health status and maternal child-care practices. To address potential selection bias, we employ quasi-experimental techniques. This article uses data from the Demographic Health Survey of 2010. The evidence suggests that the programme improved immunization status and the likelihood of health care for acute respiratory infection or fever. As expected, the programme has a greater impact on children from among the poorest people in the country. In the most advanced regions and for the beneficiaries of private health care, the effects of the programme have tended to be negligible. In this sense, our central policy recommendation is to optimize the programme for the poorest households in the country.

Keywords Child health, malnutrition, policy evaluation, health care

KEY MESSAGES

- The lack of overall child care is a problem that troubles governments.
- The Growth and Development Monitoring Programme has positive effects on immunization and the likelihood of seeking treatment to address the symptoms of acute respiratory infection or fever.
- Our central policy recommendation is to optimize the programme for the households enrolled in the subsidized health scheme.

Introduction

The lack of overall child care is a problem that troubles governments. According to the World Health Organization (WHO), approximately 6.9 million children younger than 5 years died in 2011 (WHO 2012). The primary causes of these deaths are related to respiratory problems, diarrhoea, immune deficiencies and malnutrition. This fact has long-term implications. There is evidence that educational attainment and subsequent labour productivity largely depend on early childhood development (Maluccio *et al*. 2006; Grantham-McGregor *et al*. 2007; Heckman and Masterov 2007). Governments in developing countries have implemented several policies to address this problem. These policies include the provision of nutritional supplements, price subsidies, cash transfers and child-care programmes. Despite all of these efforts, continued attention to the paediatric population remains a priority on the public health agenda.

One of the best-known early childhood interventions is the Growth and Development Monitoring Programme (GDMP). This programme has been in place since the 1970s and has been revised over the course of its existence. A noteworthy change is Resolution 0412 from 2000, which introduced the Standard Technique for the Early Detection of Impaired Growth and Development in Children younger than 10 years. Potential

beneficiaries of this policy include all infants participating in contributory and subsidized schemes—from birth up to 10 years of age. There are two types of health insurance schemes, contributory and subsidized, each with its specific benefit packages. In the contributory scheme, all employers disburse a certain percentage of formal workers' monthly wages to a number of insurers called *Empresas Promotoras de Salud*. Now, the subsidized programme is designed to insure people without payment capacity. In this case, the central government allocates an annual amount to local governments that hire insurers called *Administradoras del Régimen Subsidiado* to maximize coverage. Poor people who are not affiliated with either regime are treated in local-government health centres that provide a few early-intervention services as well as intermediate- and high-level care. The programme's goal is the prevention and early identification of problems affecting children's health and nutrition. To achieve this aim, the programme's basic strategy is to educate parents about the overall health care of infants.

The objective of this study is to quantify the impact of the GDMP on a set of outcome variables. Specifically, these variables are related to the nutrition and health status of children younger than 5 years and maternal child-care practices. To this end, we employ quasi-experimental techniques for two reasons. First, there are differences in the characteristics of relevant variables among children enrolled in the GDMP and eligible children who do not receive programme benefits, which may imply bias. Second, the scope of the programme in terms of coverage is not universal, which allows us to have an ample control group and sufficiently wide variability. Additionally, the programme is evaluated while accounting for the regional location and the type of health system in which the infants are enrolled. We conduct a technical evaluation of the GDMP, a programme that, despite its importance to the health of Colombian children, has yet to be evaluated.

The effects of other programmes targeting children in Colombia have already been measured. One is the so-called *Hogares Comunitarios de Bienestar* (HCB) of the *Instituto Colombiano de Bienestar Familiar*. Bernal *et al*. (2009) find mixed evidence regarding the impact of this programme. Although there are gains in chronic malnutrition for children between 2 and 4 years of age, the effect of the programme on the prevalence of acute respiratory infection (ARI) and diarrhoea is negative. In addition to evaluating HCB, Gaviria and Palau (2006) determine the impact of a subsidized health-care programme, the Subsidized Health Care Regime. These authors demonstrate that the Subsidized Health Care Regime has a positive impact on the birth weight of infants from the poorest households. Furthermore, they find no effect of the HCB on the height of children. Regarding another similar programme, *Familias en Acción*, the Colombian *Departamento Nacional de Planeación* (DNP) finds that the programme reduces the probability that a child will suffer from chronic malnutrition by 7% (DNP 2006).[1] The common denominator of these programmes is their relative success in terms of nutrition, whereas the results regarding other aspects of child development are less favourable.

Internationally, a programme similar to that described above was The Bangladesh Integrated Nutrition Programme. One of the primary objectives of this programme was to provide basic nutritional literacy to mothers of children with nutritional deficiencies. White and Masset (2007) found that the programme had no significant impact on malnutrition indicators. According to these authors, a potential explanation for the lack of effects is the resource constraints faced by the mothers. Other programmes that are less similar to the GDMP and have focused on improving child nutrition indicators have been evaluated. Behrman *et al*. (2004) find that Bolivia's *Proyecto Integral de Desarrollo Infantil* improves early cognitive skills and nutrition. In Mexico, Behrman and Hoddinott (2005) evaluate the *Programmea de Educación, Salud y Alimentación*, better known as PROGRESA and now called *Oportunidades*. Controlling for the heterogeneity of children, the authors find that PROGRESA has positive and significant impacts on children's height. In a different context, Andrade *et al*. (2012) examine the impact of the Brazilian *Bolsa Famĩlia* Programme on the implementation of the immunization schedule among children between 0 and 6 years of age. Their results suggest that for the year 2005, the programme does not affect the likelihood of childhood immunization. However, other studies have shown that *Bolsa Famĩlia* in Brazil contributes to the reduction of the infant mortality rate associated with causes such as malnutrition and diarrhoea (Oliveira *et al*. 2011; Rasella *et al.* 2013). This diverse array of studies reflects the differences among programmes focused on early childhood physical growth and psychoemotional well-being.

Growth and Development Monitoring Programme

In Colombia, the interest in providing continuing care to improve child development dates back to the 1960s. The dramatic rates of morbidity and mortality among children and mothers were one of the primary motivations for the introduction of such programmes. According to the Pan American Health Organization (PAHO), the first initiative implemented was called the Maternal Extension Programme and Child Protective Service under the sponsorship of the Colombian national government and the PAHO (2002). Since 1973, under the auspices of the United Nations Fund for Population Activities, the Colombian government has agreed to intensify efforts to expand child-care services. According to the National Health Plan 1968–1977, this commitment was pursued through the Maternal Child Programme, which prioritized, among other provisions, the prevention of diseases among mothers and their children through vaccination, sanitation and nutrition. As a result of these programmes, child malnutrition indicators have improved substantially since the 1970s, despite the stagnation witnessed in the first half of this century [Garcia *et al*. 2012; Demographic and Health Survey (DHS) 2011].

The GDMP was created in 2000 by Resolution 0412 to reduce the rates of infant morbidity and mortality by providing comprehensive early childhood care. Since this time, no new legal framework encompassing substantial changes in the implementation process or the way in which the GDMP intervenes has been established. Since the foundation of the programme, new beneficiaries have been allowed to register each year. Therefore, it follows that the structure of the programme continues unchanged. Specifically, the GDMP

consists of a series of procedures, interventions and evaluations of growth and development performed continuously by health professionals for children younger than 10 years. These activities included in the programme are performed periodically, allowing the doctor to take preventive measures against diseases that can affect children's normal growth and development. The growth of infants is assessed through medical check-ups, i.e. by evaluating their weight and height. On the other hand, childhood development is assessed by evaluating motor skills, hearing and personal-social language. The GDMP also aims to educate parents about balanced nutrition, immunization, early stimulation, accident prevention, oral hygiene, acute diarrhoea, ARI, etc.

Unlike other social measures of child health in Colombia, the GDMP does not focus solely on the population in extreme poverty and therefore is a programme with wide coverage. In fact, the GDMP aims for universal coverage among children. For this reason, the population eligible to participate in the GDMP is the one that belongs to the contributory or the subsidized health scheme. Once the mother, father or caregiver of an infant adopts one of these health schemes, they can enrol the newborn in the GDMP at the institution of birth. That is infants become beneficiaries of the GDMP at the same time they are registered at birth. Despite the relative ease with which the eligible population can become a beneficiary of the GDMP, there is still no universal coverage. A report by the DHS (2011) revealed that approximately 70% of mothers who gave birth between 2005 and 2010 had their children enrolled in the GDMP (DHS 2011). The children of these mothers were cared for only if they had a special card provided by the government. In the event the card was lost, a new one could be claimed at a health services institution. According to the DHS (2011), only approximately 4% of mothers declared GDMP beneficiaries did not have the card. Thus, the non-transitory possession of the card was not an obstacle to receive programme benefits.

A control scheme for growth and development, split into different age ranges, is set in the GDMP. Thus, at birth or in the first month of life, the first comprehensive assessment or medical surveillance and the early identification or registration of a newborn is carried out before departure from the health agency where birth occurs. If the latter occurs outside a health institution, enrolment is done as soon as possible after the child enters any medical institution. In any case, during the GDMP registration, parents or caregivers of infants are informed of the benefits of the programme. The first medical control includes the development of clinical history, the processing of the child's health card and the allocation of activities such as subsequent medical checks. Infants between their first month and first year of life are monitored through three to four check-ups performed annually. These controls include education in health promotion and the prevention of the most common newborn diseases, the vaccination requirements established in the Norma de Programa Ampliado de Inmunizaciones, iron supplementation for 30 days every 6 months starting from 6 months of age and motivation for mothers to breastfeed their newborns. In addition, children between 2 and 7 years of age should be examined at least 4 times (25–30 months, 31–36 months, 37–48 months, 49–60 months, 61–66 months, 67–72 months, 73–78 months, 79–84 months). The health scheme protocols for this age range require the completion of medical checks, vision and hearing assessment, iron supplementation for 30 days every 6 months to 5 years of age, prevention and oral health promotion, provision of deworming, nutrition education activities and childcare. The frequency of follow-up visits for infants between 8 and 10 years is determined by the programme scheme once every year. The guidelines of the GDMP for this latter range of age are similar to those for the previous range.

Methodology

Data

This article employs data from the DHS collected by PROFAMILIA in 2010. The DHS uses a multistage cluster sampling design to obtain a nationally representative sample of women of childbearing age, their children younger than 5 years and their spouses. The questionnaires solicit information on household socioeconomic and demographic characteristics. Mothers were asked if their children younger than 5 years were enrolled in the GDMP and, if so, were asked to present their membership cards. There are modules on health, nutrition and child-care practices, from which we extracted a set of variables that we consider the most important for assessing the impact of the GDMP. Previous studies in Colombia have already used data from the DHS to address issues related to child health, such as the determinants of antenatal care and institutional delivery (Vecino-Ortiz 2008; Trujillo *et al*. 2014). Table 1 summarizes these variables.

Children eligible for the GDMP are those participating in either the contributory or subsidized health scheme. The eligible children were classified into two groups, ''participants'' and ''non-participants''. The first consists of the children enrolled in the GDMP at the time of the survey. Children who were reported to be GDMP beneficiaries but whose parents failed to present membership cards are not considered in the analysis. This omission does not imply a substantial loss of observations (4% of all children enrolled in the GDMP). The group of non-participants is composed of potential beneficiaries who reported not being enrolled in the programme. We focus on children born between 2005 and 2010. The fact that the programme was introduced in 2000 does not affect our evaluation because the programme has not changed in legal terms since its inception and new beneficiaries can be continually registered. The total sample consisted of 10 630 children between 0 and 5 years of age, 66% of whom are enrolled in the programme. The GDMP is evaluated at the aggregate level with respect to the children's age range, region of residence and type of health programme. The age ranges are 0–2, 2–4 and 4–5 years. Geographically, the sample is divided into those residing in the Andean region and those residing in other regions. The former region is composed of the sub-set of the country's wealthiest regions in terms of Gross Domestic Product per capita, specifically Bogotá, Antioquia, Valle del Cauca and the central and eastern regions. The other regions correspond to the sub-regions of Atlántica, Pacífica, San Andrés and Orinoquía-Amazonía. The analysis does not simultaneously divide the sample by age, region and type of health system, as this would considerably reduce the sample size. For the same reason, the programme's effect on

Table 1 Description of the outcome variables

Outcome variable	Description
Health	
ADD	Symptoms of acute diarrhoeal disease in the 2 weeks preceding the survey.
ARI	Symptoms of ARI in the 2 weeks preceding the survey.
Complete vaccination[a]	Infants who received the triple viral vaccine and immunization against tuberculosis, pertussis, tetanus, diphtheria and polio.
Nutrition	
Chronic malnutrition	Low height for age and sex of the reference population.[b]
Acute malnutrition	Low weight for height and sex of the reference population.[b]
Child-care practices	
Treatment of ADD	Mothers who sought aid or treatment for the pathology
Treatment of ARI/fever	

Notes: ADD, acute diarrhoeal disease.

[a]Immunization information is only available in the survey for children younger than 2 years.

[b]The reference population is that imposed by the WHO (2006). If a child registers a weight or height two standard deviations below the reference population, she/he is said to have chronic malnutrition and acute malnutrition, respectively.

Source: Author's calculations.

acute diarrhoeal disease treatment is not assessed based on the aforementioned children's age groups.

It is important to describe how the outcome variables are investigated in the DHS. Variables that could be subject to measurement error are related to vaccination. The DHS investigates this variable asking the respondent mother to show the vaccination card. However, immunization is very difficult to be measured because individuals usually lose their cards. For infants who do not have the card, we used self-reported information by the mother. This might introduce some bias, but our estimates excluding the latter group are qualitatively similar to our main findings (Not shown).[2]

Empirical approach

In this study, we employ the Propensity Score Matching (PSM) technique. This method evaluates the impact of an intervention by considering the counterfactual of the beneficiaries' outcomes had the intervention not occurred (Rosenbaum and Rubin 1983). However, this evaluation would require observing the same individual in two states at the same time, which is naturally impossible. Thus, Rosenbaum and Rubin (1983) propose the use of the conditional probability of participation in the programme $P(Z=1|X)$ to identify individuals who can serve as counterfactuals for those in the treatment group. Specifically, an individual in the control group will serve as the counterfactual for an individual in the treatment group if both have approximately the same likelihood of programme participation, given a set of covariates. One advantage of this procedure is that it numerically summarizes important individual characteristics, which facilitates matching.

Formally, the average treatment effect on the treated (ATT) is defined as follows:

$$\mathrm{ATT} = E_{p(x)|z=1}\left\{E[Y(1)|z=1, P(X)] - E[Y(0)|Z=0, P(X)]\right\} \quad (1)$$

where $Y(1)$ and $Y(0)$ denote the observed outcome of the target variable in the treatment and control groups, respectively. In this study, Equation (1) is estimated by imposing the common support restriction. Specifically, we use the criterion of minimum and maximum, which discards the observations in each group, whose chances of participation are lower (higher) than the minimum (maximum) of the other group. This method ensures that the individuals being compared are actually comparable (Heckman *et al*. 1999). We use a logit model with robust errors as the functional form of the probability of participation. The literature agrees that there are crucial differences between the logit and probit specifications when the variable that defines the treatment is binary (Smith 1997). To identify the counterfactual outcomes in the control group, we employ two matching techniques: caliper matching and local linear regression.

The underlying assumption of this strategy is that both the probability of participation in the programme and the target variables solely depend on the variables observed by the researcher. This assumption may fail in the presence of unobservable factors that affect the probability of participation and health outcomes. An unobservable factor that in particular may be a threat to our study is the mothers' degree of knowledge of the health benefits of their children's participation in social programmes. Mothers with greater knowledge of such benefits are probably those who invest in the health care of their children even in the absence of those social programmes. The omission of this unobserved factor would lead to an overestimation of the impact of GDMP in our analysis. To address this problem, we include a large set of variables that could be related to the degree of knowledge of mothers about the importance of social programmes for child health (these variables are described in the following section). These variables include educational attainment. In particular, we argue that mothers with more education are more likely to have more and better information about the returns in the health of their children gained from participating in the GDMP. To assess the credibility of this strategy, we calculate the size of the standardized bias (SSB). That is, after pairing, we evaluate whether there are differences in observable factors that

determine participation in the programme. The observation of such differences would be an indication that there are also differences in unobservable factors. These differences, in turn, would imply that variables such as education do not adequately control for the degree of information of mothers, which would invalidate our empirical strategy. The results of this exercise are presented in the Results section.

Another important issue is ensuring that the impact on the output variables only concerns the GDMP and is not related to other interventions. In Colombia, other social interventions aimed at improving children's health have been delivered. Among these efforts, one of the most significant is the programme *Familias en Acción*. There is no legal restriction against a beneficiary of *Familias en Acción* deciding to participate in the GDMP. Therefore, if our empirical approach does not control for participation in *Familias en Acción*, it would lead to an impact on the output variables and not only the GDMP. We have no information to directly control for participation in the *Familias en Acción* program. However, this lack of a control should not actually be a problem in our study for at least two reasons. First, the main criterion for eligibility to participate in the government's other interventions is an index of household wealth (DNP 2008). This index is constructed by the DNP. The factors taken into account by this index are those related to the quality of home life.[3] If we control for this index, we implicitly eliminate the bias in our estimates attributable to participation in other interventions. We have no information on this index for the data used. However, DHS provides a wealth index based on many of the variables used by the index of the DNP. It is plausible to argue that there is a strong correlation between the two indices. Thus, we include the wealth index of the DHS as a proxy for the index of DNP. Thus, we ensure that the impacts on the outcome variables estimated in this study refer to those on the GDMP.

Second, other interventions generally focus on different populations rather than those covered by the GDMP. Indeed, other interventions focus on smaller population groups: households in extreme poverty. However, the GDMP does not focus only on households in extreme poverty but also offers much greater coverage, as detailed above. Therefore, we hold that participation in other interventions does have marginal effects on our estimates of the impact of the GDMP.

Results

Descriptive statistics

Table 2 presents descriptive statistics of the variables we use to explain participation in the GDMP. These variables correspond to those commonly used in health impact assessment and child nutrition studies (Behrman and Hoddinott 2005; Andrade *et al.* 2012). Similarly, Table 2 also presents descriptive statistics for the outcome variables. In general, significant differences are observed between enrolled and unenrolled individuals at the national level. The incidence of chronic malnutrition and the prevalence of ARI are higher for non-beneficiaries. The average age of household heads is approximately 39 years. Both schooling and the average number of antenatal consultations are slightly higher for participant mothers than for non-participants. The share of infants born in a hospital is 11 percentage points (PP) higher for those enrolled in the GDMP. The ages, in months, of children in the treatment and control groups are 30 and 24, respectively. Among first-born children, 40% are beneficiaries, whereas this figure is 30% for non-beneficiary children. The socioeconomic status of households in the treatment group is significantly higher. Overall, among the total number of children, 62% are located in urban areas, 50% live in the Andean region and 30% have mothers who perform at least one labour activity.[4]

In the regional context, there are no significant differences in the age of the household head between the treatment and control groups in the Andean region. The difference between participants and non-participants with respect to maternal education is greater in the other regions. The gap between the treatment and control groups with respect to the proportion of women who gave birth in a hospital is also eight times larger in this geographical area. No regional variations by treatment condition are observed regarding the genders of the infants. Households not enrolled in the GDMP are more likely to have children younger than 5 years, and this difference is more pronounced for households residing in the other regions. Moreover, the participants in these regions enjoy significantly better socioeconomic status than non-participants. Examining the composition of sub-national territories indicates high participation rates in the central and eastern regions of the Andean region and the Atlantic and Orinoco-Amazon regions in the other regions.

In summary, the evidence suggests that treated individuals are a select group of children who come from households facing better economic conditions, having fewer family members and that are more likely to be located in urban areas of the country. The mothers of these infants show a higher average number of prenatal visits, are more likely to give birth in a hospital and demonstrate higher educational attainment. These characteristics vary according to the region of the country under consideration. Ignoring these differences between the treatment and control groups with respect to socioeconomic and demographic variables may lead to biased results when estimating the impact of the GDMP.

Estimation results

The logit model used to estimate the probability of participation presents a good fit in all estimated models. The final specification of each model was obtained recursively. Specifically, we added quadratic and interaction terms until there were no significant differences in the explanatory variables between participants and non-participants for each "stratum" of the likelihood of participation. To select the optimal number of strata, we followed the criterion of Dehejia and Wahba (1999, 2002). The number of strata was between 5 and 10. The most significant variables in explaining the decision to participate in the programme are related to household composition, maternal characteristics and geographic location. In particular, infants from families with fewer children between 0 and 5 years of age and facing better economic conditions are more likely to be enrolled in the GDMP. The higher the number of prenatal visits and years of maternal education are, the higher the probability that a child is enrolled in the programme becomes. At the

Table 2 Descriptive statistics

	Variable type	Colombia				Andean region				Other regions			
		Total	NT	T	Difference	Total	NT	T	Difference	Total	NT	T	Difference
Output variables													
Acute malnutrition	Categorical	0.038	0.055	0.030	0.025***	0.026	0.034	0.023	0.011**	0.049	0.068	0.037	0.030***
Chronic malnutrition	Categorical	0.147	0.181	0.130	0.051***	0.105	0.113	0.102	0.011	0.183	0.223	0.158	0.064***
ADD	Categorical	0.108	0.085	0.119	−0.033***	0.095	0.074	0.103	−0.029**	0.119	0.092	0.137	−0.044***
ARI	Categorical	0.151	0.156	0.148	0.008	0.133	0.116	0.140	−0.023**	0.166	0.181	0.157	0.024**
Complete vaccination	Categorical	0.429	0.240	0.556	−0.316***	0.466	0.264	0.564	−0.299***	0.398	0.226	0.547	−0.322***
Treatment of ARI/fever	Categorical	0.476	0.402	0.509	−0.107***	0.471	0.436	0.482	−0.046*	0.480	0.385	0.534	−0.149***
Treatment of ADD	Categorical	0.411	0.357	0.439	−0.082***	0.424	0.401	0.431	−0.029	0.401	0.339	0.446	−0.107***
Individual characteristics													
Age of household head	Continuous	39.52	39.23	39.67	−0.444	38.93	38.66	39.03	−0.368	40.03	39.57	40.32	−0.749**
Age of mother	Continuous	19.74	19.28	19.98	−0.698***	20.14	19.77	20.29	−0.517***	19.40	18.98	19.66	−0.683***
Mother employed	Categorical	0.318	0.323	0.315	0.008	0.333	0.329	0.334	−0.004	0.305	0.320	0.296	0.024*
Mother married	Categorical	0.166	0.156	0.172	−0.016**	0.188	0.164	0.197	−0.032***	0.149	0.151	0.147	0.004
Years of education of mother	Continue	7.912	7.298	8.223	−0.925***	8.446	8.135	8.565	−0.430***	7.455	6.788	7.878	−1.090***
Prenatal visits	Continue	6.233	5.313	6.689	−1.376***	6.821	6.391	6.984	−0.593***	5.686	4.597	6.366	−1.769***
Institutional delivery	Categorical	0.903	0.827	0.941	−0.114***	0.958	0.941	0.965	−0.024***	0.852	0.751	0.915	−0.164***
Boy	Categorical	0.508	0.511	0.506	0.005	0.508	0.513	0.505	0.008	0.508	0.509	0.506	0.002
Child's age in months	Continue	28.40	24.66	30.24	−5.577***	28.75	25.08	30.12	−5.034***	28.10	24.41	30.37	−5.959***
Firstborn	Categorical	0.376	0.308	0.411	−0.103***	0.422	0.345	0.452	−0.107***	0.336	0.285	0.369	−0.083***
Secondborn	Categorical	0.274	0.269	0.277	−0.008	0.289	0.305	0.283	0.022	0.262	0.247	0.271	−0.024**
Household characteristics													
Total family members	Continue	5.625	6.012	5.429	0.584***	5.231	5.478	5.136	0.341***	5.963	6.337	5.724	0.613***
Children younger than 5 years	Continue	1.600	1.763	1.517	0.246***	1.479	1.594	1.435	0.158***	1.703	1.866	1.599	0.267***
Household wealth index[a]	Continue	−37 857.5	−67 169.6	−22 959.4	−44 210.2***	11 960.2	9434.5	12 925.6	−3491.2	−80 429.8	−11 3749.4	−59 248.6	−54 500.9***
Place of residence													
Urban	Categorical	0.625	0.560	0.657	−0.097***	0.720	0.735	0.714	0.020	0.543	0.453	0.600	−0.146***
Andean region													
Bogotá	Categorical	0.047	0.072	0.035	0.037***	0.104	0.192	0.070	0.122***	ND	ND	ND	ND
Antioquía	Categorical	0.056	0.035	0.066	−0.031***	0.122	0.094	0.133	−0.038***	ND	ND	ND	ND
Valle del Cauca	Categorical	0.054	0.036	0.063	−0.027***	0.117	0.095	0.126	−0.030***	ND	ND	ND	ND
Oriental	Categorical	0.142	0.156	0.135	0.021***	0.308	0.412	0.268	0.144***	ND	ND	ND	ND
Central	Categorical	0.161	0.077	0.203	−0.125***	0.348	0.205	0.403	−0.198***	ND	ND	ND	ND

(continued)

Table 2 Continued

	Variable type	Colombia				Andean region				Other regions			
		Total	NT	T	Difference	Total	NT	T	Difference	Total	NT	T	Difference
Other regions													
Atlántico	Categorical	0.196	0.176	0.206	−0.030***	ND	ND	ND	ND	0.364	0.283	0.415	−0.132***
Pacífica	Categorical	0.095	0.092	0.097	−0.004	ND	ND	ND	ND	0.178	0.149	0.196	−0.047***
San Andrés	Categorical	0.018	0.032	0.011	0.021***	ND	ND	ND	ND	0.033	0.051	0.022	0.029***
Orinoquía y Amazonía	Categorical	0.229	0.321	0.183	0.139***	ND	ND	ND	ND	0.425	0.516	0.367	0.149***

Notes: T, treated; NT, not treated; ND: no data; ADD, acute diarrhoeal disease.

[a]This is an ordinal index calculated by principal component analysis. The variables used to calculate this index reflect the economic conditions of the household. The higher the index, the better the economic situation of the household.

*, ** and *** indicate statistical significance at the 10, 5 and 1% levels, respectively.

Source: Author's calculations.

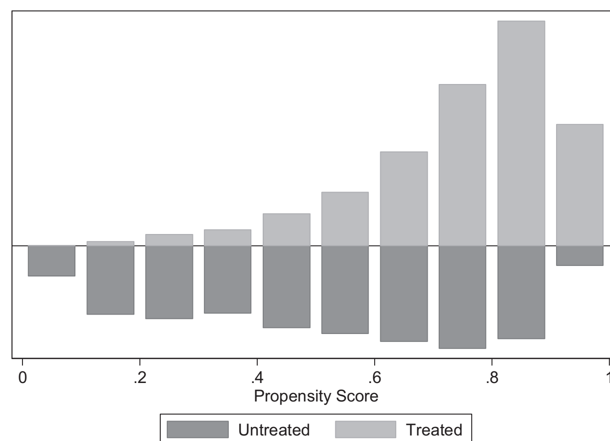

Figure 1 Distribution of the probability of participation among beneficiaries and non-beneficiaries. *Source*: Author's calculations.

territorial level, rural children are less likely to belong to the treatment group than are urban children.[2]

Figure 1 depicts the distribution of the probability of participation among beneficiaries and non-beneficiaries in the full sample. As noted above, there is a degree of asymmetry between the two groups. In essence, although there is a larger share of participants in the highest deciles of the distribution, with respect to non-participants in the lowest deciles, the opposite is true. This finding suggests the need for matching with replacement in Caliper Matching. To assess matching quality, we test whether the set of explanatory variables regarding the probability of participation is balanced between the treated and untreated. To do so, we calculate the size of the standardized bias (SSB) from Rosenbaum and Rubin (1985). If the quality of matching is good, the value of the SSB for each variable must be approximately between 3 and 5% (Sianesi 2004; Caliendo *et al*. 2008). As shown in Figure 2, most of the SSB values are large before matching. When comparing treated individuals with their respective counterfactuals in the control group, these values are reduced considerably and are therefore located near the tolerance thresholds. Thus, the evidence suggests that the matching quality is good.

Table 3 presents the ATT estimates for Colombia as a whole, the Andean region and the other regions. Nationally, the results indicate that the GDMP has a positive impact on immunization and treatment of ARI/fever. Specifically, the likelihood that a child has received the full course of immunizations recommended for a child of his/her age increases by nearly 13 PP if he/she participates in the programme. Moreover, beneficiary infants are approximately 6 PP more likely to have received medical treatment when exhibiting symptoms of ARI or fever than non-beneficiaries. However, the programme's impact on IRA prevalence is negative but has no effect on the other output variables. Some dissimilarities can be observed when comparing the results by region of residence. Although in the other regions, the programme produces gains in acute malnutrition (1.6 PP decline in the number of children suffering from this condition), in the Andean region, the effect of the GDMP is not significant. Similarly, the programme increases the likelihood of receiving treatment for ARI/fever (10 PP) in the other regions, whereas no impact is observed in the Andean region. The

results regarding the other outcome variables are qualitatively identical to those observed for the country as a whole.

The ATT estimates by age group are presented in Table 4. The GDMP has no impact on malnutrition or the prevalence of ADD. With respect to the incidence of ARI, the programme has a negative impact, resulting in a 4-PP increase in the likelihood of developing this disease. This impact is attenuated among children younger than 4 years. The programme has a positive effect on IRA/fever treatment. This effect is homogeneous across age groups and results in a 6–11 PP increase in the likelihood of receiving medical treatment for ARI or fever.

Lastly, the estimations by health system type are presented in Table 5. As can be observed, in the contributory regime, the GDMP only has an impact on vaccination, as it increases the probability of being immunized by 10 PP. In the subsidized scheme, the programme has no impact on chronic malnutrition or the incidence and treatment of EDA. Regarding the prevalence of IRA, the programme's impact is negative, as the participating children are 5 PP more likely to suffer from this health condition than non-participants. In contrast, in the same regime, the GDMP reduces the likelihood of suffering from acute malnutrition by 1.5 PP. Children who present signs of

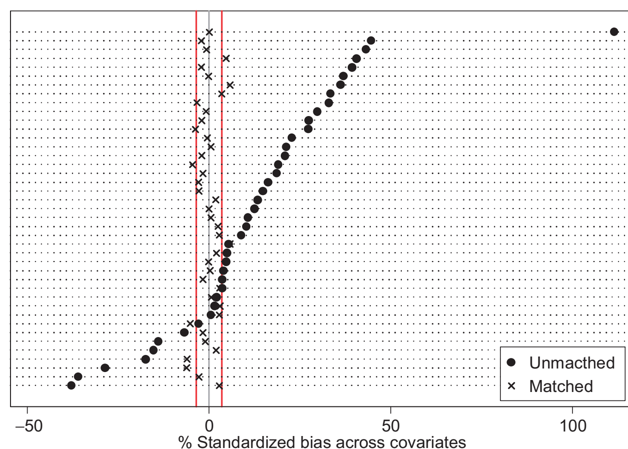

Figure 2 Size of the standardized bias. Note: the line represents the threshold of tolerance (3.5%). *Source*: Author's calculations.

Table 4 Estimation of ATT by age groups

	ATT[a]			**ATT[b]**		
	0–2	2–4	4–5	0–2	2–4	4–5
Acute malnutrition	−0.012	−0.004	0.000	−0.004	−0.013	−0.012
	(0.013)	(0.012)	(0.021)	(0.006)	(0.011)	(0.015)
Chronic malnutrition	0.000	−0.013	0.029	0.015	−0.021	0.017
	(0.020)	(0.022)	(0.030)	(0.015)	(0.017)	(0.024)
ADD	−0.002	0.015	−0.017	−0.009	0.005	−0.015
	(0.023)	(0.022)	(0.030)	(0.019)	(0.017)	(0.022)
ARI	0.042*	0.041	0.000	0.022	0.041**	−0.003
	(0.023)	(0.025)	(0.034)	(0.022)	(0.021)	(0.035)
Treatment of ARI/fever	0.064*	0.119***	0.059	0.033	0.069*	0.113*
	(0.037)	(0.043)	(0.080)	(0.032)	(0.035)	0.066

Notes: ADD, acute diarrhoeal disease. The values in parentheses represent standard error.
[a]Caliper matching.
[b]Local linear regression.
*, ** and *** indicate statistical significance at the 10, 5 and 1% levels, respectively.
Source: Author's calculations.

Table 3 Estimation of ATT for Colombia and the Andean region and other regions

	Colombia		**Andean region**		**Other regions**	
	ATT[a]	ATT[b]	ATT[a]	ATT[b]	ATT[a]	ATT[b]
Acute malnutrition	−0.006	−0.008	0.000	−0.001	−0.015	−0.016*
	(0.007)	(0.005)	(0.009)	(0.006)	(0.010)	(0.008)
Chronic malnutrition	0.006	0.001	0.020	0.012	−0.002	−0.008
	(0.013)	(0.010)	(0.017)	(0.012)	(0.018)	(0.015)
ADD	0.002	0.000	0.002	0.002	0.003	−0.003
	(0.014)	(0.011)	(0.020)	(0.016)	(0.019)	(0.015)
ARI	0.010	0.025*	0.019	0.001	0.051**	0.043**
	(0.014)	(0.013)	(0.022)	(0.019)	(0.020)	(0.017)
Complete vaccination	0.138***	0.127***	0.132***	0.111***	0.101***	0.142***
	(0.029)	(0.021)	(0.043)	(0.033)	(0.035)	(0.027)
Treatment of ARI/fever	0.052*	0.068***	0.010	0.039	0.091***	0.100***
	(0.027)	(0.022)	(0.042)	(0.031)	(0.033)	(0.029)
Treatment of ADD	0.048	0.060	0.083	0.074	−0.010	0.004
	(0.050)	(0.040)	(0.089)	(0.060)	(0.062)	(0.056)

Notes: ADD, acute diarrhoeal disease. The values in parentheses represent standard error.
[a]Caliper matching.
[b]Local linear regression.
*, ** and *** indicate statistical significance at the 10, 5 and 1% levels, respectively.
Source: Author's calculations.

Table 5 Estimation of ATT by health system type

	ATT[a]		ATT[b]	
	Subsidized	Contributory	Subsidized	Contributory
Acute malnutrition	−0.011	0.009	−0.015*	0.004
	(0.010)	(0.008)	(0.007)	(0.007)
Chronic malnutrition	−0.001	0.022	−0.005	0.009
	(0.018)	(0.017)	(0.014)	(0.013)
ADD	0.007	−0.026	0.008	−0.030
	(0.019)	(0.022)	(0.015)	(0.020)
ARI	0.052**	0.006	0.051**	0.002
	(0.021)	(0.023)	(0.013)	(0.024)
Complete vaccination	0.116***	0.094	0.131***	0.100**
	(0.031)	(0.060)	(0.027)	(0.046)
Treatment of ARI/fever	0.112***	0.032	0.110***	0.005
	(0.033)	(0.052)	(0.026)	(0.042)
Treatment of ADD	0.066	−0.165	0.068	−0.068
	(0.054)	(0.113)	(0.050)	(0.107)

Notes: ADD, acute diarrhoeal disease. The values in parentheses represent standard error.
[a]Caliper matching.
[b]Local linear regression.
*, ** and *** indicate statistical significance at the 10, 5 and 1% levels.
Source: Author's calculations.

ARI or fever are 11 PP more likely to receive medical treatment if they are enrolled in the GDMP and participate in the subsidized health programme. These children are also between 11 and 13 PP more likely to have completed the vaccination schedule.

Discussion

This study quantifies the effects of the GDMP on nutrition, health status and child-care practices among children between 0 and 5 years of age in Colombia. The main findings indicate that the programme has positive effects on immunization and the likelihood of seeking treatment to address the symptoms of ARI or fever. However, negative effects are observed for ARI prevalence. The programme's impact varies according to the region and type of health system. In most cases, the effect of the programme changes from positive to null when moving from the other regions to the Andean region or when moving from the subsidized to the contributory regime.

Several reasons may explain the GDMP's lack of nationwide effects on chronic and acute malnutrition. Among these reasons are the heterogeneity by region and type of health programme. When the sample is divided between the more prosperous regions and the rest of the country, the latter shows a positive impact on acute malnutrition. This finding suggests that providing education on infant-care practices is irrelevant in high-income regions where malnutrition rates are relatively low. In contrast, providing instruction on early childhood care appears to play a major role in the poorest regions, where the level of maternal education is low and the figures regarding nutrition are more troubling. This approach is reinforced by analysing the total sample while controlling for health regime type. Indeed, the programme has a positive effect on acute malnutrition under the health scheme to which the poorest segments of population belong, while having no effects under the contributory health programme. This result leads us to conclude that the effects of the GDMP are essentially confined to children from the poorest families in the country. Even when considering the region or type of health system separately, the programme fails to have an effect on EDA. The explanation for this finding may be that the GDMP has a miniscule effect on malnutrition. In fact, malnutrition has been shown to be a major contributor to the prevalence of EDA in developing countries (Black *et al*. 1984; Schorling *et al*. 1990; Yoon *et al*. 1997). We caution policymakers that the GDMP is in urgent need of reform that considers this relationship.

The results of this study indicate that the GDMP has some similarities to and differences from the HBC programme. According to Bernal *et al*. (2009), the HBC has positive effects on chronic malnutrition for children between 2 and 4 years of age. We failed to observe any impact of the GDMP on this indicator for all age groups considered. As the HCB targets poor families, a potential explanation for this difference is that we do not simultaneously discriminate by household economic status and age group, due to sample size limitations, which reinforces the need for future work. Bernal *et al*. (2009) find that the HCB has negative effects on immunization; however, in this study, we find positive and economically significant effects. The results of this study are consistent with those of Bernal *et al*. (2009) with respect to the incidence of ARI. Both the HCB and the GDMP are found to have reduced the incidence of this disease. As the GDMP promotes childhood social interaction, the transmission of infections is likely to increase (Rylander 2000; Forssell *et al*. 2001). Therefore, it is necessary to warn mothers about this risk and review hygiene practices.

In the international context, our results are consistent with those of White and Masset (2007) regarding the little effect observed for the Bangladesh Integrated Nutrition Project on malnutrition indicators. These authors state that the resource constraint faced by mothers is one of the primary explanations for this result. Mothers participating in the PINB spend much of their time at work, which results in low attendance rates at programme workshops. In the case of the GDMP, the number of consultations attended by the beneficiaries is less than that required. Only 13% of participating children made the number of visits required by the GDMP. Consequently, one recommendation would be to establish strict compliance conditions, thereby increasing attendance in the activities covered by the GDMP. An example of such a condition would be to make programme participation conditional on limiting the number of absences over a given period of time. This procedure is successfully implemented in the Brazilian *Bolsa Familia* and Mexico's *Oportunidades* (Fernaud et al. 2008; Duarte *et al*. 2009). Of course, such changes should consider a cost-benefit analysis.

As observed in this study, the GDMP has the greatest impact on the poorest people in the country. Therefore, our central policy recommendation is to optimize the programme for the households enrolled in the subsidized health scheme. The incidence of problems related to nutrition, health conditions and child care

Table 6 Output variables by health system type (%)

	Subsidized	Contributory
Acute malnutrition	4.6	1.8
Chronic malnutrition	17.3	7.4
ARI	11.2	9.4
ADD	16.3	11.7
Complete vaccination	41.2	47.6
Treatment of ARI/fever	45.7	53.4
Treatment of ADD	38.9	49.4

Notes: ADD, acute diarrhoeal disease.
Source: author's calculations.

are lower for families involved in the contributory system (Table 6). The focus on the subsidized health regime should account for the existing regional differences in Colombia. It may be irrelevant to focus on high-income regions where there is a lower incidence of child-care problems. In this manner, the effects of GDMP could be reinforced and therefore translate into improvements in early childhood welfare in Colombia.

PSM is not a panacea. We acknowledge that the results of this study could be biased if the control variables used for pairing do not capture the effect of unobserved factors. For example, if there are unobservable factors, such as the effort of mothers for caring their infants, then our estimates would overestimate the true effect of the intervention. In this case, our estimates should be interpreted with caution.

The GDMP is a very specific programme for Colombia. Therefore we also recognize that the external validity of our study is limited. That is, the degree to which our results help to predict the effect of social programmes might not be clear to other countries, even with similar level of development. However, the results of our study are useful to encourage discussion to help improve the GDMP and encourage research that seeks to assess the impact of this programme using techniques to isolate the effect of other confounding factors.

We recommend that future research estimate the effects of the programme according to the outcomes of children with respect to the duration of their participation in the GDMP. That is, it would be pertinent to ask whether children who have been enrolled in the GDMP for longer periods of time obtain greater benefits than those who participated for shorter periods. Another recommendation is to obtain long-term estimates of the impacts of the GDMP. Thus, it would be possible to further investigate the reasons that the programme has no effect on certain variables. In particular, assessments could be made with respect to the degree to which maternal resource constraints affect programme implementation. Lastly, it is imperative to employ a larger sample size to obtain simultaneous and disaggregated estimates by age, region of residence and type of health programme.

Conclusion

This article has aimed to quantify the impact of the GDMP on nutrition, health status and child-care practices among children between 0 and 5 years of age in Colombia. The results reveal that the programme has positive effects on immunization and the likelihood of seeking treatment to address the symptoms of ARI or fever. As anticipated, the findings also indicate that the GDMP has greater positive effects in the less economically developed regions of the country and for beneficiaries of the subsidized health regime. In the more developed regions, as well as for the beneficiaries of the private health system, the effects of the programme tend to be negligible. Thus, our central policy recommendation is to optimize the programme for the poorest households in the country.

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Endnotes

[1] The Colombian *Departamento Nacional de Planeación* is an administrative department belonging to the executive branch of government and reports directly to the President of the Republic. The DNP is a highly technical institution that does not have legislative initiative responsible for the implementation of a strategic vision of the country's social, economic and environmental fields, through design, orientation and evaluation of the Colombian public policy, management and allocation of public investment and the realization of such plans, programmes and projects of the Government.

[2] Given space constraints we do not present the results of this sensitivity exercise. The results are available on request from the authors.

[3] These factors include the quality of housing, access to public services, asset holdings and other contextual variables. For more details on the construction of this wealth index, see DNP (2008).

[4] The results for the logit model are available upon request.

References

Andrade M, Chein F, Rodrigues de Souza L, Puig-Juno J. 2012. Income transfer policies and the impacts on the immunization of children: the Bolsa Família programme. *Cadernos de Saúde Pública* **28**: 1347–58.

Behrman J, Cheng Y, Todd P. 2004. Evaluating preschool programmes when length of exposure to the programme varies: a nonparametric approach. *The Review of Economics and Statistics* **86**: 108–32.

Behrman J, Hoddinott J. 2005. Programme evaluation with unobserved heterogeneity and selective implementation: the Mexican PROGRESA impact on child nutrition. *Oxford Bulletin of Economics and Statistics* **67**: 547–69.

Bernal R, Fernández C, Flórez CE *et al.* 2009. Evaluación del impacto del programmea Hogares Comunitarios de Bienestar del ICBF. *Documentos Centro de Estudios sobre Desarrollo Económico.* Universidad De Los Andes.

Black R, Brown K, Becker S. 1984. Malnutrition is a determining factor in diarrheal duration, but not incidence, among young children in a longitudinal study in rural Bangladesh. *American Journal of Clinical Nutrition,* **39**: 87–94.

Caliendo M, Hujer R, Thomsen SL. 2008. The employment effects of job-creation schemes in Germany: a microeconometric evaluation. *Advances in Econometrics,* **21**: 381–428.

Dehejia RH, Wahba S. 1999. Causal effects in nonexperimental studies: reevaluating the evaluation of training programmes. *Journal of the American Statistical Association* **94**: 1053–62.

Dehejia RH, Wahba S. 2002. Propensity score matching methods for nonexperimental causal studies. *The Review of Economics and Statistics* **84**: 151–61.

DHS. 2011. Encuesta Nacional De Demografía Y Salud. http://www.profamilia.org.co, accessed 15 October 2012.

DNP. 2006. *Programmea Familias en Acción—Resultados de Impacto un año después de implementado el Programmea. Evaluación de Políticas Públicas*. Bogotá: Departamento Nacional de Planeación.

DNP. 2008. *Diseño del índice del SISBEN en su Tercera Versión. SISBEN III*. Bogotá.

Duarte G, Sampaio B, Sampaio Y. 2009. Programmea Bolsa Família: impacto das transferências sobre os gastos com alimentos em famílias rurais. *Revista de Economia e Sociologia Rural* **47**: 903–18.

Fernaud L, Gertler P, Neufeld L. 2008. Role of cash in conditional cash transfer programmemes for child health, growth, and development: an analysis of Mexico's Oportunidades. *The Lancet* **371**: 828–37.

Forssell G, Hakansson A, Mansson N. 2001. Risk factors for respiratory tract infections in children aged 2–5 years. *Scandinavian Journal of Primary Health Care* **19**: 122–5.

Garcia S, Sarmiento OL, Forde I, Velasco T. 2012. Socio-economic inequalities in malnutrition among children and adolescents in Colombia: the role of individual-, household- and community-level characteristics. *Public Health Nutrition* **16**: 1703–18.

Gaviria A, Palau MD. 2006. Nutrición y salud infantil en Colombia: determinantes y alternativas de política segundo semestre de 2006. *Coyuntura Económica*. **xxxvi**: 33–63.

Grantham-McGregor S, Cheung Y, Cueto S *et al.* 2007. Developmental potential in the first 5 years for children in developing countries. *The Lancet,* **369**: 60–70.

Heckman J, LaLonde R, Smith J. 1999. The economics and econometrics of active labor market programmes. In: O. Ashenfelter, D. Card (eds.) *Handbook of Labor Economics* **III**: 1865–2097.

Heckman J, Masterov D. 2007. The productivity argument for investing in young children. *Applied Economics Perspectives and Policy,* **29**: 446–93.

Maluccio J, Hoddinott J, Behrman J *et al.* 2006. The impact of nutrition during early childhood on education among Guatemalan adults. *PIER Working Paper*. University of Pennsylvania. 06-026.

Oliveira FdCC, Rosângela MMC, Andréia QR *et al.* 2011. Estado nutricional e fatores determinantes do déficit estatural em crianças cadastradas no Programa Bolsa Família. *Epidemiologia e Serviços de Saúde* **20**: 7–18.

Pan American Health Organization (PAHO). 2002. *La OPS y el Estado Colombiano: Cien años de historia 1902 – 2002*. new.paho.org.

Rasella D, Rosana A, Carlos ATS, Rômulo P-S, Mauricio LB. 2013. ''Effect of a conditional cash transfer programme on childhood mortality: a nationwide analysis of Brazilian municipalities.'' *The Lancet* **382**: 57–64.

Rosenbaum P, Rubin D. 1983. The central role of the propensity score in observational studies for causal effects. *Biometrika* **70**: 41–50.

Rosenbaum P, Rubin D. 1985. Constructing a control group using multivariate matched sampling methods that incorporate the propensity score. *The American Statistican* **39**: 33–8.

Rylander MY. 2000. Environmental risk factors for respiratory infections. *Archives of Environmental Health,* **55**: 300–3.

Schorling J, McAuliffe J, Souza Md, Guerrant R. 1990. Malnutrition is associated with increased diarrhoea incidence and duration among children in an urban Brazilian slum. *International Journal of Epidemiology,* **19**: 728–35.

Sianesi B. 2004. An evaluation of the active labour market programmemes in Sweden. *The Review of Economics and Statistics* **86**: 133–55.

Smith H. 1997. Matching with multiple controls to estimate treatment effects in observational studies. *Sociological Methodology* **27**: 325–53.

Trujillo JC, Carrillo B, Iglesias WJ. 2014. Relationship between professional antenatal care and facility delivery: an assessment of Colombia. *Health Policy and Planning* **29**: 443–9.

Vecino-Ortiz AI. 2008. Determinants of demand for antenatal care in Colombia. *Health Policy* **86**: 363–72.

White H, Masset E. 2007. Assessing interventions to improve child nutrition: a theory-based impact evaluation of the Bangladesh Integrated Nutrition Project. *Journal of International Development* **19**: 627–52.

WHO Multicentre Reference Study Group. 2006. Assessment of differences in linear growth among populations in the WHO Multicentre Growth Reference Study. *Acta Pediatr* **450**: 56–65.

WHO. 2012. *Children: Reducing Mortality*. http://www.who.int/mediacentre/factsheets/fs178/en/, accessed 15 October 2012.

Yoon P, Black R, Moulton L, Becker S. 1997. The effect of malnutrition on the risk of diarrheal and respiratory mortality in children < 2 years of age in Cebu, Philippines. *American Journal of Clinical Nutrition* **65**: 1070–7.