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Cardona-Sosa, Lina and Medina, Carlos (2017) The effects of in utero programs on birth outcomes: the case of Buen Comienzo. Economía, 17 (2). 93 - 134. ISSN 1529-7470

10.31389/eco.67

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The Effects of In Utero Programs on Birth Outcomes: The Case of *Buen Comienzo*

ABSTRACT This paper studies the effects of an in utero program on birth outcomes for vulnerable pregnant women. We use information from the *Buen Comienzo* program, an initiative run by the local government of Medellín, the second-largest city of Colombia. To identify the effects, we obtain matching estimates using data from program participants and national birth statistics. We find that the program increased the birth weight of participant children by 0.09 and 0.23 standard deviations for boys and girls, respectively, and reduced the prevalence of low birth weight by 2.6 and 4.6 percentage points for boys and girls, respectively. In terms of size, the program reduces the incidence of being short by 3 and 4 percentage points, for boys and girls, respectively. The program also significantly reduced preterm births between 3 and 8 percentage points. We also provide evidence of the existence of heterogeneous effects depending on a mother's exposure to the program and her frequency of attendance. Finally, an estimate of the cost-benefit ratio of the program suggests that the benefits could be two to six times the costs, respectively, for boys and girls born to participant mothers with early exposure to the program.

JEL Classifications: I38, J13, J18
Keywords: early childhood programs, program evaluation, selection on observables.

Birth outcomes are important predictors of a child's health in the short run, as well as of different outcomes as an adult in the long run. While in the short run birth outcomes are related to child mortality, in the long run, they affect an adult's education and health.[1] This, in turn, affects the individual's labor market performance, one of the determinants of poverty and inequality.

ACKNOWLEDGMENTS The authors thank the administrators of the *Buen Comienzo* program and their technical team for help with the data. We are very grateful to Juan Felipe González, Henry Puerta, and Gladys Restrepo for all their support in clarifying the program. The contents of the paper do not necessarily reflect the opinion or policies of the Banco de la República de Colombia (Bank of the Republic of Colombia) or its Board of Directors.

1. Barker (1995); Barker and Osmond (1986).

Previous studies find that a 10 percent increase in birth weight represents a reduction of children's one-year mortality rate and a 1 percent increase in future earnings.[2] Similarly, a 0.57 centimeter increase in a child's size translates into a 0.06 higher IQ score at age eighteen (on a scale from one to nine). As a result of these and similar findings, economists and governments have supported policy strategies aiming to improve nutrition, education, and health for children under five. According to Cunha and Heckman, it is fairly straightforward to influence a child's inputs at this stage, and the long-term returns in cognitive and noncognitive skills are higher than for later interventions.[3] Thus, early childhood programs should consider birth weight due to its role in improving skills that affect poverty transmission. In this paper, we examine one of the early-childhood strategies launched in Colombia and its effects on children's birth outcomes (weight and size), with the purpose of identifying not only the effectiveness of the program, but also its potential long-run contribution.

In Colombia, infants weighing under 2,500 grams (or with low birth weight, LBW) account for 8.7 percent of all newborns regardless of their gestational length.[4] This contrasts with the low incidence of LBW in developed countries (3 percent), but is significantly below the rate in South Asia (40 percent). Of all infants born worldwide, 15.5 percent have low birth weight, of which 96 percent are located in developing countries.

The incidence of LBW is not homogeneous across the Colombian population. By gender, the proportion of girls born with LBW is 9 percent, versus 7 percent for boys. By type of health insurance, the incidence of LBW among those using the subsidized regime (low-income households and vulnerable population) is between 7.9 percent and 8.3 percent. In rural areas, the incidence of LBW is about 7.3 and 7.9 percent for boys and girls, respectively. Finally, large cities such as Bogotá and Medellín have some of the highest rates of LBW in the country (13.0 and 9.1 percent, respectively, in 2010).

Governments around the world have implemented different strategies to improve early childhood development in disadvantaged households. In the United States, programs such as the Perry Preschool Project, the Milwaukee Project, and the Carolina Abecedarian Early Intervention Project explored ways to boost nutrition and enhance education among children.[5] In Bolivia

2. Black, Devereux, and Salvanes (2007).
3. Cunha and Heckman (2010). See also Cunha and others (2006).
4. Pinzón-Rondón and others (2015).
5. Barnett (1995).

and Colombia, the Integrated Child Development Project (PIDI) and *Hogares Comunitarios* (Community Households), respectively, have made strides in improving children's development.

While much of the literature focuses on programs addressing the needs of young children, there is less evidence on initiatives aimed at pregnant women (or in utero programs). Such programs include the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in the United States, and the National Social Emergency Response Plan (PANES) in Uruguay. More general anti-poverty strategies also affect a mother's health during pregnancy. Examples include the Supplemental Nutrition Assistance Program (SNAP), formerly known as the Food Stamp Program (FSP), in the United States, and the conditional cash-transfer programs in Brazil (*Bolsa Scuola*), Mexico (*Progresa/Oportunidades*), and Colombia (*Familias en Acción*). The main advantage of programs addressed exclusively to pregnant women is that they provide not only in-kind transfers, but also interdisciplinary support during pregnancy and training for future parents, which has been found to be effective in early childhood programs.[6] However, little is known about the effect of in utero programs in Colombia, which is the aim of this study.

In 2009, the Colombian municipality of Medellín launched the in utero component of the program *Buen Comienzo,* an early childhood initiative aimed at infant development. The strategy consists of two elements: a nutritional supplement for pregnant women and parental training. In this paper, we study the effects of the first component, targeted at pregnant women. We examine short-run outcomes such as birth weight, height, and the APGAR score.[7] Due to the nonrandom assignment of the program, we use a non-experimental setting to identify the effects, linking administrative information from program beneficiaries to vital statistics from the compilation of births in the country. To complement the demographic information in our data, we link this information with data from the Colombian means-test classification system (SISBEN).

Our results suggest that *Buen Comienzo* increased the birth weight of girls from participant mothers by a 0.23 standard deviation, which is equivalent to a weight increase of approximately 115 grams. For boys, the increase in weight was only about 45 grams (that is, 0.09 standard deviation). This represents an upper bound of the program's effect, since it is observed for women who

6. Bernal and Camacho (2010).
7. APGAR is an acronym for appearance, pulse, grimace, activity, and respiration.

attended the program once a month after the first trimester of pregnancy. This finding provides evidence of the importance not only of being treated, but also of the intensity of the treatment. Regarding children's height, we found an increase of 0.19 standard deviation among treated girls (or 0.47 centimeter). Moreover, a cost-benefit analysis reveals that the benefits of the program are between two and six times the cost for boys and girls, respectively.

The article is organized as follows. The next section outlines the causes of LBW and its consequences. The article then identifies the main features of the *Buen Comienzo* program and lays out the methodology used for the analysis. We go on to describe the data and present our results. Finally, we summarize our main findings and conclusions.

Causes and Consequences of Low Birth Weight

Low birth weight (LBW) can result from two different factors: fetal growth retardation (commonly known as intrauterine growth retardation, IUGR) or a gestational length below thirty-seven weeks (preterm birth). The medical literature identifies the following factors as the main predictors of intrauterine growth retardation: poor nutrition during pregnancy, low mother's weight and stature, mother's economic activity, prenatal care, and poor mother's health (for example, suffering from diabetes or malaria during pregnancy).[8] In contrast, the causes of prematurity are not well understood, although preterm births are associated with previous abortions and preterm births, poor prepregnancy weight, inadequate prenatal care, mother's physical and economic activities, stress, and cigarette smoking. The causes of LBW also vary by country. Kramer concludes that while LBW in developed countries is primarily due to preterm births, intrauterine growth retardation is the main explanation for the incidence observed in the developing world.[9] This should not be surprising considering that nutrition, one of the factors delaying fetal growth, is an issue in many developing countries.

In Colombia, the latest government figures suggest that half of LBW is due to IUGR and the other half to preterm births.[10] Earlier studies in the country identify risk factors including previous abortion experiences; inadequate

8. See Kramer (1987) for a complete survey of the literature's main findings.
9. Kramer (1987).
10. Quiroga (2014).

weight gain during pregnancy; diabetes; inadequate prenatal control; mother's stress, anxiety, or depression; mother's ingestion of alcohol, coffee, or drugs; and some environmental issues.[11] The mother's age—over thirty-five or under twenty—also affects the probability of being born below 2,500 grams. In Colombia, teenage mothers account for 22 percent of total births in the country and have an incidence of LBW of about 12 percent (versus 9 percent nationally).[12] Moreover, Pinzón-Rondón and others show that the absence and quality of prenatal care and the number of doctor visits are among the most important determinants of LBW in Colombia.[13]

These studies suggest that there is scope for policymakers to lower the incidence of LBW by targeting modifiable factors. If the source of LBW is IUGR, public policy can effectively improve a mother's nutrition or provide prenatal care, whereas if gestational length is a primary cause, prenatal training can influence a mother's habits (such as alcohol consumption or stress), in addition to an increasing her caloric intake. Reducing LBW should be a policy priority given the evidence on the long-lasting effects of improving birth weight. Economic studies show that LBW has significant medium- and long-term effects on education and employment. For example, LBW due to IUGR affects an individual's academic performance through micronutrient deficiency, which accounts for the deficit in weight: iodine deficiency directly affects children's cognitive development and can result in mental retardation, while the lack of folic acid (folate) increases the risk of a neural tube defect.[14] Both of these conditions affect future academic performance.

Estimating the causal effect of LBW on individual outcomes is challenging because unobserved factors affecting a child's birth weight—such as genetics, parental interest, and individual motivation—could be correlated with the outcomes under study (health, education, and employment). To address this issue, most studies rely on within-twin comparison, a method that allows the researcher to keep constant observable and unobservable family and household characteristics. Twins living in the same household, sharing the same mother, and facing the same environment with the same gestational length would differ in birth weight mainly due to differences in vitamin intake before birth. Sibling studies have a similar advantage, except for the fact that they lack the same gestational length.

11. INS (2016).
12. Quiroga (2014).
13. Pinzón-Rondón and others (2015).
14. Black (2003, 2008); Molloy and others (2008).

Behrman and Rosenzweig use the within-twin variation technique for a sample of monozygotic (identical) twins in the United States.[15] They find that birth weight is an important predictor of adult height and that LBW has a negative impact on adult labor market outcomes. According to their results, a 482-gram (17-ounce) increase in birth weight among LBW children in the United States would increase an individual's lifetime earnings by 10 percent. Although the analysis is based on a very restricted sample (only monozygotic twins), Johnson and Schoeni reach a similar conclusion regarding labor market earnings using a sample of siblings.[16] They find that LBW children see their labor market earnings reduced by 15 percent.

Black, Devereux, and Salvanes, who use data on fraternal and monozygotic twins in Norway, show that a 10 percent increase in a child's birth weight reduces his or her one-year mortality probability.[17] They also find that a 0.57-centimeter increase in size at birth increases an individual's IQ score by 0.06 at age eighteen (on a scale from one to nine). Furthermore, high-school completion rates increase by just under 1 percentage point, while earnings are augmented by 1 percent. In terms of next-generation effects, they find that an improvement in children's birth weight leads to an increase in their offspring's birth weight.

Royer similarly exploits within-twin variation to estimate the effect of LBW on long-run outcomes of children in California and Great Britain.[18] He finds that a one-kilo increase in birth weight is related to a 0.13 increase in the number of years of education. Since there is a negligible probability that a program will increase birth weight by 1,000 grams, the authors translate the effect into a lower scale, showing that a 200-gram increase in weight increases the number of years of education by 0.03 for an average child and by 0.08 for those born under 2,500 grams. Another study for the United States, which includes siblings in the analysis, finds that the probability of repeating a grade in school is 4 percentage points higher for a child with LBW than for an average child.[19]

Glewwe, Jacoby, and King, who use longitudinal data on siblings rather than twins, find that a higher birth weight is related to a better school performance among Filipino children.[20] In a similar study using Scottish data, Lawlor and

15. Behrman and Rosenzweig (2004).
16. Johnson and Schoeni (2011).
17. Black, Devereux, and Salvanes (2007).
18. Royer (2009).
19. Fletcher (2011).
20. Glewwe, Jacoby, and King (2001).

others find that among all male siblings, a one-standard-deviation increase in birth weight translates into higher IQ scores by age seven.[21] Although this finding was observed by keeping the mother's gestational length constant, other studies have found that being preterm (for example, with a gestational length below thirty-seven weeks) also has negative effects on children's cognitive scores.[22]

In terms of health outcomes, Almond, Chay, and Lee, who use twin data, find that a one-standard-deviation increase in a child's birth weight reduces infant mortality by 0.41 standard deviation, improves the APGAR score by 0.5 standard deviation, and reduces the need for assisted ventilation by 0.25 standard deviation.[23] The authors also provide an estimation of hospital costs related to LBW: a one-standard-deviation increase in birth weight (667 grams) is equivalent to a US$3,200 reduction in hospitalization costs. In line with the previous finding, Glewwe, Jacoby, and King estimate that for each dollar invested in programs aiming to improve birth weight through nutritional strategies, three dollars will be returned through improvement in educational performance.[24]

Although within-twin studies allow the analyst to identify the causal effect of LBW for a given gestational length, there is some concern about twins' representativeness of the general population, given that they occur in less than 1 percent of the population. Other approaches for identifying the effects of LBW include exogenous changes such as policy reforms, the introduction of new programs, or institutional shocks.[25] Alderman, Hoddinott, and Kinsey combine both methods, using within-sibling variation and civil war shocks to identify differences in nutrition across siblings.[26] They find that an increase of 3.4 centimeters in a child's height increases the number of grades completed at school by 0.85 and reduces the age of entering school by six months. Similarly, Alderman and others use price shocks during the preschool stage to see how early nutrition (measured with height *z* score) affects enrollment rates in rural Pakistan, finding a negative effect.[27]

21. Lawlor and others (2006).
22. See the meta-analysis by Bhutta and others (2002).
23. Almond, Chay, and Lee (2005).
24. Glewwe, Jacoby, and King (2001).
25. See, for example, Currie and MacLeod (2008); Hoynes, Page, and Stevens (2009); Hoynes, Miller, and Simon (2012); Alderman, Hoddinott, and Kinsey (2006).
26. Alderman, Hoddinott, and Kinsey (2006).
27. Alderman and others (2001).

Almond and others use a regression discontinuity design to identify the effect of having a very low birth weight (1,500 grams) on hospital costs.[28] The study shows that for infants born above 1,500 grams, the probability of one-year mortality is reduced by one percentage point, while having a birth weight below 1,500 grams increases hospital costs by 10 percent.

A number of other studies use instrumental variables to identify the effect of weight indicators, such as height for age, on long-run outcomes. For instance, Glewwe, Jacoby, and King use distance to health facilities and father's height as instruments to explain height for age. Their findings support evidence that lower height for age delays school entrance.[29]

Very few cross-sectional studies address the selectivity problem that arises when identifying the effects on children's outcomes of interventions directed to vulnerable populations.[30] Rahu and others apply linear regression approaches to data for Estonia, finding that a 500-gram increase in birth weight is associated with a 0.7 point increase in children's IQ scores.[31] Sorensen and others also report an increase in IQ scores as a result of a higher birth weight for all Danish men living in a particular region.[32] Although administrative data have many advantages and reduce the self-selectivity bias present in some surveys, they suffer from bias due to unobservable variables driving both birth and adult outcomes.

In-Kind Programs Affecting LBW

A number of strategies can be employed to reduce LBW. Research shows that in the presence of IUGR, intake of folic acid, iodine, vitamin B6, protein, and iron reduces the incidence of LBW.[33] Thus, food supplement programs could have an important effect on a child's birth weight. Kowaleski-Jones and Duncan report that children's birth weight increased by 7.5 percent among treated mothers.[34] Bitler and Currie find that, although mothers attending the U.S. Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) are a negatively selected sample of the population, the program has a positive effect on children's birth outcomes for eligible mothers.[35]

28. Almond and others (2010).
29. Glewwe, Jacoby, and King (2001). See also Glewwe and Jacoby (1995).
30. Bitler and Currie (2005) examine this bias.
31. Rahu and others (2010).
32. Sorensen and others (1997).
33. Kramer (1987); McArdle and Ashworth (1999).
34. Kowaleski-Jones and Duncan (2002).
35. Bitler and Currie (2005).

Specifically, the probability of the mother beginning prenatal care in the first trimester increases by 6 to 7 percent, while the probability of a child being born under the twenty-fifth percentile of the weight distribution decreases around 2 percent for a given gestational length. Moreover, the study finds that the effects are even larger among teenage mothers and high school dropouts.

In another assessment of the WIC program, Currie and Rajani use the mother's fixed effects and New York administrative records to identify the program's impact on birth outcomes.[36] They find that the probability of LBW is reduced by 5.6 percent among treated infants, while the probability of being small for their age is reduced by 4.9 percent. Moreover, for firstborns, the probability of being born with LBW is reduced by a third. Foster, Jiang, and Gibson-Davis reach a similar conclusion based on a propensity score matching approach, namely, that the program reduces the probability of LBW by 1 percent.[37]

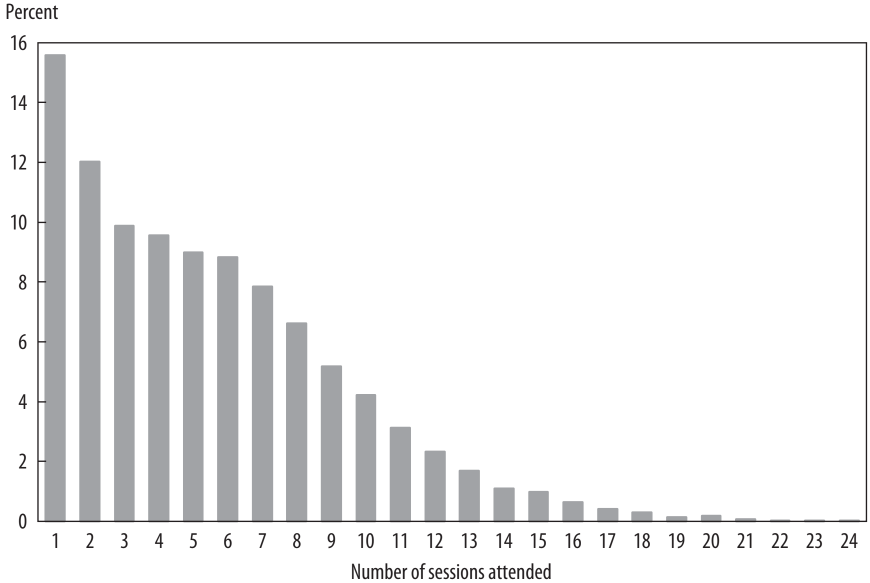
Almond, Hoynes, and Schanzenbach exploit the timing of operation of the U.S. Food Stamp Program between counties.[38] The authors find a 7 percent reduction in the incidence of LBW among mothers exposed to the program with infants at the bottom of the weight distribution. Figlio, Hamersma, and Roth, using a large administrative data set and implementing a regression discontinuity design (RDD), find that WIC participation reduces the probability of both LBW and very high birth weights.[39]

Description of the Program

Buen Comienzo is an early childhood strategy launched by the local government of Medellín to help poor families with young children (below the age of six) by promoting children's healthy development, early stimulation, and nutrition and parental training. Program strategies are delivered through different modalities depending on the child's age, as follows: pregnant and breastfeeding mothers and children up to one year old; children from one to two years old; children from two to four years old; and children from five to six years old. Of these groups, we focused on pregnant mothers for our study.

36. Currie and Rajani (2014).
37. Foster, Jiang, and Gibson-Davis (2010).
38. Almond, Hoynes, and Schanzenbach (2011).
39. Figlio, Hamersma, and Roth (2009).

FIGURE 1. Number of Sessions Attended by Treated Mothers during Pregnancy



Source: Authors' calculations, based on program records.

The program trains future parents during pregnancy, with support from an interdisciplinary group of professionals including nutritionists, social workers, psychologists, instructors, and physical educators. Parents are invited to participate in the program when they visit the doctor for the first time during pregnancy. As beneficiaries of *Buen Comienzo,* they are offered a nutritional supplement once a month and three hours of parental training every two weeks. Less regularly, they receive visits from different professionals to complement their training at home. The nutritional supplement accounts for 20 percent of a mother's daily nutritional requirement, and it includes calcium, folic acid, zinc, iron, and vitamin B.

Although attendance is not mandatory, mothers are self-motivated to attend at least one session a month, when the nutritional supplement is delivered. Nevertheless, the program's professionals work very hard at motivating parents to attend twice a month, explaining to them the importance of the training. Figure 1 shows the number of sessions attended by participant mothers per month. A large share of participants attended only one session, and most attended fewer than seven sessions (which could be once a month after they know they are pregnant). Mothers are weighed every session, and a special follow-up is made for women with low pregnancy weight. Unfortunately, the program's administrative information on this question is incomplete for the period analyzed.

Program Eligibility

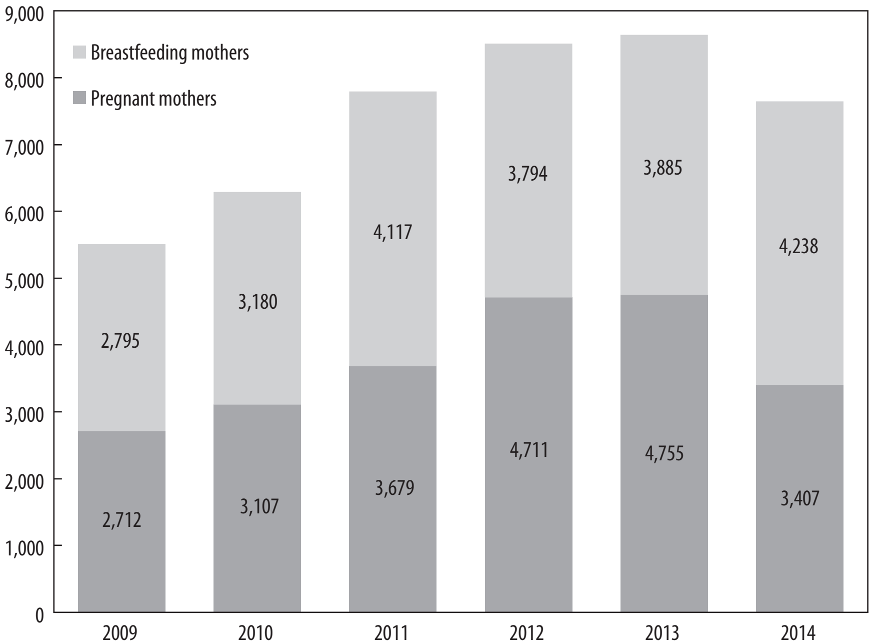
To improve the delivery of social services, the Colombian government introduced the System for the Identification of Potential Social Program Beneficiaries (SISBEN) in 1995. This proxy means test is based on an index that weights households' demographic characteristics (for example, income, education, and wealth) to determine their eligibility for social programs. SISBEN has gone through three versions since its introduction (I, II, and III). SISBEN-II, collected around 2005, assigned a score from zero to a hundred to each household and then used that score to classify households into six different levels, where level one represented the most disadvantaged households and level six the least disadvantaged ones. In general, households classified in the first two levels of SISBEN-II were eligible for government programs, including *Buen Comienzo.*[40] The system was updated to SISBEN-III in 2009 (the year the gestational component of *Buen Comienzo* was introduced), changing the way the SISBEN score is estimated and defining a new threshold for household eligibility for government programs.

Although the new SISBEN was introduced at the same time as the gestational component, administrators of *Buen Comienzo* continued to accept households that were eligible under the old classification (that is, levels one and two of SISBEN-II) while also incorporating households that had been reclassified under the new version with equivalent conditions (that is, a score less than 47.99 in SISBEN-III). Moreover, displaced households, victims of conflict, and ethnic minorities were automatically eligible for the program, as were women with at-risk pregnancies, such as teenagers (around 22 percent of all mothers) and women over thirty-five (8 percent of all mothers).

Although the SISBEN score requirement was meant to be a necessary (and sufficient) condition for program eligibility, in practice there were beneficiaries and nonbeneficiaries on both sides of the SISBEN-II and SISBEN-III cutoffs. Pregnant mothers who were potentially eligible for the program were invited to participate during their first visit to the doctor. The program sessions took place in public health facilities in the city; hence, at the beginning, the

40. See Bottia, Cardona-Sosa, and Medina (2012).

FIGURE 2. Mothers Who Participated in *Buen Comienzo* during Pregnancy and Breastfeeding, 2009–14



Source: Authors' calculations, based on *Indicadores de la Educación Medellín, 2004–2014* (Medellín: Secretary of Education); program attendance data, 2009–10; and the *Buen Comienzo* Information System, 2011–14.

physicians and health practitioners from public health centers were the ones who promoted participation in the program. In some cases, women learned about the program through neighbors or friends. Furthermore, mothers who were considered at risk due to their age, low gestational weight, or an illness were encouraged to participate in the program, and mothers who were already receiving government support for poverty reduction would also be invited and highly encouraged to participate in the program.

Although there is no official record of the take-up rate—that is, how many of the mothers who received an invitation actually attended program sessions—anecdotal evidence suggests that the nutritional supplement and the free biscuits were an important motivation for mothers to attend at least one session. The program database shows that between 2,712 and 4,755 pregnant mothers attended *Buen Comienzo* sessions every month (see figure 2). According to vital statistics, this accounts for almost 11 to 18 percent of all

TABLE 1. Births in Medellin, by Mother's Age, Health Insurance Coverage, and Eligibility for *Buen Comienzo*

	2009		2010		2011	
Maternal characteristic	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
Total births	31,874	100	28,521	100	27,600	100
Mothers with subsidized or no health insurance	14,040	44	12,413	44	15,197	55
Mothers under 20 years of age (with any type of health insurance)[a]	2,693	8	2,463	9	1,444	5
Mothers over 35 years of age (with any type of health insurance)[a]	2,176	7	2,005	7	1,280	4
Total eligible mothers	18,909	60	16,881	60	17921	65
Mothers who participated in the program	2,712		3,107		3,679	
Percent of eligible mothers		14		18		20

Source: Authors' calculations, based on vital statistics for 2009–11 and *Indicadores de la Educación Medellín, 2004–2014* (Medellín: Secretary of Education).

a. The program also prioritizes mothers under twenty years old and over thirty-five years old, even if they do not fulfill the requirements and have some type of insurance.

births in Medellín and around 21 percent of mothers who are either covered under the subsidized health regime or uninsured (who have a higher probability of being eligible due to a low SISBEN score).[41] Moreover, if we consider at-risk pregnant women, the number of potentially eligible mothers increases, as shown in table 1. From all births happening in the municipality, about 60 percent would be eligible for *Buen Comienzo:* mothers without health insurance, teenage mothers, and mothers over thirty-five years of age.

According to these figures, the program has not yet reached the complete target population, leaving some scope to compare birth indicators between eligible mothers participating in the program and eligible mothers who have not benefited from it.

Although public health centers and hospitals where mothers are told about the program for the first time are well distributed across the city, participant mothers may not be a random sample of the population. This could be the case if mothers living in slightly better neighborhoods are more motivated to participate or if, on the contrary, those in worse conditions are persuaded to attend. In both cases, the effect of the program could be biased by unobserved factors (such as physicians, mother's motivation, and so on) that influence participation in the program and birth outcomes. Figure 3 shows the distribution

41. Since the percentage figures in the table are monthly averages, they actually represent 12/9 times the reported shares, that is, between 14 and 25 percent of mothers actually become beneficiaries.

FIGURE 3. Distribution of Beneficiaries of *Buen Comienzo* in Medellín

A. Pregnant women beneficiaries, 2009

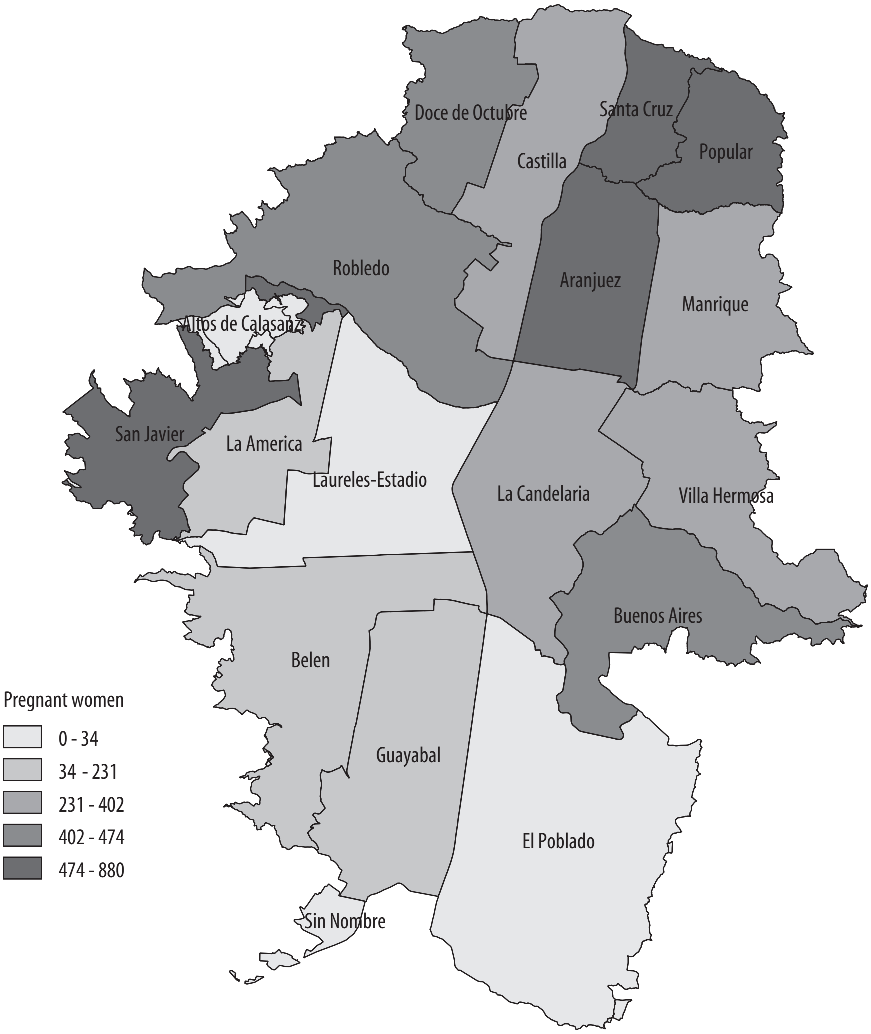
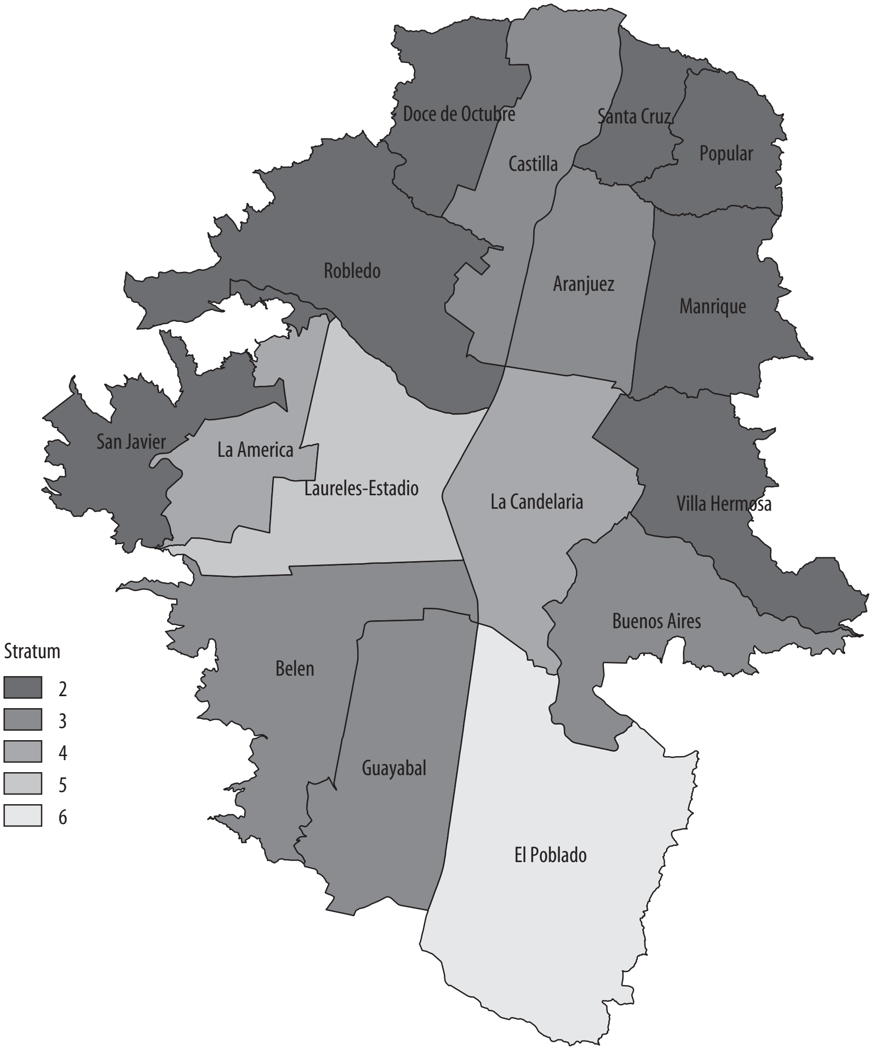


FIGURE 3. Distribution of Beneficiaries of *Buen Comienzo* in Medellín (*Continued*)

B. Average socioeconomic strata of neighborhoods, 2012



Source: Authors' calculations, based on vital statistics for 2009–11 and *Indicadores de la Educación Medellín, 2004–2014* (Medellín: Secretary of Education).

of beneficiaries across the city (panel A) and the average socioeconomic strata of neighborhoods across the city (panel B). The socioeconomic stratum is a residential classification used to target subsidies for public utilities services, with households in the first stratum being the poorest and households in the sixth stratum the wealthiest. As the figure shows, most of the disadvantaged neighborhoods are located in the north of the city, which is also where most of the beneficiaries live. Moreover, a high percentage of births in deprived areas (strata two and three) were not covered by the program at the beginning, leaving some scope to compare birth outcomes among similar mothers participating and not participating in the program.

Empirical Strategy

As described above, once pregnant women are identified at public health centers, they are invited to enroll in *Buen Comienzo,* provided they meet the eligibility criteria. Nonetheless, not all eligible mothers have received care from the program, which allows us to compare participant and nonparticipant eligible mothers. As mentioned, one of the main program eligibility conditions is having a SISBEN-III score below 47.99, but a large number of women are admitted into the program based on other criteria (for example, being displaced, being younger than twenty or older than thirty-five, or experiencing other risk factors). Consequently, the SISBEN score did not work as a forcing variable: our tests found no significant evidence for the existence of a discontinuity in the probability of being treated with the SISBEN cutoff. We therefore discarded the possibility of using a regression discontinuity approach to identify the effects of the intervention, at least for the phase of the program under analysis (2009–11). Instead, we followed a matching approach based on the assumption that pregnant women self-select into the program as a result of observable characteristics[42]. Several unobservable variables might also affect both selection into the program and the assessed outcomes, including ethnicity, the parents' height and weight, and the mother's cigarette and alcohol consumption.[43] Our estimates should still be unbiased once we condition on our set of observables, however, as long as these unobserved variables are balanced. Since we were able to control for a wide set of characteristics, we expect this to have been the case. Particularly, we expect newborns with

42. Heckman, Ichimura, and Todd (1998).
43. Kramer (1987).

equally aged and educated parents, similar household sizes, income, socioeconomic stratum, home ownership, type of health insurance coverage, and so forth to be similar in their unobservable traits regardless of whether or not they were beneficiaries of the program.[44]

The conceptual framework is based on the child's health production function (Y_i), which is determined by the genetic endowment, captured, in part, through the child's family characteristics (F_i). Other inputs affecting a child's health include nutrition and parental care provided (I_i) and other components that are usually unobserved by the researcher (ε_i).

$$Y_i = f(F_i; I_i; \varepsilon_i). \quad (1)$$

The reduced form would be given by

$$Y_i = \beta_0 + \beta_1 \text{FAM}_i + \beta_2 \mathbf{X}_i + \beta_3 I_i + \varepsilon_i, \quad (2)$$

where Y_i is a proxy for nutrition at the birth of child i (for example, weight and size); FAM_i is the child's set of sociodemographic characteristics (for example, parents' age and schooling, parents' economic activity, income, and so on);, $\mathbf{X}_i$ is a vector of individual characteristics of the child at birth (such as duration of the pregnancy, child's gender, and type of birth); I_i is an indicator of additional inputs received by the child (including a nutritional complement and better parental care); and ε_i captures other factors that affect the health status of the newborn.

The effect of the *Buen Comienzo* program on birth outcomes can be estimated using the model for potential outcomes proposed by Roy and Rubin, which defines participation in the program as the treatment under study and participating individuals as the treated individuals.[45] The model starts with the existence of a binary treatment (participation and nonparticipation), where the treatment indicator, D_i, is equal to one if the individual i is treated and zero otherwise. There are two potential outcomes, $Y_i(D_i)$, for a given individual: the outcome with treatment, $Y_i(1)$, and without treatment, $Y_i(0)$. Hence, the effect of the treatment (T_i) for individual i could be written as the difference in outcomes between the participating and nonparticipating individual:

$$T_i = Y_i(1) - Y_i(0). \quad (3)$$

44. Bitler and Currie (2005).
45. Roy (1951); Rubin (1978).

Nevertheless, the main problem with any program evaluation (equation 3) is that it is not possible to observe the same individual under both states, that is, as an individual participating in the program in the state of nonparticipation. In other words, the main difficulty is that we cannot observe $Y_i(0)$, which results in a missing-data problem.[46] An alternative way to estimate equation 3 would be to average the participants' outcome and subtract it from the average for nonparticipants. This would bias the estimate, however, given that participants and nonparticipants could differ systematically in their characteristics even in the absence of the program. Similarly, participants may not be a random sample of the population and could share particular characteristics that determined their participation in the program, which at the same time could be affecting some of the individuals' outcomes under study.

In the absence of a randomly assigned treatment, the best approach is to match participants with nonparticipants. In the presence of a binary treatment, the outcome of nonparticipation is imputed from individuals with similar characteristics, but with a different treatment.[47] Moreover, the identification strategy is valid once the method's assumptions hold. Under such assumptions, the differences in outcomes between participants and nonparticipants would be due to the program itself.

To conduct the matching between participants and nonparticipants of *Buen Comienzo,* we used the nearest-neighbor matching approach. This method identifies the individual with the closest distance to the treated individual in terms of their observable characteristics. Hence, the estimated effect is essentially the difference between two sample means (between participants and nonparticipants). We obtained the biased-corrected matching estimators from Abadie and Imbens, which allow for a match with replacement (meaning that an individual used as a counterfactual or control can be used more than once) and estimate standard errors by using the differences between means, thus avoiding bootstrapping.[48]

For policy purposes, the average treatment effect on the treated (ATT) could be of major interest, since it is more relevant to estimate the effect of the program on the initially targeted population.[49] We estimate the ATT and allow the software to conduct four matches per treated observation.

46. Caliendo (2006); Blundell and Dias (2009).
47. Abadie and Imbens (2002).
48. Abadie and others (2004); Abadie and Imbens (2011).
49. Heckman, Ichimura, and Todd (1997).

Data

The data used for the analysis come from a number of sources, including administrative records on the program, vital statistics, and government surveys. The data on participants were obtained from the administrative records of the *Buen Comienzo* program for pregnant women, from August 2009 to November 2011. The available information includes the national identification number for each participating mother, date of entry into the program, and the phase of participation (pregnant or lactating). Although the information is presented as an unbalanced panel of participants (with a monthly frequency), we use it as a cross section, relying on the fact that each participant could attend several sessions during the period analyzed.

The data on birth weight, height, and health outcomes were obtained from the vital statistics data set, a census of all individuals born alive in a particular year. We matched the mothers' information from this source and the program administrative records to identify the birth outcomes of treated women. One concern is that the births registered in the vital statistics data set are underreported; Duryea, Olgiati, and Stone find that the underreporting of births is widespread in Latin America. In the case of urban areas of Colombia, the main reasons for not reporting a birth were the lack of parental identification, lack of time, or lack of the proper stationery at the registry office.[50] Nationally, 16 percent of births go unreported, on average. The rate is lower in Medellín, the city where the program took place (4 percent). Finally, in the sample used for the analysis (to match treated and untreated mothers), all of the women are registered in SISBEN, which implies that they have parental identification, a condition that reduces the probability of not having registered the births.

To create the counterfactual (that is, the group of nonparticipants), we merged vital statistics data with data from SISBEN. As described earlier, SISBEN allocates a score to households according to their socioeconomic characteristics and classifies them into six levels, where level 1 is the most disadvantaged and level 6 the least disadvantaged. The government uses this classification to allocate education and health subsidies to households classified in the first three levels.

The SISBEN data set for Medellín has information on approximately 1.5 million individuals (out of a total population of 2.5 million in the municipality, excluding the surrounding metropolitan area). This corresponds

50. Duryea, Olgiati, and Stone (2006).

to 60 percent of the city's population, all of them socioeconomically disadvantaged. To identify which mothers did not participate in the program, we merged the participant data with the SISBEN data (already merged with vital statistics). We then used the SISBEN group that did not match with participant data to construct the untreated or control group.

Merging the three data sets produces 41,659 observations for mothers (including their children's outcomes), which is the sample that we use for the estimations. The treated group has 19,525 observations; the control group (mothers not attending the program) has 22,134 observations. Depending on the outcomes analyzed, the observations are slightly reduced.

Birth Outcomes

The main outcomes studied here are birth weight, height at birth, and the APGAR score. Following the literature, we started by estimating the standardized version (or z score) for weight and height (that is, each outcome is normalized to have a mean of zero and a standard deviation of one). The APGAR is built as a dummy variable that takes the value of one if the child scores between seven and ten, which are the normal measures for vital signs at birth during the first and fifth minute after birth, and zero otherwise.

Additional indicators for birth weight and size follow the World Health Organization (WHO) standards, which are used in Colombia to characterize children's growth and their nutritional state.[51] We use weight per age, which in our case corresponds to a child's birth weight. We define a given child's weight outcome according to the position of a child's weight relative to the mean and standard deviation proposed by the WHO, by gender. For example, the weight indicators are classified as very low weight, low weight, at risk of low weight, and normal weight; the height indicators are low height, at risk of low height, and normal height.

Another indicator that can be used to measure birth outcomes is weight for length, which is the recommended measure to define overweight and obese children before two years of age. It is similar to the body mass index (BMI), which is the common measure for children over two years of age, except that the BMI uses height squared. We report the latter in the tables for informative purposes, but our estimates focus on the standardized measures.

51. The WHO standards were adopted in 2010, per Resolution 2,121.

TABLE 2. Reference Measures for Children in Colombia

	No. standard deviations from the mean						
Variable	*−3*	*−2*	*−1*	*0*	*1*	*2*	*3*
Boys' weight (kg)	2.1	2.5	2.9	3.3	3.9	4.4	5.0
Girls' weight (kg)	2.0	2.4	2.8	3.2	3.7	4.2	4.8
Boys' height (cm)	44.2	46.1	48.0	49.9	51.8	53.7	55.6
Girls' height (cm)	43.6	45.4	47.3	49.1	51.0	52.9	54.7
Boys' BMI (kg/cm^2)	10.2	11.1	12.2	13.4	14.8	16.3	17.7
Girls' BMI (kg/cm^2)	10.1	11.1	12.2	13.3	14.6	15.1	18.1

Source: Colombian Resolution 00002121 of 2010.

Table 2 shows the reference measures used to define the different categories of birth outcomes. Table 3 reports the different cutoffs for the categorizations. We built dummy variables indicating whether or not each child's outcome belongs to that classification.

Descriptive Statistics

The matched sample between SISBEN and vital statistics data comprises 46,726 mothers. From this total, we excluded mothers for whom we were unable to determine the number of months they had attended the program and those with unlikely answers. This resulted in a sample of 40,229 mothers, of which 14,865 were treated and 25,364 were included in the control group. The literature suggests that there could be heterogeneous effects from a

TABLE 3. Criteria to Classify Children's Birth Indicators by Their Anthropometric Measures

Variable and classification	*No. standard deviations from the mean*
Weight	
Very low weight	< −3
Low weight	< −2
At risk of low weight	> −2, < −1
Appropriate weight	> −1, < 1
Height	
Low height	< −2
At risk of low height	> −2, < −1
Appropriate height	> −1
BMI	
Overweight	> 1, < 2
Obese	> 2

Source: Colombian Resolution 00002121 of 2010.

particular treatment depending on individual differences regarding exposure to the program and frequency of attendance.[52] We therefore built four different treatment groups to account for that difference: group 1 corresponds to the whole sample of treated mothers participating in the program regardless of their time of exposure and frequency of attendance; group 2 includes only treated individuals who entered the program during the first trimester of their pregnancy; group 3 comprises treated mothers who entered during the third trimester of pregnancy; and group 4 corresponds to those mothers who not only entered the program during the first trimester of pregnancy, but also attended at least once a month in the last six months of gestation. According to program officials, group 3 (late participants) is heavily represented by women who were diagnosed as at risk due to difficulties during pregnancy, such as anemia or low gestational weight.

In all cases, the control group was the same: mothers who did not participate in the *Buen Comienzo* program. This resulted in four different samples, whose sizes varied according to the group under analysis. Group 1 (which included treatment group 1 and the control group) included 40,229 mothers; group 2 had 29,146 mothers; group 3 had 29,146 mothers; and group 4 had 27,635 mothers.

The main set of variables characterizing the sample and each group are presented in tables 4 to 7. Tables 4 and 5 report, for boys and girls, respectively, the differences in the main outcomes between treated and control mothers in our most extended definition of treatment (that is, regardless of the time of exposure to the program). Tables 6 and 7 compare the main set of demographic variables between treated and control mothers, again for boys and girls, respectively. These variables were included in the matching procedure. The variables included from SISBEN and vital statistics data include mother's characteristics (for example, marital status, years and level of education, economic activity, socioeconomic stratum, housing, and health insurance); father's level of education and age; and a child's birth characteristics, such as type of labor or delivery, whether or not it was a multiple birth, whether or not the SISBEN score was below 47.99, timing of registration after the birth, and birth year dummies.

The information reported in the tables suggests that children from participant mothers have better birth outcomes than those from the control group

52. Behrman, Cheng, and Todd (2004).

TABLE 4. Girls' Difference in Means between Treatment and Control Groups

Variable	*Treatment*	*Control*	*Difference in means*	*Standard error*
Weight outcomes[a]				
Weight in grams	3,021.31	2,997.71	23.60***	7.07
Z score of weight	0.04	−0.01	0.05***	0.01
Low birth weight (< 2,500 grams)	0.11	0.11	−0.01	0.00
Low birth weight (< 3,000 grams)	0.44	0.46	−0.02**	0.01
Insufficient birth weight (2,500–2,999 grams)	0.33	0.34	−0.01	0.01
Very low birth weight for girls (<−3 std dev)	0.02	0.03	−0.01***	0.00
Low birth weight for girls (<−2 std dev)	0.08	0.08	−0.01*	0.00
Risk of low birth weight for girls (−2 to <−1 std dev)	0.19	0.20	−0.01	0.01
Normal birth weight for girls (−1 to 1 std dev)	0.68	0.67	0.01	0.01
Height outcomes[b]				
Height in cm	48.94	48.81	0.13***	0.04
Z score of the height	0.03	−0.01	0.05***	0.01
Low height for girls (<−2 std dev)	0.07	0.09	−0.02***	0.00
Risk of low height for girls (−2 to <−1 std dev)	0.15	0.15	0.00	0.01
Normal height for girls (=−1 std dev)	0.78	0.77	0.01*	0.01
Overweight/obesity				
Body mass index	12.56	12.52	0.05**	0.02
Overweight girl (>1 to 2 std dev)	0.05	0.05	0.00	0.00
Obese girl (>2 std dev)	0.01	0.01	−0.00	0.00
APGAR 1 minute 7–10 points	0.96	0.96	0.00	0.00
APGAR 5 minute 7–10 points	0.99	0.99	0.00	0.00
Birth before 38 weeks	0.18	0.23	−0.05***	0.01
No. observations	7,244	12,264		

* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. Weight standard deviation in grams: 476.
b. Height standard deviation in centimeters: 2.7.

(higher birth weight and height). Moreover, the comparison of demographic characteristics shows that participant mothers are slightly more disadvantaged than nonparticipants. Participant mothers have fewer years of education and are more likely to have completed primary education but not secondary education. Similarly, they are less likely to be working and are more likely to belong to the lowest socioeconomic stratum. Thus, in the presence of negative selection of the treated population, the existence of a positive effect would imply the existence of the impact.[53]

53. Bitler and Currie (2005).

TABLE 5. Boys' Difference in Means between Treatment and Control Groups

Variable	Treatment	Control	Difference in means	Standard error
Weight outcomes[a]				
Weight in grams	3,117.47	3,094.54	22.94***	7.31
Z score of weight	0.04	−0.01	0.04***	0.01
Low birth weight (< 2,500 grams)	0.09	0.09	−0.01	0.00
Low birth weight (< 3,000 grams)	0.35	0.37	−0.02***	0.01
Insufficient birth weight (2,500–2,999 grams)	0.26	0.27	−0.01*	0.01
Very low birth weight for boys (<−3 std dev)	0.03	0.04	−0.01**	0.00
Low birth weight for boys (<−2 std dev)	0.09	0.09	−0.01	0.00
Risk of low birth weight for boys (−2 to <−1 std dev)	0.19	0.19	−0.01	0.01
Normal birth weight for boys (−1 to 1 std dev)	0.69	0.68	0.01	0.01
Height outcomes[b]				
Height in cm	49.39	49.36	0.03	0.04
Z score of height	0.01	0.00	0.01	0.01
Low height for boys (<−2 std dev)	0.10	0.10	−0.00	0.00
Risk of low height for boys (−2 to <−1 std dev)	0.07	0.07	0.00	0.00
Normal height for boys (=−1 std dev)	0.83	0.83	0.00	0.01
Overweight/obesity				
Body mass index	12.71	12.62	0.09***	0.02
Overweight boy (>1 to 2 std dev)	0.05	0.05	−0.00	0.00
Obese boy (>2 std dev)	0.01	0.00	0.00*	0.00
APGAR 1 minute 7–10 points	0.94	0.95	−0.01**	0.00
APGAR 5 minute 7–10 points	0.99	0.99	−0.00	0.00
Birth before 38 weeks	0.19	0.25	−0.06***	0.01
No. observations	7,603	13,039		

* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. Weight standard deviation in grams: 508.
b. Height standard deviation in centimeters: 2.8.

Estimates of the Program's Impact on Birth Outcomes

Tables 8 and 9 show the birth weight estimates from the nearest-neighbor matching approach for girls and boys, respectively. Each row corresponds to a different anthropometric category used as dependent variable. With the exception of the *z* score, all outcomes are expressed as indicator variables, that is, showing the change in a child's probability of being in each of the weight categories. The tables show the estimated outcome for each of the treatment groups in four columns. For example, the estimates in column 1 correspond to the first group, so the estimates indicate whether or not there is a program effect among all participant mothers regardless of the start date

TABLE 6. Girls' Descriptive Statistics by Treatment Status

Descriptive statistic	*Treatment*	*Control*	*Difference in means*	*Standard error*
Married or cohabitating	0.33	0.51	−0.18***	0.01
Disabled	0.01	0.00	0.00**	0.00
Attending school	0.24	0.16	0.08***	0.01
Years of schooling	8.12	9.80	−1.69***	0.05
No education	0.02	0.01	0.01***	0.00
Primary school	0.22	0.12	0.10***	0.01
Secondary school	0.73	0.71	0.01	0.01
Technical education	0.03	0.09	−0.06***	0.00
Degree	0.01	0.06	−0.05***	0.00
Post-degree	0.00	0.00	−0.00***	0.00
No activity	0.16	0.08	0.08***	0.00
Working	0.14	0.34	−0.20***	0.01
Looking for a job	0.05	0.04	0.01***	0.00
Studying	0.24	0.14	0.10***	0.01
Several tasks	0.42	0.41	0.01	0.01
Retired	0.00	0.00	−0.00***	0.00
Household size	1.07	1.05	0.02***	0.00
Monthly income	37,216.32	140,319.33	−103,103.02***	3,749.18
Income—missing data	0.86	0.72	0.14***	0.01
No. of prenatal appointments	6.44	6.80	−0.36***	0.04
No. of prenatal appointments—missing data	0.01	0.03	−0.01***	0.00
Socioeconomic stratum 0	0.00	0.00	0.00**	0.00
Socioeconomic stratum 1	0.37	0.19	0.18***	0.01
Socioeconomic stratum 2	0.54	0.53	0.01	0.01
Socioeconomic stratum 3	0.09	0.28	−0.19***	0.01
Socioeconomic stratum 4	0.00	0.00	−0.00**	0.00
SISBEN score below 48	0.77	0.57	0.20***	0.01
Registration: no. months after birth	0.09	0.05	0.04***	0.00
Registration: no. months after birth—missing data	0.43	0.64	−0.21***	0.01
Certified by a doctor	0.98	0.98	0.01***	0.00
Twins	0.00	0.00	0.00	0.00
Twins category—missing data	0.98	0.98	0.00**	0.00
Labor: spontaneous	0.70	0.59	0.11***	0.01
Labor: cesarean	0.27	0.34	−0.07***	0.01
Labor: instrumented	0.03	0.06	−0.03***	0.00
Labor: attended by a doctor	1.00	1.00	0.00	0.00
Father's age	27.97	29.35	−1.38***	0.12
Father's education level: no schooling	0.01	0.00	0.00***	0.00
Father's education level: primary	0.09	0.04	0.05***	0.00
Father's education level: vocational	0.32	0.21	0.11***	0.01
Father's education level: technical	0.02	0.03	−0.01***	0.00
Father's education level: degree	0.03	0.03	−0.01**	0.00
Father's education level: missing data	0.53	0.69	−0.15***	0.01
Own house	0.39	0.35	0.04***	0.01
Health insurance: subsidized	0.77	0.32	0.45***	0.01
Health insurance: none	0.17	0.14	0.03***	0.01
Health insurance: contributes	0.06	0.54	−0.47***	0.01
Year of birth: 2009	0.16	0.42	−0.26***	0.01
Year of birth: 2010	0.45	0.28	0.17***	0.01
No. observations	7,244	12,264		

** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.

TABLE 7. Boys' Descriptive Statistics by Treatment Status

Descriptive statistic	*Treatment*	*Control*	*Difference in means*	*Standard error*
Married or cohabitating	0.34	0.50	–0.16***	0.01
Disabled	0.01	0.00	0.00**	0.00
Attending school	0.23	0.15	0.08***	0.01
Years of schooling	8.05	9.83	–1.77***	0.04
No education	0.01	0.01	0.01***	0.00
Primary school	0.24	0.12	0.12***	0.01
Secondary school	0.71	0.72	–0.01	0.01
Technical education	0.02	0.09	–0.06***	0.00
Degree	0.01	0.06	–0.06***	0.00
Post-degree	0.00	0.00	–0.00***	0.00
No activity	0.16	0.08	0.08***	0.00
Working	0.15	0.34	–0.19***	0.01
Looking for a job	0.04	0.04	0.01*	0.00
Studying	0.23	0.14	0.09***	0.01
Several tasks	0.42	0.40	0.02***	0.01
Retired	0.00	0.00	–0.00**	0.00
Household size	1.07	1.05	0.03***	0.00
Monthly income	38,398.71	141,861.20	–103,462.49***	4,089.45
Income—missing data	0.86	0.71	0.15***	0.01
No. of prenatal appointments	6.42	6.76	–0.34***	0.03
No. of prenatal appointments—missing data	0.01	0.02	–0.01***	0.00
Socioeconomic stratum 0	0.00	0.00	0.00**	0.00
Socioeconomic stratum 1	0.37	0.19	0.18***	0.01
Socioeconomic stratum 2	0.54	0.53	0.01	0.01
Socioeconomic stratum 3	0.09	0.28	–0.19***	0.01
Socioeconomic stratum 4	0.00	0.00	–0.00***	0.00
SISBEN score below 48	0.78	0.58	0.19***	0.01
Registration: no. months after birth	0.09	0.05	0.04***	0.00
Registration: no. months after birth—missing data	0.43	0.64	–0.21***	0.01
Certified by a doctor	0.99	0.98	0.01***	0.00
Twins	0.00	0.00	0.00	0.00
Twins category—missing data	0.98	0.98	0.01**	0.00
Labor: spontaneous	0.68	0.56	0.11***	0.01
Labor: cesarean	0.29	0.37	–0.08***	0.01
Labor: instrumented	0.03	0.06	–0.03***	0.00
Labor: attended by a doctor	1.00	1.00	0.00	0.00
Father's age	27.96	29.35	–1.39***	0.11
Father's education level: no schooling	0.01	0.00	0.00***	0.00
Father's education level: primary	0.09	0.04	0.05***	0.00
Father's education level: vocational	0.32	0.21	0.11***	0.01
Father's education level: technical	0.02	0.03	–0.01***	0.00
Father's education level: degree	0.03	0.03	–0.01**	0.00
Father's education level: missing data	0.53	0.68	–0.15***	0.01
Own house	0.40	0.35	0.05***	0.01
Health insurance: subsidized	0.76	0.32	0.44***	0.01
Health insurance: none	0.17	0.14	0.03***	0.01
Health insurance: contributes	0.07	0.54	–0.48***	0.01
Year of birth: 2009	0.15	0.42	–0.26***	0.01
Year of birth: 2010	0.45	0.29	0.17***	0.01
No. observations	7,603	13,039		

* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.

TABLE 8. Impact of *Buen Comienzo* on Birth Outcomes among Girls[a]

	Treatment group			
Dependent variable	*Group 1*	*Group 2*	*Group 3*	*Group 4*
Z score of birth weight	0.057***	0.193***	0.007	0.230***
	(0.021)	(0.028)	(0.034)	(0.036)
Low birth weight (LBW)	–0.012***	–0.037***	–0.001	–0.046***
	(0.006)	(0.007)	(0.009)	(0.009)
Very low birth weight	–0.014***	–0.031***	0.003	–0.028***
	(0.003)	(0.004)	(0.006)	(0.005)
At risk of LBW	–0.005	–0.022**	–0.020	–0.024*
	(0.008)	(0.012)	(0.013)	(0.014)
Insufficient birth weight	–0.010	–0.007	–0.030*	–0.008
	(0.01)	(0.014)	(0.016)	(0.018)
Normal weight	0.012	0.048***	0.018	0.054***
	(0.01)	(0.014)	(0.016)	(0.017)
Birth weight < 2,500 g	–0.007	–0.044***	0.008	–0.054***
	(0.006)	(0.009)	(0.01)	(0.011)
Birth weight < 1,500 g	–0.006***	–0.015***	0.002	–0.011***
	(0.002)	(0.003)	(0.004)	(0.004)
Z score of birth height (cm)	0.047***	0.159***	–0.003	0.195***
	(0.02)	(0.028)	(0.033)	(0.035)
Short	–0.014***	–0.038***	0.006	–0.046***
	(0.006)	(0.007)	(0.009)	(0.009)
At risk of being short	0.005	0.002	–0.020*	0.006
	(0.008)	(0.01)	(0.012)	(0.013)
Normal height	0.008	0.034***	0.013	0.039***
	(0.009)	(0.012)	(0.014)	(0.015)
Height < 45 cm	–0.014***	–0.038***	0.006	–0.046***
	(0.006)	(0.007)	(0.009)	(0.009)
No. observations	18,911	13,994	13,654	12,931

* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. We include LBW and having a birth weight below 2,500 grams as separate outcomes because in the case of girls, LBW (defined as 2 standard deviations below the average) is below 2,400 grams. In the case of boys, the two indicators are the same. Similarly, low height and being shorter than 45 cm are included as different outcomes because in the case of boys, low height is defined as shorter than 46 cm. In the case of girls, the two indicators are the same. The covariates include the child's mother's characteristics (such as age, marital status, disability, school attendance, number of years of education, education level, indicators of economic activity, health insurance, and multiple births), household size, household income, socioeconomic stratum, father's education level, and housing. Standard errors are in parentheses.

or frequency of their participation. For girls (table 8), the results suggest that the program improves birth weight by a 0.06 standard deviation (for example, 30 grams) and reduces the probability of low birth weight and very low birth weight by 1 percentage point.

The remaining columns test for the existence of heterogeneous effects, as suggested by Behrman, Cheng, and Todd, by examining whether the program effects varied among mothers with different participation start dates and frequency.[54] Column 2 estimates the impact of *Buen Comienzo* on mothers who started attending the program in the first trimester of pregnancy. The results for this smaller sample suggest a 0.19 standard deviation improvement in girls' birth weight and a significant reduction in the probability of LBW, on the order of 3.7 percentage points for low birth weight and 3.1 percentage points for very low birth weight. Similarly, the probability of a normal birth weight increases by 5 percentage points. The estimates for birth height in the second treatment group also suggest that the program increased girls' length at birth by 0.15 standard deviations (that is, 37 mm) and reduced the probability of being born short (that is, below 45 centimeters) by 4 percentage points.

For the group for mothers who started participating in the program in the last trimester of pregnancy (group 3, column 3), the estimates show less evidence of program effects on birth outcomes. Although group 3 is overrepresented by women with at-risk pregnancies, our set of covariates does not include information on the mother's health status either at the baseline or during pregnancy, so we are unable to control for these traits. This limitation affects the interpretation of the results for this group, where these traits are known to be much more prevalent. This will very likely prevent us from being able to obtain an appropriate match from mothers in the control group, potentially leading to an underestimation of the program effects.

Frequency of attendance is another factor that affects the outcome of an intervention.[55] In column 4, we examine whether this was the case during the first stage of the *Buen Comienzo* program by restricting the sample to mothers who began participating in the program in their first trimester and attended program sessions at least once a month in the last six months of their pregnancy. The estimates suggest that the program increased girls' birth weight by 0.23 standard deviation (around 115 grams), reduced the incidence of LBW (as defined in tables 2 and 3) by 4.6 percentage points, and reduced the probability of a birth weight below 2,500 grams by 5.4 percentage points.[56] The reduction in LBW is larger than the effect of the PANES cash-transfer program in Uruguay (1.9 to 2.4 percentage points) , suggesting that in-kind transfer programs might have a larger impact on children's health than cash

54. Behrman, Cheng, and Todd (2004).

55. Behrman, Cheng, and Todd (2004).

56. LBW and birth weight below 2,500 grams are included as different outcomes because in the case of girls, LBW is defined as 2 standard deviations below the average, which is below 2,400 grams. In the case of boys, the two indicators are the same.

transfers.[57] The results in this column further suggest that the program reduced the probability of very low birth weight by 3.0 percentage points and the risk of LBW by 2.4 percentage points. In terms of birth height, column 4 shows a reduction in the probability of being short and being born shorter than 45 centimeters by 4.6 percentage points,[58] while the coefficient for the *z* score of birth height increased by 0.19 standard deviation.

Table 9 presents the program's impacts on boys born to participant mothers. The estimates in column 2 suggest that mothers attending the program in the first trimester of pregnancy had a lower probability of having a boy with low birth weight or very low birth weight: in both cases, the probability was reduced by 2 percentage points. Similarly, they were 3.6 percentage points more likely to have a normal weight and 2.7 percentage points less likely to be short. The impact of the treatment for mothers who entered the program in the last trimester of pregnancy is null or negative (column 3). As in the case of girls, this result needs to be read with caution, since our set of covariates does not include information on the mother's health status either at the baseline or during pregnancy.

Once we account for mothers with the longest exposure and a moderate frequency of attendance (column 4), the results suggest that the program increased boys' birth weight by a 0.09 standard deviation (approximately 45 grams), reduced the probability of LBW and very LBW by 2.6 and 2.7 percentage points, respectively, and increased the probability of normal birth weight by 3.6 percentage points. Finally, the APGAR estimates (not shown in the table) were found to be negligible.[59]

Another possible outcome that could be affected by the program is the probability of having a preterm birth (that is, birth before 38 weeks). Parental training and good practices such as the intake of vitamins and micronutrients are some of the factors that affect gestational length. Table 10 reports the results using an indicator for whether or not the pregnancy resulted in a preterm birth as the dependent variable. As above, the table presents the results in four columns, for each of the treatment groups used in the analysis. The results suggest that treated mothers were less likely to have a preterm delivery: the probability was reduced between 3 and 9 percentage points depending

57. Amarante and others (2016).

58. Low height and being shorter than 45 centimeters are included as different outcomes, because low height is defined as being shorter than 46 centimeters for boys versus 45 centimeters for girls (that is, the indicators are the same for girls).

59. These results are available on request.

TABLE 9. Impact of *Buen Comienzo* on Birth Outcomes among Boys

	Treatment group			
Dependent variable	*Group 1*	*Group 2*	*Group 3*	*Group 4*
Z score of birth weight	0.006	0.088***	–0.098***	0.090***
	(0.02)	(0.027)	(0.033)	(0.034)
Low birth weight (LBW)	0.003	–0.021***	0.024***	–0.026***
	(0.006)	(0.007)	(0.01)	(0.009)
Very low birth weight	–0.002	–0.022***	0.018***	–0.027***
	(0.004)	(0.004)	(0.006)	(0.005)
At risk of LBW	–0.006	–0.011	0.011	–0.002
	(0.008)	(0.011)	(0.013)	(0.015)
Insufficient birth weight	–0.003	–0.006	0.013	0.002
	(0.009)	(0.013)	(0.014)	(0.017)
Normal weight	0.005	0.036***	–0.024	0.036***
	(0.009)	(0.014)	(0.015)	(0.017)
Birth weight < 2,500 g	0.003	–0.021***	0.024***	–0.026***
	(0.006)	(0.007)	(0.01)	(0.009)
Birth weight < 1,500 g	–0.005***	–0.015***	0.007*	–0.014***
	(0.002)	(0.002)	(0.004)	(0.003)
Z score of birth height (cm)	–0.017	0.065***	–0.132***	0.091***
	(0.02)	(0.026)	(0.034)	(0.033)
Short	–0.003	–0.027***	0.018*	–0.038***
	(0.006)	(0.008)	(0.01)	(0.01)
At risk of being short	0.014***	0.018***	0.013	0.011
	(0.005)	(0.007)	(0.008)	(0.009)
Normal height	–0.011	0.009	–0.033***	0.025***
	(0.008)	(0.01)	(0.012)	(0.013)
Height < 45 cm	–0.002	–0.024	0.022***	–0.026***
	(0.005)	(0.006)	(0.008)	(0.007)
No. observations	20,012	14,797	14,529	13,654

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

*** Statistically significant at the 1 percent level.

a. We include LBW and having a birth weight below 2,500 grams as separate outcomes because in the case of girls, LBW (defined as a 2 standard deviations below the average) is below 2,400 grams. In the case of boys, the two indicators are the same. Similarly, low height and being shorter than 45 cm are included as different outcomes because in the case of boys, low height is defined as shorter than 46 cm. In the case of girls, the two indicators are the same. The covariates include the child's mother's characteristics (such as age, marital status, disability, school attendance, number of years of education, education level, indicators of economic activity, health insurance, and multiple births), household size, household income, socioeconomic stratum, father's education level, and housing. Standard errors are in parentheses.

TABLE 10. Preterm Birth

	Treatment group							
	Group 1		*Group 2*		*Group 3*		*Group 4*	
Dependent variable	*Boys*	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*
Born before week 38	–0.036***	–0.036***	–0.065***	–0.080***	0.005	–0.002	–0.073***	–0.087***
	(0.008)	(0.008)	(0.011)	(0.012)	(0.013)	(0.014)	(0.014)	(0.015)

*** Statistically significant at the 1 percent level.

a. The covariates include the child's mother's characteristics (such as age, marital status, disability, school attendance, number of years of education, education level, indicators of economic activity, health insurance, and multiple births), household size, household income, socioeconomic stratum, father's education level, and housing. Standard errors are in parentheses.

on the length of exposure and frequency of attendance. That represents a relative increase between 12.5 percent and 32.0 percent with respect to the control group's mean. Boys and girls born to mothers attending the program are, on average, 3.6 percentage points less likely to be born preterm.[60] Similarly, boys whose mothers attended the program starting in the first trimester experienced a reduction of 6.5 percentage points in the probability of a preterm birth, which rises to 7 percentage points when we account for those attending program sessions at least once a month. For girls, the probability of a preterm birth for women participating in the program starting the first trimester and attending once a month decreases 6.5 and 8.7 percentage points, respectively.[61]

Balancing Test for Covariates

Table 11 reports the covariate balance for treated and control mothers for the matched sample. A comparison of the difference in means between the treatment and control groups that were matched with the average difference reveals that the differences in the matched sample are smaller than the differences presented in tables 6 and 7.[62] This provides evidence that the matching procedure considerably reduced the difference between the treated and control mothers in terms of observable characteristics.

Cost-Benefit Analysis

To conduct a cost-benefit analysis of the program, we define the following as program benefits: the positive impact on birth outcomes; the long-term consequences of birth improvement (for example, an individual's productivity); and the consequential reduction of bad outcomes (for example, infant mortality, hospitalization, medical care, and so on). The cost of the program is the per capita amount of money allocated yearly by the municipality to each participating mother. The unitary costs of each of the health practices

60. This is somewhat smaller than the effect found by Haeck and Lefebvre (2016), but it is still statistically significant.

61. This is similar to the effect found by Bitler and Currie (2005). Both Haeck and Lefebvre (2016) and Bitler and Currie (2005) assess food and nutrition advice programs.

62. We conducted a covariate balance test for the extended group used in the analysis (group 1), which includes all mothers attending the program regardless of the length of exposure or number of sessions attended.

TABLE 11. Covariate Balance after Matching

Covariate	Girls: Control group	Girls: Treatment group 1	Girls: Difference in means	Boys: Control group	Boys: Treatment group 1	Boys: Difference in means
Married or cohabitating	0.33	0.37	−0.04***	0.34	0.37	−0.03***
Disabled	0.01	0.01	0.00	0.00	0.00	0.00
Attending school	0.24	0.23	0.01***	0.23	0.22	0.01***
Years of schooling	8.14	8.52	−0.38***	8.08	8.46	−0.37***
Primary school	0.22	0.20	0.02***	0.24	0.22	0.02***
Secondary school	0.73	0.76	−0.03***	0.72	0.75	−0.03***
Technical education	0.03	0.02	0.00	0.02	0.02	0.00**
Degree	0.01	0.01	0.00	0.01	0.01	0.00
Post-degree	0.00	0.00	0.00	0.00	0.00	0.00
Working	0.14	0.15	−0.00	0.15	0.15	−0.00
Looking for a job	0.05	0.04	0.00	0.04	0.04	0.00
Studying	0.24	0.23	0.01***	0.23	0.22	0.01*
Several tasks	0.42	0.44	−0.03***	0.42	0.45	−0.03***
Retired	0.00	0.00	0.00	0.00	0.00	0.00
Household size	1.07	1.04	0.03***	1.07	1.04	0.03***
Monthly income	37,277.99	42,162.70	−4,884.72***	39,099.99	43,174.63	−4,074.64***
Income—missing data	0.86	0.88	−0.02***	0.86	0.88	−0.02***
Socioeconomic stratum 1	0.37	0.32	0.04***	0.37	0.34	0.03***
Socioeconomic stratum 2	0.54	0.58	−0.04***	0.54	0.57	−0.04***
Socioeconomic stratum 3	0.09	0.10	−0.01***	0.09	0.09	0.00
Socioeconomic stratum 4	0.00	0.00	0.00	0.00	0.00	0.00
Sisben score below 48	0.77	0.77	0.01	0.77	0.77	0.00
Twins	0.01	0.01	0.00	0.00	0.00	0.00
Twins category—missing data	0.98	0.98	−0.00	0.98	0.98	−0.00
Father's age	27.97	27.50	0.46***	27.96	27.46	0.50***
Father's education level: no schooling	0.01	0.01	0.00	0.01	0.01	0.00
Father's education level: primary	0.09	0.08	0.01***	0.09	0.09	0.01***
Father's education level: vocational	0.34	0.32	0.02***	0.34	0.32	0.02***
Father's education level: technical	0.02	0.02	0.00	0.02	0.02	0.00
Father's education level: degree	0.03	0.03	0.00	0.03	0.03	0.00
Father's education level: missing data	0.52	0.54	−0.03***	0.52	0.54	−0.03***
Own house	0.39	0.36	0.03***	0.39	0.36	0.04***
Health insurance: none	0.17	0.14	0.03***	0.17	0.14	0.03***
Health insurance: contributes	0.07	0.23	−0.17***	0.07	0.23	−0.17***
Year of birth: 2009	0.15	0.22	−0.07***	0.15	0.22	−0.07***
Year of birth: 2010	0.45	0.34	0.10***	0.45	0.36	0.09***
Mother's age	23.56	23.74	−0.18***	23.52	23.64	−0.11**

TABLE 11. Covariate Balance after Matching (*Continued*)

	Girls			*Boys*		
Covariate	*Control group*	*Treatment group 1*	*Difference in means*	*Control group*	*Treatment group 1*	*Difference in means*
Birth month 2	0.07	0.06	0.00	0.06	0.06	0.00
Birth month 3	0.08	0.08	0.00	0.08	0.08	0.00
Birth month 4	0.07	0.07	0.00	0.07	0.07	0.00
Birth month 5	0.07	0.07	0.00	0.07	0.07	0.00
Birth month 6	0.06	0.06	0.00	0.06	0.06	0.00
Birth month 7	0.07	0.06	0.00	0.07	0.07	−0.00
Birth month 8	0.09	0.09	0.00	0.09	0.09	0.00
Birth month 9	0.10	0.10	0.00	0.11	0.11	0.00
Birth month 10	0.11	0.11	−0.00	0.11	0.11	0.00
Birth month 11	0.10	0.10	−0.00	0.10	0.10	0.00
Birth month 12	0.11	0.11	0.00	0.11	0.11	−0.00
SISBEN score	35.20	37.17	−1.97***	35.12	36.88	−1.76***

* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The average values correspond to the matched number of observations using treatment group 1, four matches, and bias correction.

and health indicators (child mortality, hospitalization costs, and so on) were difficult to find and estimate for Colombia, mainly due to the lack of public information and available sources. We therefore use the assumptions proposed by Behrman, Alderman, and Hoddinott to obtain benefit-cost ratios for the program.[63] In that study, the authors provide average health cost estimates for low- and middle-income countries using data from Africa, Asia, and Latin America, where birth weight and child indicators are usually a concern.

The cost-benefit analysis is reported in table 12 for all four treatment groups. We focus here on the results for groups 2 and 4, given the potential limitations of our methodology for identifying the program effects on women in group 3, as mentioned above. The table includes our estimates for the program's benefits and costs for each of the populations considered in the study. We include benefits for a shift from below to above the 2.5 kilo threshold and for increased birth height. Following Behrman, Alderman, and Hoddinott, we estimate seven benefits of children not being born with LBW.[64] First, we include the benefits of reducing infant mortality, estimated by the authors as a 7.8 percent reduction in the likelihood of a child dying due to LBW,

63. Behrman, Alderman, and Hoddinott (2004).
64. Behrman, Alderman, and Hoddinott (2004).

TABLE 12. Cost-Benefit Estimates

		Treatment group							
		Group 1		*Group 2*		*Group 3*		*Group 4*	
Concept	*Parameter or unit*	*Boys*	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*
Benefit									
A. *Birthweight (total benefit)*[a]	US$	**0.00**	**0.00**	**85.30**	**229.90**	−128.60	**0.00**	**103.70**	**284.50**
Impact estimate: weight below 2,500 g		0.003	−0.007	−0.021***	−0.044***	0.024***	0.008	**−0.026*** **	−0.054***
		(0.006)	(0.006)	(0.007)	(0.009)	(0.01)	(0.01)	**(0.009)**	**(0.011)**
Discount rate	5.0%								
1. Reduction in infant mortality									
Drop in probability of infant death for moving from 2.00–2.49 to 2.50–2.99 kg	7.8%								
Cost of saving a life (US$2,012)	US$1,520.00		0.80	2.40	4.90	−2.80		2.90	6.10
Years discounted	1								
2. Reduction in neonatal medical care									
Estimated cost per child born at < 2.5 kg	US$255.00		1.70	4.90	10.10	−5.70		5.90	12.60
90% born at hospital, 10% at home	0								
Home costs = 10% hospital costs									
3. Reduction in cost of illness and medical care for infants and children									
Cost per child under 2.5 kg	US$48.00		0.30	1.00	2.00	−1.10		1.20	2.50
Years discounted	1								
4. Increase in lifetime productivity due to reduced stunting									
Share of annual earnings	2.2%		8.00	22.00	46.00	−25.00		27.00	56.00
Expected annual earnings	US$250.00								
Years discounted	60								

5. Increase in lifetime productivity due to increased abilities									
Share of annual earnings (7.5 − 2.2 = 5.3%)	5.3%		18.00	53.00	110.00	−61.00		64.00	136.00
Years discounted	60								
6. Reduction in cost of chronic diseases									
Reduction in probability of chronic disease	8.7%		1.00	2.00	5.00	−3.00		3.00	6.00
Number of years of earnings	10								
7. Cross–generational impacts of LBW		0.00	0.00	0.00	52.40	−29.30	0.00	0.00	64.90
B. Height (total benefit)[a]	US$	**0.00**	**177.00**	**245.00**	**603.00**	−499.00	**0.00**	**343.00**	**740.00**
Impact estimate: *z* score of height		−0.017	0.047***	0.065***	0.159***	−0.132***	−0.003	0.091***	0.195***
		(0.02)	(0.02)	(0.026)	(0.028)	(0.034)	(0.033)	(0.033)	(0.035)
Increase in lifetime earnings	US$	**0.00**	**177.00**	**245.00**	**603.00**	−499.00	**0**	**343.00**	**740.00**
% per 0.25 standard deviation increase	2.0%								
Years discounted	60								
Total benefits (weight + height)	US$	**0.00**	**177.00**	**330.00**	**833.00**	−628.00	**0.00**	**447.00**	**1,024.00**
Cost		**163.50**	**163.50**	**163.50**	**163.50**	**65.40**	**65.40**	**163.50**	**163.50**
Unitary cost per month	US$21.80								
Number of months		7.5	07.50	7.50	7.50	3.00	3.00	7.50	7.50
Benefit/cost ratio		0.00	1.08	**2.02**	**5.10**	−9.60	0.00	**2.74**	**6.27**

* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. Assumptions based on Behrman, Alderman, and Hoddinott (2004).

multiplied by the likelihood of the child moving out of LBW thanks to the program. Second, we include the reduction in neonatal medical care, where medical costs are estimated at US$255 per child born weighing less than 2.5 kilos. Given that about 90 percent of all children are born at the hospital, we assume that the costs for children born at home are 10 percent of those for children who were born at the hospital. After multiplying the figure obtained by the likelihood of the child not being born with LBW thanks to the program, the net present value of this benefit for boys in group 2 is US$4.90.

The third benefit is the reduced cost of subsequent illnesses and medical care for infants and children, where the baseline cost is estimated at around US$48 per child with a birth weight of less than 2.5 kilos. The net present value of this benefit for boys in group 2 is US$1.00.

The fourth benefit considered in this analysis is the increase in an individual's lifetime productivity due to a reduction in stunting, which is estimated to be 2.2 percent of earnings. We estimate a child's future earnings at US$2,500, discount this flow over 60 years, and then multiply the figure by the likelihood of the child not being born with LBW thanks to the program. This results in a net present value of US$22.00 for boys in group 2.

The fifth benefit is the increase in an individual's lifetime productivity thanks to the increased ability associated with normal birth weight versus LBW. This benefit is estimated to be 5.3 percent of lifetime earnings, according to Behrman, Alderman, and Hoddinott.[65] After following a similar procedure to that of the previous benefit, we obtain a net present value of this benefit of US$53.00 for boys in group 2.

The sixth benefit we consider is the reduction of the costs associated with chronic diseases, which are estimated to be ten years of an individual's earnings. Our calculations generate a net present value of US$2.00 for boys in group 2. The seventh and final benefit considered is the intergenerational cost of being born with low birth weight. We follow Behrman, Alderman, and Hoddinott, who estimate that the children of LBW mothers have a higher probability of being born with LBW, implying future costs that must be discounted to the present value.[66] The same does not apply to LBW fathers,

65. Behrman, Alderman, and Hoddinott (2004).

66. Behrman, Alderman, and Hoddinott (2004). The authors' assumptions are as follows: (a) these effects are only for LBW mothers, not fathers; (b) on average, they have four children, born when the mother is 17, 20, 26, and 35; (c) the LBW probability for each of her children is 20 percent; (d) this probability is 10 percent if she was not LBW; and (e) the benefits of reducing LBW for the children over their life cycles are the same as the benefits for the mothers, but lagged, with such possibilities over three generations of children.

however, so this benefit is only estimated for girls. For example, the estimated benefit for girls in group 2 is US$52.40.

We next estimate the program benefits from the effect on children's height at birth. As before, we use the parameters suggested by Behrman, Alderman, and Hoddinott: a 2 percent increase in lifetime earnings for each 0.25 standard deviation increase in birth height.[67] We multiply the estimated earnings from the impact of the program by the child's height, measured by its impact on the *z* score for height. For girls in group 2, the estimated benefits are US$603.00. The total benefits of the program are the sum of those obtained from birth weight and height.

The costs of the program are estimated to be US$21.80 per month. Under the conservative assumption that treatment groups 1, 2, and 4 remain in the program for 7.5 months while treatment group 3 only participates for three months, we calculate the total cost for each of the treated mothers. The benefit-cost ratio calculated from these figures is reported in the last row of the table. When a participant mother is exposed to the program for 7.5 months and attends at least six sessions, the benefits from the program are between two and six times the costs for boys and girls, respectively. When eligible mothers who are pregnant with girls participate in the program starting in the first trimester of pregnancy, the benefit is five times the program's costs. Groups 2 and 4, which are our preferred specification, reinforce the importance of length of exposure and frequency of attendance.

Conclusions

Using a matching estimator approach, we estimated the impact of a program run by the local authorities of Medellín, the second largest city in Colombia. The program, called *Buen Comienzo* (meaning "a good start"), includes a component for pregnant women, which promotes parental training and complements maternal nutrition as its main strategies. We assess its impact on birth outcomes, estimating it separately for boys and girls and for four different treatment groups, classified according to the length of exposure to the program and the frequency of attendance.

We found that the program had a positive impact on birth weight among treated mothers in three of the four treatment groups considered in the

67. Behrman, Alderman, and Hoddinott (2004).

analysis: all participant mothers; women enrolled in the program during the first trimester of pregnancy; and women enrolled in the first trimester and who attended at least one session a month during the last six months of their pregnancy. For the latter group, the program reduced the likelihood of girls being born underweight (that is, below 2.5 kilograms) by between 3 and 5 percentage points. This result is slightly greater than the effect of a cash-transfers program on LBW in Uruguay, which points to the importance of in-kind transfer programs.[68]

The program also reduced the likelihood of boys being born below 2.5 kilograms by 2.6 percentage points. Similarly, the program also reduced the probability of being short (below two standard deviations) by 5 and 4 percentage points for girls and boys, respectively. Furthermore, the program reduced the likelihood of premature birth (before thirty-eight weeks) in the same three treatment groups, in magnitudes ranging from 3 percentage points for the whole sample to around 9 percentage points for the sample of women with the longest exposure to the program.

We also assessed the total costs and benefits of the program for this population using estimates calculated for low- and middle-income countries.[69] We found a benefit-cost ratio ranging from 2.02 for boys and 6.27 for girls. The ratio is largest for women who enrolled in their first trimester of pregnancy and attended sessions frequently. This reinforces the the importance of enrolling women in the program early in their pregnancy to guarantee significant impacts on their children's weight and height at birth, given the lower benefits found for women enrolling later. Thus, detecting and enrolling pregnant mothers early in their pregnancy, preventing mothers from enrolling late in their pregnancy, and making additional efforts to retain mothers who are already in the program are promising ways to make this a cost-effective program.

Finally, since the program is essentially gender blind, one reason behind our differential impact estimates for boys and girls could be the greater capacity of boys to capitalize on the maternal food supply in utero relative to girls.[70] Another possibility is that the differences reflect cultural traits that lead women to act differently during pregnancy depending on the child's gender. This is an issue worth assessing in future research.

68. Amarante and others (2016).
69. Behrman, Alderman, and Hoddinott (2004).
70. Eriksson and others (2010).

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