Early Life Health Interventions and Academic Achievement

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Abstract

Do early life health interventions affect schooling outcomes later in life? We exploit medical recommendations and rules for treating very low birth weight (VLBW) infants and find that infants who receive extra medical care do better in school. Using detailed administrative data on schooling and vital statistics from Chile, we find that children who receive extra medical care at birth obtain scores that are around 0.18 SD higher in math. In addition, we examine a specific early childhood intervention by examining the impact of Chile's national surfactant policy which was introduced in 1998. Since surfactant therapy was especially recommended for VLBW infants, we find evidence suggesting that this policy helped in raising test scores even more. We also find interventions targeted towards VLBW infants to significantly decrease infant mortality. Treated infants are 5% less likely to die within a year of birth than untreated infants. Our results are robust to a wide variety of regression discontinuity checks, including checks aimed at detecting (and accounting for) non random heaping of data, which might occur in the case of birth weight.

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1 Introduction

While vast resources have been invested into improving early childhood health in developed and developing countries, considerable research remains to be done to assess the influence of these health interventions on outcomes later in life. For example, UNICEF estimates that about 15% of all births in developing countries require emergency obstetric care, and providing such care has been a focus of UNICEF's strategy aimed at reducing infant and child mortality. While the stated goal of many such interventions is to improve childhood health and reduce infant and childhood mortality, understanding spillovers and externalities of such interventions is key to estimating the efficacy of such programs. A likely spillover of such health interventions is on academic achievement. In addition to the policy relevance of such an exercise, we can gain insight into the health-income gradient by examining the role of health interventions on school outcomes. In an influential article, Case, Lubotsky, and Paxson (2002) suggest that the origins of the health-income gradient in adulthood has its origins in childhood health. School performance and achievement can be viewed as potential mechanisms that connect childhood health and adult labor market outcomes. In several recent articles, James Heckman and co-authors have emphasized the role of early childhood environments in determining inequalities in abilities seen later in life.[1] If health interventions in early childhood impact academic achievement, perhaps such interventions can make some progress towards closing the inequality gap in ability that begins in childhood.

An important indicator of early childhood health is birth weight. In many studies in medicine and economics, birth weight is often considered the most important summary measure of infant health. As a result, numerous papers have examined the role of maternal behavior and environment in producing birth weight; many papers also view birth weight as an input and examine the impact of birth weight on various outcomes such as adult health, labor market outcomes, school performance et cetera.[2] In general, these studies find that low birth weight (LBW - less than 2500 grams) and VLBW infants do poorly in terms of development outcomes and later life success. As a result, policy focus has been on methods to increase birth weight via nutritional supplements to pregnant women; or in the instance of a LBW/VLBW birth, to provide the infant

[1] For example see Heckman and Masterov (2007), Heckman (2006), Cunha, Heckman, and Schennach (2010) and Conti, Heckman, and Urzua (2010).

[2] A sampling of economics papers on this topic include Currie and Hyson (1999), Behrman and Rosenzweig (2004), Black, Devereux, and Salvanes (2007), Royer (2009), Grossman and Joyce (1990), Currie and Moretti (2007), Deschênes, Greenstone, and Guryan (2009), Almond and Mazumder (2008), and Bharadwaj, Eberhard, and Neilson (2010).

with additional medical care. Health interventions pertaining to LBW and VLBW are of even greater importance in developing countries like India where almost a quarter of all births are low birth weight (NFHS 2005). This paper focusses on post birth medical treatments for VLBW births and draws out implications of these treatments on academic achievement in school.

The challenge in examining the causal link between health interventions during infancy and school outcomes is that interventions are often not administered randomly. Hence, infants who receive special medical attention might be different along various other dimensions that might affect school performance. For example, infants who receive additional medical attention at birth might have parents who are more educated. Parental education might then be the factor affecting school performance, not medical intervention. To get around such confounding factors, we adopt the idea used in Almond, Doyle, Kowalski, and Williams (2010) (henceforth ADKW). The essence of their idea lies in the fact that doctors often use rules of thumb to administer medical care to children who are born at risk. Since such rules often say, for example, that infants below 1500 grams be admitted to the neonatal intensive care unit (NICU), what ADKW point out is that children born just *below* 1500 grams do better in terms of mortality outcomes than infants born just *above* 1500 grams - even though the general relationship between birth weight and mortality is negative. The underlying assumption is that an infant born with a birth weight of 1490 grams is essentially identical to an infant born with a birth weight of 1510 grams except for the extra medical attention that one infant might receive simply because he/she was born below a somewhat arbitrary cutoff.

Such rules of thumb appear to be used by doctors outside the United States as well. In guidelines published by the Ministry of Health in Chile, medical recommendations for children born below 1500 grams are explicitly stated. In addition, these guidelines clearly state that children below 32 weeks of gestational age should also be treated. Thus, for the remainder of the paper, we only consider infants whose gestational age was greater than or equal to 32 weeks, since the birth weight rule of thumb is potentially binding for this group. We show in the results section that the birth weight cut off rule does not seem to apply for children who are less than 32 weeks in gestational age. Among numerous tests (including a 5 day follow up) and recommendations, it is suggested that these infants be seen by a neonatologist immediately (for a full translated transcript of recommendations please see the Appendix). More recent expansions of public health care provision explicitly state the 1500 gram cutoff as a requirement for eligibility for several treatments and follow up care (a 2003 Ministry of Health document *explicitly* states that VLBW children are eligible for supplemental nutrition program). We exploit this rule of thumb to identify the link between extra medical care and performance in school. Using the population of births between 1992-2001 matched to their school outcomes in Chile, we find that children born just below the 1500 gram cutoff do better in school, compared to children born just above the cutoff, even though the correlation between birth weight and test outcomes is positive. In particular, children born just below the cutoff have math scores that are on average 0.18 SD higher than children born above the cutoff.

We also analyze a specific policy initiative aimed at improving lung performance among preterm and underweight infants. In 1998, Chile introduced universal surfactant therapy (used to combat respiratory distress, which is highly correlated with death and/or brain injuries in VLBW infants) to be administered to children who were born at risk and with low birth weights (Gonzalez et al 2006). We find strong suggestive evidence that after the introduction of this policy, the effect of being just below the cutoff is an *additional* increase in math scores of 0.1 SD compared to being born just above the cutoff.

Finally, consistent with ADKW, we find that extra medical attention also decreases infant mortality. Children born just below 1500 grams are 5% less likely to die within a year of birth compared to children born just above 1500 grams. This is a large effect as the infant mortality rate for children born between 1400-1600 grams is approximately 8%.

Our identification strategy is based on the idea that children born just below and just above the cutoff are practically identical along observed and unobserved dimensions. We show that being born just below or above the cutoff is not systematically related to a host of demographic and parental characteristics. In a recent paper, Barreca et al (2010) question the results of ADKW by showing that the "heaps" in birth weight data hide important information pertaining to the quality of medical care or socio-economic characteristics of parents. We show several ways in which our results are not susceptible to these concerns. First, birth weight is *always* measured in grams in Chile; hence, there is no case in which hospital quality determines whether birth weight is measured in grams or ounces (Barreca et al (2010) point out that an ounce heaps raise robustness issues in ADKW's results). Second, heaping does not appear correlated with observable characteristics. Third, we show our results are similar when we adopt Barreca et al's (2010) recommended approach of a donut regression discontinuity design or employing heaping fixed effects to account for any potential bias due to unobservables that might be correlated with heaping. Finally, for a subset of the data, we can employ hospital fixed effects estimate that mitigate the role of hospital quality in determining heaps.

This paper contributes to identifying the link between childhood health interventions and school outcomes. While the link between health and school outcomes has been well studied in economics,[3] the long term impact of early life health *interventions* is less well established. In the seminal work on educational externalities of health interventions by Miguel and Kremer (2004), the intervention examined is contemporaneous with school outcomes. Two related works include Field, Robles, and Torero (2009), who find that children born to mothers subjected to an iodine supplement program while pregnant complete more years of schooling and Alderman, Hoogeveen, and Rossi (2009), who examine the relationship between preschool nutrition and school attainment and delayed entry in Tanzania. In spirit, this paper is quite close to these two papers, although we examine school achievement rather than years of attainment. Perhaps more closely related to the current study is a recent paper by Chay, Guryan, and Mazumder (2009). They relate the narrowing of the black-white test score gap in the US to improved health access for blacks during infancy. Hence, we add to a growing literature on the role of early childhood health and medical interventions on later life cognitive outcomes.

The rest of this paper is organized as follows. Section 2 provides some background on VLBW births in Chile, and highlights some of the guidelines for taking care of VLBW infants. Section 3 discusses the data and the regression discontinuity design in detail. Section 4 discusses the main results on school outcomes and various robustness checks, including accounting for "heaping" in birth weight data as recently suggested by Barreca et al (2010). Section 5 concludes.

2 VLBW births in Chile and birth weight cutoffs

Health care in Chile is primarily funded by the public system and approximately 70% of the population uses the public insurance system (Palomino, Morgues, and Martinez 2005). Beginning in the early 1990s, considerable efforts were made by the government

[3]A small sampling of these studies include Miguel and Kremer (2004), Bleakley (2007), Behrman (1996), Glewwe, Jacoby, and King (2001), Alderman, Hoddinott, and Kinsey (2006), Maccini and Yang (2009), Kazianga, De Walque, and Alderman (2009) and Field, Robles, and Torero (2009).

to expand the coverage of neonatal care across the country. One of the first policies implemented was to require trained neonatologists to be present at each of the regional hospitals and establishing Neonatal Intensive Care Units (NICUs), which would be equipped for providing specialized care to VLBW infants. The national health system has 26 regions, and as a result of the policies in 1991, each region has at least one hospital with a Neonatal Intensive Care Unit (Gonzalez et al 2006). The setting up of the NICUs was followed later on in the mid 1990s by the provision of modern equipment and specialized training programs.

One of the larger and more well known programs introduced in Chile was the national surfactant program in 1998. Under this program artificial lung surfactant was provided to public hospitals across the country to be used to treat respiratory distress syndrome in VLBW infants. Several public health articles on Chile which study infant and neonatal mortality, give credit to this program in reducing mortality rates among VLBW infants in Chile (Jimenez and Romero 2007, Gonzalez et al 2006). In 2003 a national nutritional program called "PNAC para prematuros" was introduced (Ministry of Health, 2003). This program provides free fortified nutritional supplements for VLBW children for a twelve month period and included several checkups later on. In 2005 a larger public health reform called AUGE added several additional treatments for VLBW births. These include i) screening for Retinopathy of Prematurity (ROP), which helps avoid blindness, ii) screening and followup treatment for Sensorineural Hearing Loss (SHL), and iii) treatment for Bronchopulmonary Dysplasia (BPD) which is a chronic lung disease common in VLBW births. Important to our design is the fact that while virtually all births occur under the care of a doctor or a trained midwife, approximately 68% of births occur in hospitals with a NICU (Gonzalez et al 2006).[4]

The policies mentioned above all emphasize treatments for births below 1500 grams and/or 32 wks of gestation either as a technical recommendation or explicitly as a rule which determined eligibility. According to Gonzalez et al (2006), since 1991

> "A protocol has been implemented at the national level to regulate the referral of neonates who are born in hospitals without a NICU to the regional hospitals. There also are *standardized protocols for the treatment of newborns who weigh less than 1500g* and for cases of respiratory distress syndrome." (emphasis added)

Later in 1999 the Ministry of Health published the first manual for training programs

[4] According to the same study, the number of NICU's in the country did not change between 1992-2000.

at NICUs which had the title ”Orientaciones Tecnicas para el seguimiento del recien nacido <1500 y/o <32 semanas al nacer” which translates to ”Technical Orientations for Births Below 1500 grams and or 32 Weeks of Gestation.” This publication lists the numerous medical treatments recommended for children who are born with a weight of less than 1500 grams and/or less than 32 weeks in gestational age. These include, but are not limited to: examination by a neonatologist, a 5 day check up, various X-rays and other forms of specialized care (for an abbreviated translated transcript see the Appendix).

The focus on this particular group of births is also seen clearly in the explicit rules regarding eligibility for the PNAC nutritional supplements program later in 2003. In this case, babies are eligible if their birth weight is below 1500 grams or their gestation is less than 32 weeks. We continue to see this emphasis in the application of the new AUGE eligibility criteria in 2005. The AUGE program explicitly guarantees screening and treatment for ROP, BPD and SHL for births which are under 1500 and/or 32 weeks of gestation, which is the only criteria for eligibility (Ministry of Health, 2005).

The medical literature cites BPD and early childhood lung diseases to be significantly correlated with cognitive outcomes (Singer et al 1997, D'Angio et al 2002, Marlow et al 2005). One of the pathways by which preterm birth might affect cognitive outcomes appear to be related to the development of the lung and the delivery of oxygen to the brain. Hypoxia (reduction in oxygen supply to tissues) or ischemia (a severe low oxygen state) in the perinatal period is one of the leading causes of brain injury in preterm infants (Luciana 2003).

In sum, it appears that the ”rules of thumb” as mentioned in ADKW are very much present in the Chilean context. Moreover, due to universal health care and official policies surrounding the treatment of VLBW infants, we expect such rules of thumb to be implemented quite rigorously.

3 Data and Empirical Design

3.1 Data

We use a database that has matched the administrative records of the population of births in Chile between 1992-2007 to the administrative records on the population of deaths during the same period. This generates a match for virtually all (99%) of official infant deaths over the period we study. The data on the population of births is also matched to the administrative records on the population of students who attended school in Chile between 2002-2008. However, as most children in the later years of the data are too young to be observed in school, we use births between 1992-2001 for our school sample and all births between 1992-2007 for our mortality sample. Within this sample frame, the match between administrative records of birth and school outcomes is above 96%.

The data on births and deaths were provided by the Health Ministry of the government of Chile. This dataset provides data on the sex, birth weight, birth length, weeks of gestation and several demographics of the parents such as the age, education and occupational status. In addition, the dataset provides a variable describing the type of birth, be it a single birth, double (twins), triple (triplets), etc. We obtain death records (by age) from the same agency.

The data on school achievement comes from administrative data on the grades and test scores of every student in the country between 2002 and 2008. Use of this data was provided by the Ministry of Education of Chile (MINEDUC) where data from the Health Ministry was merged with schooling data using a unique individual identifier. The database consists of the grades by subject of each student in a given year. We standardize grades for each student at the class room level. In addition, we use the results of a national exam administered to 4th and 8th grade students in Chile called the SIMCE. This test is accompanied by a survey which provides a rich set of demographic characteristics. We refer the interested reader to Bharadwaj, Eberhard, and Neilson (2010) for details on the data used in this paper.

We observe approximately 4.01 million births between 1992 and 2007, out of which approximately 0.9% (35,500 births) are observed to be below 1500 grams in birth weight. Within the bandwidths we examine in this paper (between 1400 and 1600 grams) we observe approximately 12,200 births. Among these 12,200 births about 6,700 births are for infants who are above 32 weeks of gestation (inclusive). This is the largest sample we observe for the mortality regressions.

3.2 Empirical Design

Our empirical design closely follows that of ADKW, and other regression discontinuity studies like Imbens and Lemieux (2008) and Lee and Lemieux (2010). We choose a small (100 gram) window around the cutoff of 1500 grams[5] and estimate the following regression for child i at born at time t:

$$\begin{aligned} T_i &= \beta_1 VLBW_i + \beta_2 VLBW_i * (bw_i - 1500) \\ &\quad + \beta_3 (1 - VLBW_i) * (bw_i - 1500) + \alpha X_i' + \gamma_t + \epsilon_i \end{aligned} \tag{1}$$

Where T_i is a standardized summary test score for child i (we do the analysis by grade as well, but our main results are for the average score the child attains during the period we observe him/her in the school data), $VLBW_i$ is an indicator which takes on a value of 1 if the child is below 1500 grams and 0 if the child weighs greater than or equal to 1500 grams. We include linear trends above and below the cutoff, although we also show results for polynomials around the cutoff. We estimate this regression using OLS and report the coefficients with robust standard errors clustered at the gram level.

We might worry about selection issues that arise due to specialized care given to infants just below the cutoff that might affect mortality rates just below and just above the cutoff (as was shown in ADKW). While this is indeed the case (we describe the mortality results later in the text), we think that this might lead to an underestimate of our effects. The infants who do not survive (and are born just above the cutoff) are likely the weakest infants in that group and would have perhaps performed worse in school. Hence, selection due to mortality will lead us to observe a smaller effect on test scores than we might otherwise.

[5] In the results section we show the sensitivity of the results to various bandwidths between 50 grams and 150 grams at 10 gram intervals. Intuitively, while a larger bandwidth leads to greater precision, it also leads to comparing more dissimilar infants. We also conduct sensitivity analysis for the number of polynomials included in the analysis. Using checks suggested by Lee and Lemieux (2010) (inclusion of 10 gram bin dummies and jointly testing that the coefficients on these dummies are zero) we find that using a linear approximation around the cutoff is perhaps most prudent.

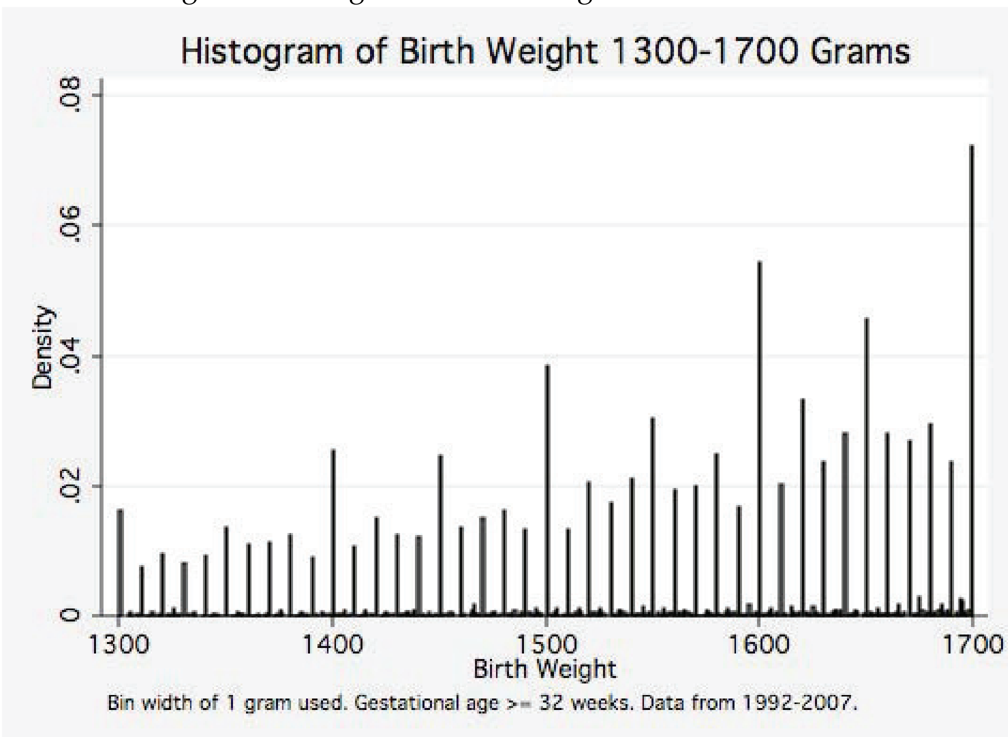
4 Results

4.1 Distribution of birth weight around 1500 grams

Figure 1 shows the distribution of birth weight for a 200 gram window around the VLBW cutoff. There are pronounced heaps in this distribution. Heaping occurs at the 10, 50 and 100 gram intervals, presumably due to rounding. Heaping in birth weight in US data was found to be systematically correlated with socio-economic characteristics (Barreca et al 2010); in the section on robustness checks we show that our results are not driven by data that appears at heaps. However, Figure 1 at least visually mitigates the concern that women might perfectly predict birth weight and choose birth timing such that they fall on one side of the cutoff at 1500 grams. Certainly, there could be more complicated ways in which birth weight reporting could be manipulated such that unobservably sicker or healthier infants fall on one side of the cutoff or the other. We attempt to deal with this issue in a later section where we show that parental education and other covariates do not vary systematically around the cutoff. Finally, as in ADKW, we implement a version of the McCrary (2008) test for manipulation of the birth weight variable. In the same framework as in equation 1, we use the number of births at each gram interval to verify that there are no greater or fewer births around the cutoff (β_1=-16.93 and the standard error is 30.38.[6]

[6]This result is from the sample of births between 1992-2007 and above 32 weeks of gestation. For the sample of births between 1992-2001 and above 32 weeks of gestation, β_1=-16.63 and the standard error is 26.58

Figure 1: Histogram of Birth Weight



4.2 School performance

Figure 2 shows in the simplest terms the basic import of our findings. Children born just to the left of the cutoff perform better in school[7] than children born just to the right of the cutoff, even though birth weight in general is positively related to test score performance

[7]Since we observe children repeatedly across multiple grades, we simply take the average performance of the child during the period for which we can observe him/her in the data. In Table 3, we estimate equation 1 by grade level. We use performance in math as the measure of school performance.

Figure 2: Math Scores around the cutoff

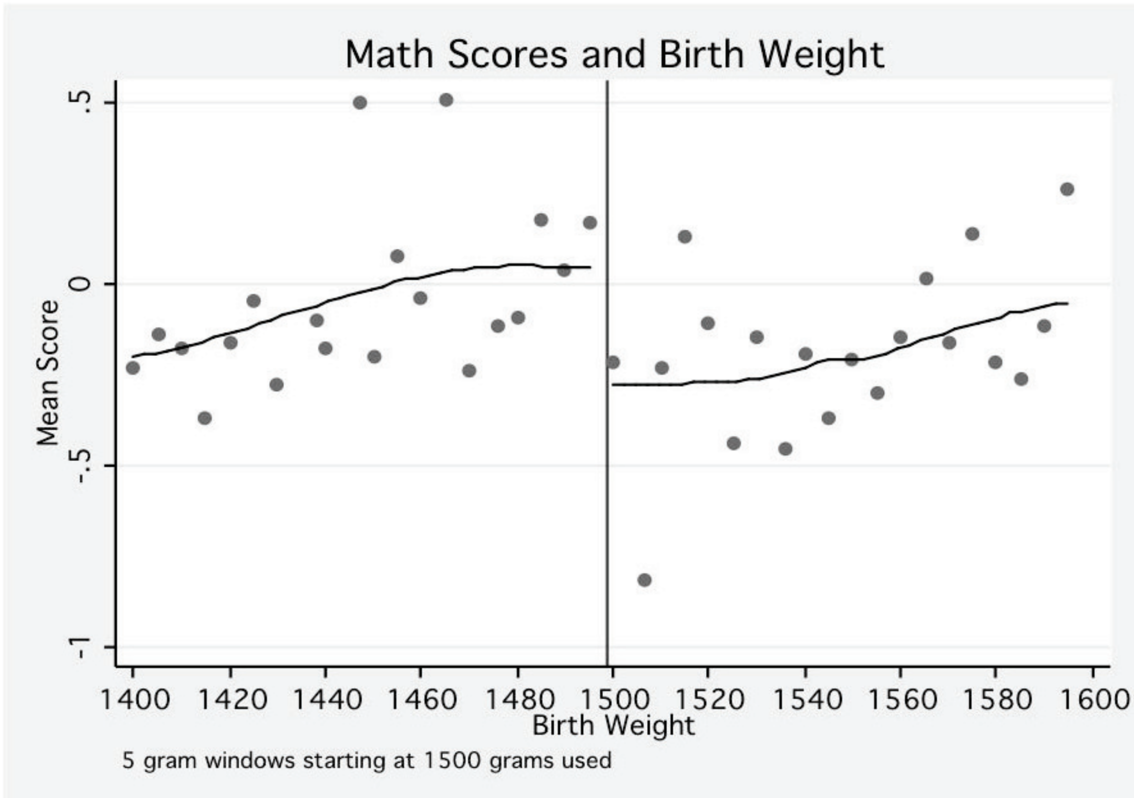


Table 1 estimates equation 1 with increasing number of covariates.[8] One casual check for a valid RD design is that if the running variable (in this case birth weight) cannot be manipulated, then adding covariates should not dramatically change the results. Table 1 shows that increasing the number of covariates does not significantly alter the coefficient on $VLBW$. Table 1 thus suggests that being to the left of the cutoff increases school math performance by around 0.18 SD.

An important aspect of the "rules of thumb" we discussed in Section 2 is that most of these rules regarding birth weight are only applicable to infants whose gestational age is greater than or equal to 32 weeks. This is because most of the recommendations are

[8] Due to the nature of the data, exact hospital location is known only starting in 2001. Hence, we are unable to use a hospital fixed effects approach in this case. In the case of mortality, (we have mortality data up to 2008) we show that our results are largely unchanged even with a hospital fixed effect. This mitigates concerns that hospital level variables might be driving the results.

for children who are born with a birth weight of 1500 grams *and/or* less than 32 weeks in gestational age. Unfortunately gestational age is not measured at fine intervals, and using gestational age of 32 as a cut off point will essentially result in comparing infants 31 weeks in age to infants 33 weeks in age. Since this is a crucial period of growth in utero, comparing infants with such different gestational ages does not appear to be a feasible design.

The gestational age rule however, provides us with a check on the birth weight rule. For births that are less than 32 weeks in gestational age, the 1500 gram birth weight rule should not be applicable. These infants should receive treatment based on the fact that they qualify under the gestational age rule. Table 2 shows that this appears to be the case. For births below 32 weeks, there appears to be no cut off around 1500 grams. Almost all the effects in column 1 (overall sample) appear to be driven by births that are above 32 weeks in age.

Table 3 shows the results by each grade in school. The coefficients are mostly similar to the average grade findings, although the effect is not statistically significant in every grade. The effect appears significant for grades 1, 2 and 3 (and that too only at the 10% level for grades 1 and 2). Table 4 shows similar results for the national test scores rather than classroom level test scores. As mentioned in the Data section, Chile administers a nationalized test to all 4th and 8th graders. Unfortunately SIMCE was not administered every year to 4th graders - hence, the sample sizes are smaller for these. Table 4 suggests that children below the 1500 gram cut off tended to have scores around 0.2 SD higher in their 4th grade test.

As mentioned earlier, in 1998, Chile introduced universal surfactant therapy to be administered to VLBW infants. Table 5 examines the consequences of this national policy which was targeted towards VLBW infants on subsequent test performance. We find suggestive evidence that the surfactant program had a positive impact, although the results are statistically significant only at the 10% level. Moreover, it is possible that the publication of the orientation manuscript around the same time (see Section 2) could be driving some of this result. Hence, we regard these as being suggestive rather than conclusive. The coefficient of interest in Table 5 is the interaction between the birth cutoff and post 1998 dummy. Under the assumption that the surfactant policy was the *only* change in neonatal service after 1998, Table 4 suggests that children born just below the cutoff but born after 1998 performed even better in math in school.

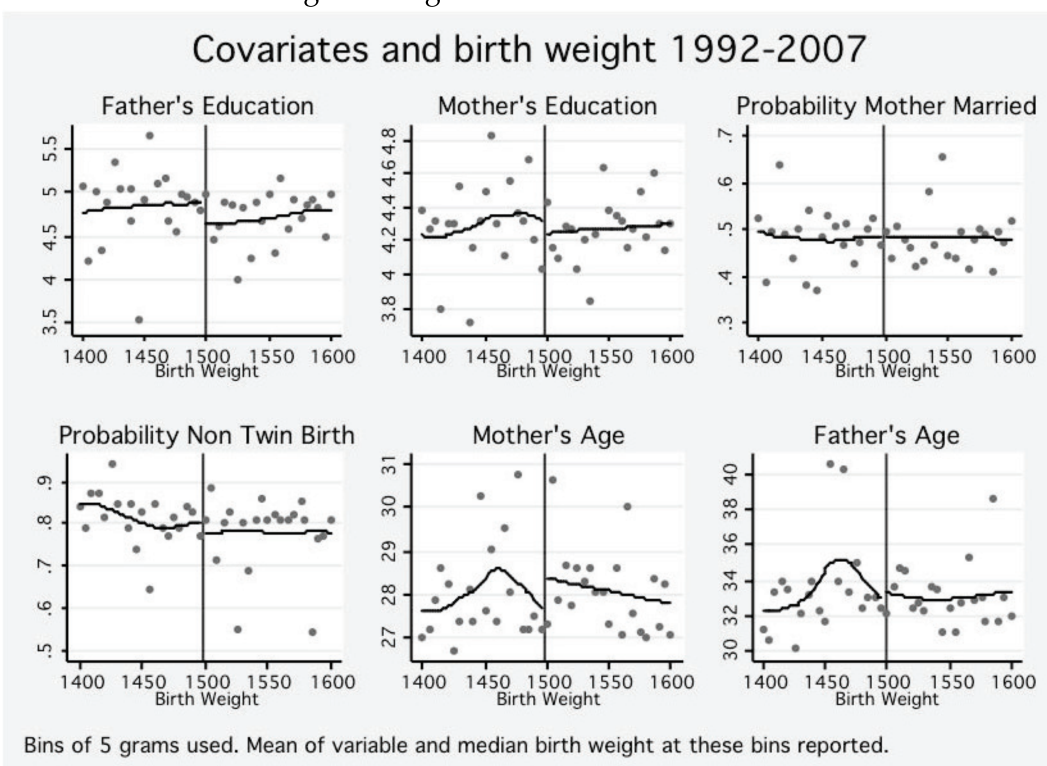
4.3 Robustness Checks

We perform several robustness checks to ensure our results are picking up the effect of additional medical care and not some other systematic variation.

4.3.1 Covariates

While Table 1 showed some indication that covariates do not play an important role in assignment of birthweight to either side of the cutoff, Table 6 and the figure below make that notion clear. Covariates do not appear to shift at the cutoff point. In pictures, while some covariates show some movement around 1500 grams (like mother's age, for example), these are not significant in regression analysis.

Figure 3: Figure 3



4.3.2 The role of heaping

Rounding in this data set is not significantly correlated to observable demographics or socioeconomic status as measured in the data available. Table 7 explores whether heaping at 10, 50 and 100 gram intervals (which appear to be the most common intervals where heaps occur) is correlated with characteristics like parental education, age and other characteristics. For any heaping interval, heaping does not seem to be correlated with observable characteristics.

However, given the recent findings of Barreca et al (2010), we show our results are robust including fixed effects for heaps and even for removing points at heaps entirely. Table 8 shows that the coefficient on the cutoff remains largely unchanged as we account for heaping at 10, 50 or 100 gram intervals. Table 9 employs a "donut" regression discontinuity approach where increasingly points to the left and right of 1500 grams are removed from the analysis. This too does not change the basic import of our findings.

4.3.3 Other cutoffs

Table 10 examines whether similar discontinuities in test scores appear at every 100 gram interval between 1100 and 3000 grams. 1500 seems to be the only point at which there is a statistically significant positive result. Not only are other cut off points statistically insignificant (if positive), they are also much smaller in magnitude.

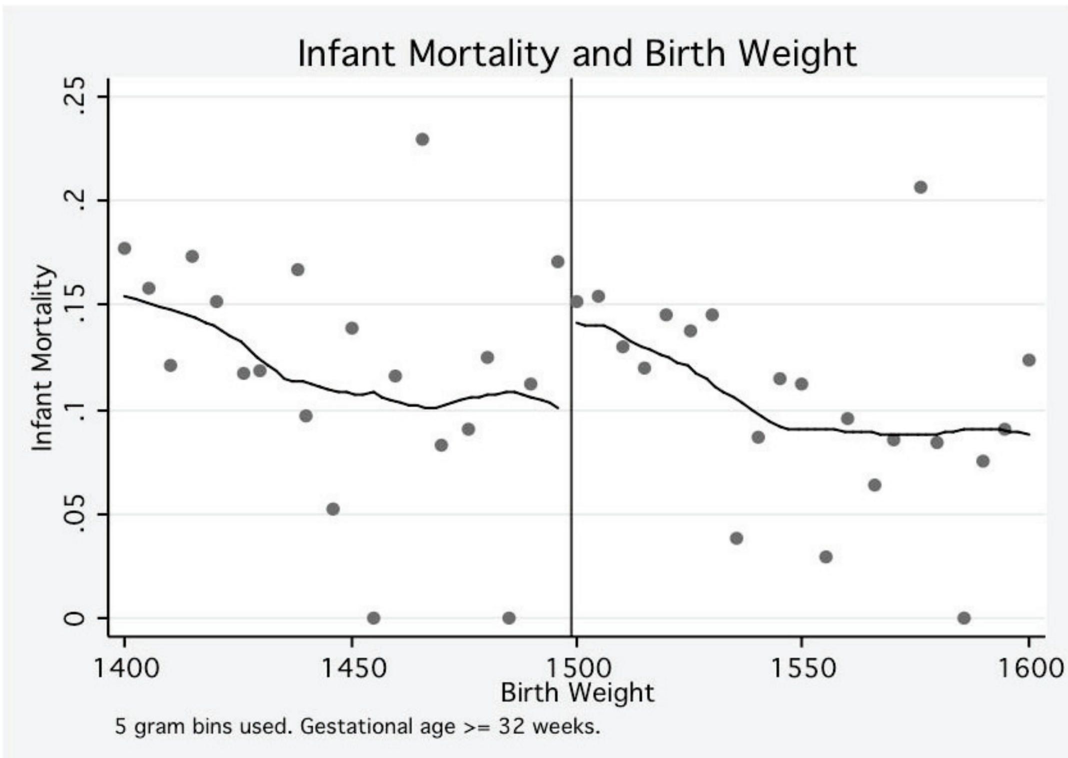
4.3.4 Polynomial and Bandwidth Selection

Appendix Table 1 shows estimates equation 1 for a wide variety of bandwidths and polynomials on either side of the 1500 gram cutoff. While the results are large consistent across different bandwidths for a given polynomial selection, the results across different polynomials for a given bandwidth do tend to differ. To the extent that the results are largely similar for polynomials 1 and 2, especially in more reasonable bandwidths, we consider our results to be largely robust. Moreover, visual inspection of the data (Figure 1) and the check suggested by Lee and Lemieux (2010) (for our case, we include 10 gram bin dummies and jointly test whether the coefficients on these dummies are zero) seem to imply that linear trends around the cutoff is a good fit.

4.4 Infant Mortality

We obtained mortality data from 1992-2007 and estimate the impact of being just under 1500 grams on infant mortality in a similar fashion. If greater medical care is provided to children just below the cutoff, then it is likely that they will also have lower mortality rates than children born just above the cutoff. The figure below shows that this indeed is the case.

Figure 4: Figure 4



As we did in the case of test scores, Table 11 shows that adding covariates does not significantly alter the coefficient on the birth weight cutoff variable (although adding the control of heaping at 100 grams raises the coefficient by quite a bit). An important addition in this table, which we were unable to implement in the case of test scores due to data imitations is the inclusion of hospital fixed effects. The last column of Table 11 shows that inclusion of hospital fixed effects does not change our results, which suggests that differences across hospitals which might be correlated with quality and socioeconomic characteristics are likely not driving the results. Thus, it appears that being born just below 1500 grams reduces the likelihood of mortality by 5% compared to being born just above the cutoff. Table 12 again finds that most of the results in the overall sample (Table 12 column 1) is driven by births above the gestational age of 32 weeks. This is presumably because all infants, regardless of birth weight get treatment if they are less than 32 weeks in age.

Table 13 shows results for neonatal and 24 hour mortality and the results appear similar to that of infant mortality. Although adding covariates raises standard errors, resulting in statistically insignificant results in column 3 (Table 13). Tables 14-16 do the same robustness checks as in the case of test scores, but using infant mortality as an outcome variable. The tables show that cutoffs other than 1500 grams do not appear to hold, and the results are robust to a wide variety of heaping checks. Finally in Appendix Table 2, we show the sensitivity of the results to different polynomials and bandwidths. The results appear robust to a wide range of bandwidths and a second degree polynomial. The third degree polynomial however, appears to have somewhat different results for larger bandwidths.

5 Conclusion

We examined the role of medical interventions early in life and found that early life health interventions have an impact on school achievement many years later, as well as on infant mortality. Children who by virtue of having been born with a birth weight of just less than 1500 grams receive more treatment along various dimensions as a result of "rules of thumb" in medical practice in Chile. Consequently, they appear to have higher math scores in school compared to children born just a few grams heavier than 1500 grams. We also observe decreases in infant and neonatal mortality as a result of extra medical care administered to these infants.

While the main goal such policies is to lower infant or neonatal mortality, by examining the impact of treatments on later life test scores, we highlight important spillovers that arise from medical care provided early in life. Moreover, the evidence we provide might help explain why the health-income gradient in adulthood exists: better health in childhood likely improves accumulation and formation of human capital via better cognitive achievement. Moreover, medical interventions might be a key input for reducing inequalities in abilities that are seen later in life, but have their foundations in early childhood health and environment. At the moment we do not have the data to assess the costs of such medical interventions and weigh them against the benefits of improved test scores and lower mortality. As mentioned in the introduction, this would be useful for analyzing the cost effectiveness of such interventions.

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6 Appendix - Medical recommendations for VLBW infants

Newborn Child Assessment 1500 grs.

by Dr Virginia Berrios, Neonatology Service, Puerto Montt Hospital, Santiago, Chile
Downloaded from www.prematuros.cl on October 2, 2010

1. All infants of BW less than 1500 g should be treated in the Neonatal Service at tertiary level, since most likely require Intensive Care Unit (NICU). Should be treated in the best possible conditions, making it important presence in the immediate attention of a Neonatologist and specialized Matron. The clinical characteristics of each patient determine the need for additional laboratory tests, imaging and procedures.

2. During the first few hours of life
   - Thermoregulation: Transfer of RN transport incubator to the NICU. Radiant heat cradle if you need multiple procedures. (Must be transferred as soon as possible to an intensive care incubator, ideally within 3 hours). Incubator should be preferred initially intensive care if it does not require multiple procedures. Cover with plastic cover for newborn to prevent insensible water loss.
   - Tests to perform: Central hematocrit (blood count), Calcemia, Glucose, or Reflolux: after installing the serum was assessed at 30 min, then every 12 hours or earlier if the patient requires. Glycosuria: Glycemia be done if it is greater than 90 mg / dl and at least one time per day. CBC - PCR: as infection screening when necessary. (Cell Dyn: after 10:00 AM). Bilirubin every 12 hours as the risk of hyperbilirubinemia, especially if prophylactic therapy is not indicated (see Clinical Practice Guidelines Hyperbilirubinemia). Blood gases in cases of respiratory distress. Chest radiograph (AP-side): If respiratory distress and are mandatory after every intubation. (Do not forget to record the findings of Rx. Pectus medical record) AP and lateral radiograph thoracoabdominal if placed central venous catheter and / or pressure. Blood cultures (2) where a history of RPM, chorioamnionitis or respiratory distress. Plasma electrolytes every 12 hours in children under 1,000 grams.

3. Tests during the first 5 days:
   - Glucose or Reflolux every 12 hours as the patient.
   - Plasma electrolytes every 24 hrs.
   - BUN and creatinine on the 3rd day
   - Bilirubin every 12 or 24 hours.
   - Coagulation tests within 72 hours (or sooner if bleeding).
   - Brain ultrasonography in 5 days and 4 th week (or sooner depending on clinical picture)

- Blood gases as the patient's condition
- X-ray if respiratory symptoms persist and / or there is suspicion of patent ductus arteriosus (PDA).
- Echocardiography in suspected DAP or other congenital heart disease.

4. Early detection of pathologies and problems in newborns less than1500 grams:
    - Cardiorespiratory depression at birth: training of personnel who receive the newborn as Neonatal Resuscitation Manual.
    - Alterations in thermoregulation: the thermal environment management is a primary measure in all RN and very particularly in the premature (See Standards of Nursing neonatal).
    - Jaundice: Bilirubin and Serial Control phototherapy according to clinical practice guideline hyperbilirubinemia.
    - Hypo or Hyperglycemia: start as soon as possible fleboclisis glucose load 4-6 mg / kg / minute and adjust as reflolux or glucose.
    - Hypocalcemia: treat if hypocalcemia research.
    - Water balance: water balance strictly control the first five days at least and at least every 24 hours. View Clinical Practice Guidelines electrolyte requirements.
    - Nutrition has become an increasingly important role in the management of these newborns (see Clinical Practice Guidelines for nutrition)
    - Surfactant deficiency disease (EDS) is important to insist on the use of antenatal steroids for preventing ESD. It should ideally indicate exogenous surfactant before the first 2 hours of life (see Clinical Practice Guidelines for the Use of surfactant).
    - Early detection of hemodynamic changes: availability of sufficient number of monitors, must know how to use it. In the critically ill technique using invasive procedures (in blood pressure for example).
    - Patent ductus arteriosus: See Clinical Practice Guidelines for prophylactic use of indomethacin and DAP.
    - Coagulation: control platelets and coagulation tests (TTPK and protrombinemia) during the first 72 hours or sooner if bleeding occurs. (See Clinical practice guidelines for transfusions).
    - Necrotizing enterocolitis: prevention and early diagnosis (see NEC in neonatal surgery)
    - Intra hemorrhage / periventricular: its prevention and early diagnosis (see intracranial hemorrhage)
    - Infections: Observe strict hand washing and nursing guidelines.
    - Metabolic bone disease of prematurity: an additional contribution of Calcium, Phosphorus and Vitamin D as serial standards and controls with relevant laboratory tests (serum calcium, fosfemia, alkaline phosphatase).

- Anemia of prematurity: Serial control of hematocrit, hemoglobin and reticulocyte count (see Clinical Practice Guidelines for transfusions and use of oral iron in anemias).
- Retinopathy of prematurity: the examination must be performed and trained ophthalmologist should ideally run at 4 weeks, with a ceiling at 6 weeks (View ROP Clinical Practice Guidelines).
- Bronchopulmonary dysplasia: careful management of fluid intake, oxygen and mechanical ventilation. Emphasize prevention and timely treatment of infections, alveolar rupture and ductus arteriosus.
- Screening of endocrine-metabolic diseases: phenylketonuria (PKU) and congenital hypothyroidism.

Table 1 - Discontinuity at 1500 grams with covariates

100 gram band width around 1500	1	2	3	4	5
Birth Weight<1500	0.167 [0.056]***	0.212 [0.057]***	0.193 [0.050]***	0.188 [0.063]***	0.179 [0.054]***
(Birth Weight - 1500) X Birth Weight<1500	0.002 [0.001]***	0.003 [0.001]***	0.003 [0.001]***	0.003 [0.001]***	0.003 [0.001]***
(Birth Weight - 1500) X Birth Weight>=1500	0 [0.000]	0 [0.000]	0.001 [0.000]	0 [0.001]	0 [0.001]
Covariates included		1+ triangular weights	2+Mother's age, education, marital status; type of birth service, region of birth and year of birth	3+100 gram heap fixed effect	4+Municipality of birth fixed effect
Constant	-0.196 [0.024]***	-0.2 [0.022]***	-0.269 [0.079]***	-0.264 [0.099]***	-0.195 [0.110]*
Observations	3162	2584	2276	2276	2276

Standard errors in brackets, clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%
Notes: 100 gram bandwidth chosen; infants with gestational age equal to or greater than 32 weeks in sample. Births from 1992-2001 in sample.

Table 2 - Math Scores around 1500 grams by Gestational Age

Mortality esitmates	All gestational ages	Gestational age >=32 weeks	Gestational age < 32 weeks
Birth Weight<1500	0.102 [0.051]**	0.188 [0.063]***	-0.005 [0.067]
(Birth Weight - 1500) X Birth Weight<1500	0.002 [0.000]***	0.003 [0.001]***	0.001 [0.001]**
(Birth Weight - 1500) X Birth Weight>=1500	0 [0.001]	0 [0.001]	0 [0.001]
Constant	-0.163 [0.069]**	-0.264 [0.099]***	0.017 [0.132]
Observations	3976	2276	1700

Std errors clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%
Notes: 100 gram bandwidth chosen; Covariates: Municipality of birth, Mother's age, Mother's education, Mother's marital status, Type of birth service, Year of birth, 100 gram heap fixed effects. Triangular weights used in all specifications. Births from 1992-2001 in sample.

Table 3 - Test score effect evaluated by grade level

Grade in school	1	2	3	4	5	6
Birth Weight<1500	0.183	0.181	0.31	0.147	0.08	0.005
	[0.096]*	[0.105]*	[0.089]***	[0.119]	[0.088]	[0.100]
(Birth Weight - 1500) X Birth Weight<1500	0.003	0.001	0.004	0.003	0.001	0.003
	[0.001]**	[0.001]	[0.001]***	[0.002]*	[0.001]	[0.001]***
(Birth Weight - 1500) X Birth Weight>=1500	0.001	0.001	0.001	0.001	0	-0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Constant	0.296	-0.41	-0.858	-0.293	-0.422	-0.377
	[0.283]	[0.224]*	[0.220]***	[0.221]	[0.127]***	[0.303]
Observations	1298	1462	1465	1577	1458	1163

Std errors clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%

Covariates: Region of birth, Mother's age, Mother's education, Mother's marital status, Type of birth service, Year of birth. Infants above 32 weeks (inclusive of 32 weeks) of gestational age used in analysis. Triangular weights used in all specifications. Births from 1992-2001 in sample.

Table 4 - National Scores in Math

Grade in school	Grade 4 SIMCE	Grade 8 SIMCE
Birth Weight<1500	0.219	0.11
	[0.129]*	[0.168]
(Birth Weight - 1500) X Birth Weight<1500	0.004	0
	[0.002]*	[0.003]
(Birth Weight - 1500) X Birth Weight>=1500	0	0.001
	[0.001]	[0.002]
Constant	0.346	0.374
	[0.213]	[0.455]
Observations	1139	391

Std errors clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: 100 gram bandwidth around each cutoff chosen; Covariates: Region of birth, Mother's age, Mother's education, Mother's marital status, Type of birth service, Year of birth, 100 gram heap fixed effects. Infants above 32 weeks (inclusive of 32 weeks) of gestational age used in analysis. Triangular weights used in all specifications. Births from 1992-2001 in sample.

Table 5 - Impact of National Surfactant Program on test scores around 1500 grams

	Math Test Scores	
Mortality esitmates (1992-2005 data only)	Avg score 1-4th grade	Avg score 1-8th grade
Post 1998 * Birth Weight cutoff	0.095	0.102
	[0.056]*	[0.057]*
Post 1998 (1=1998 and later, 0 otherwise)	0.009	0.001
	[0.057]	[0.072]
Birth Weight<1500	0.163	0.183
	[0.060]***	[0.089]**
Constant	-0.249	-0.141
	[0.097]**	[0.152]
Observations	2276	2155

Std errors clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: 100 gram bandwidth around each cutoff chosen; Covariates: Region of birth, Mother's age, Mother's education, Mother's marital status, Type of birth service, Year of birth, 100 gram heap fixed effects. Infants above 32 weeks (inclusive of 32 weeks) of gestational age used in analysis. Triangular weights used in all specifications. Births from 1992-2001 in sample.

Table 6 - Other covariates examined at 1500 grams

Covariates	Mother's Age	Father's Age	Mother's Education	Father's Education	Mother married	Birth Mother Employed
Birth Weight<1500	-0.371	0.33	-0.007	0.036	0.012	0.058
	[0.391]	[0.749]	[0.096]	[0.104]	[0.022]	[0.036]
(Birth Weight - 1500) X Birth Weight<1500	-0.006	0	-0.001	-0.001	0	0.001
	[0.006]	[0.012]	[0.002]	[0.002]	[0.000]	[0.000]**
(Birth Weight - 1500) X Birth Weight>=1500	-0.003	-0.002	-0.001	0.001	0	0
	[0.005]	[0.010]	[0.001]	[0.001]	[0.000]	[0.001]
Constant	28.064	35.816	4.188	4.7	0.604	0.297
	[0.784]***	[2.201]***	[0.291]***	[0.184]***	[0.047]***	[0.038]***
Observations	5388	5688	5693	5693	5276	5688

Std errors clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: 100 gram bandwidth chosen; Covariates: Region of birth. Triangualar weights used in each specification. This table uses data from 1992-2007. Test score results are only available for births between 1992-2001.

Table 7 - Heaping and Demographic Characteristics

	Heaps observed (in grams)			Heaps observed (in grams) - with hospital fixed effects		
Birth weight ranges from 1000-3000 grams	10	50	100	10	50	100
Mother's Education	-0.001	0.002	0	0	0	-0.007
	[0.002]	[0.003]	[0.002]	[0.004]	[0.007]	[0.006]
Father's Education	0	0	0	0.003	-0.002	0
	[0.002]	[0.002]	[0.001]	[0.004]	[0.004]	[0.003]
Mother's Age	-0.001	-0.001	-0.001	0.001	0.002	0.002
	[0.001]**	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]
Father's Age	0	0	0	0	0	0
	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.001]
Married	0.026	0.024	0.031	-0.018	0.018	0.034
	[0.009]***	[0.014]*	[0.012]***	[0.019]	[0.030]	[0.026]
Single Birth	0.021	0.006	-0.002	-0.054	-0.031	-0.034
	[0.012]*	[0.014]	[0.011]	[0.022]**	[0.032]	[0.030]
Constant	1.065	0.515	0.385	1.061	0.528	0.456
	[0.032]***	[0.156]***	[0.170]**	[0.156]***	[0.336]	[0.305]
Observations	6276	6276	6276	1832	1832	1832

Std errors clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: Infants above 32 weeks in gestational age in sample. Region of birth fixed effects in all regressions. Triangular weights used in all specifications. This table uses data from 1992-2007. Test score results are only available for births between 1992-2001.

Table 8 - Robustness to Heaping

Average scores grade 1-8	Fixed effects for heaps			Removing points at heaps		
	10	50	100	10	50	100
Birth Weight<1500	0.171	0.158	0.17	0.603	0.176	0.18
	[0.050]***	[0.053]***	[0.064]***	[0.308]*	[0.062]***	[0.065]***
(Birth Weight - 1500) X Birth Weight<1500	0.003	0.003	0.003	0.002	0.003	0.003
	[0.001]***	[0.001]***	[0.001]***	[0.003]	[0.001]***	[0.001]***
(Birth Weight - 1500) X Birth Weight>=1500	0	0	0	0.002	0.001	0
	[0.000]	[0.000]	[0.001]	[0.005]	[0.001]	[0.001]
Constant	-0.151	-0.244	-0.262	1.114	-0.296	-0.312
	[0.118]	[0.088]***	[0.094]***	[0.461]**	[0.116]**	[0.101]***
Observations	2178	2178	2178	174	1624	1964

Std errors clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%

Covariates: Region of birth, Mother's age, Mother's education, Mother's marital status, Type of birth service, Year of birth. Infants above 32 weeks (inclusive of 32 weeks) of gestational age used in analysis. Triangular weights used in all specifications. Births from 1992-2001 in sample.

Table 9 - Donut RD Design

	Size of donut around 1500 grams							
	0	1	2	3	4	5	6	7
Birth Weight<1500	0.18	0.18	0.18	0.18	0.18	0.167	0.167	0.163
	[0.065]***	[0.065]***	[0.065]***	[0.065]***	[0.065]***	[0.065]**	[0.065]**	[0.065]**
(Birth Weight - 1500) X Birth Weight<1500	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
	[0.001]***	[0.001]***	[0.001]***	[0.001]***	[0.001]***	[0.001]***	[0.001]***	[0.001]***
(Birth Weight - 1500) X Birth Weight>=1500	0	0	0	0	0	0	0	0
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Constant	-0.312	-0.312	-0.312	-0.312	-0.312	-0.306	-0.306	-0.316
	[0.101]***	[0.101]***	[0.101]***	[0.101]***	[0.101]***	[0.101]***	[0.101]***	[0.101]***
Observations	1964	1964	1964	1964	1964	1958	1958	1957

Std errors clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: 100 gram bandwidth chosen; Covariates: Region of birth, Mother's age, Mother's education, Type of birth service, Year of birth, 2nd order polynomial of birth weight on either side of the 1500. Births from 1992-2001 in sample.

Table 10 - Examining Cutoffs between 1100-3000 grams

Infant mortality used as outcome

Cutofff point	Coefficient on cutoff	Cutofff point	Coefficient on cutoff
1100	-0.406	2100	0.022
	[0.195]**		[0.025]
1200	-0.091	2200	-0.014
	[0.150]		[0.016]
1300	-0.082	2300	0.025
	[0.107]		[0.032]
1400	0.05	2400	0.003
	[0.059]		[0.014]
1500	0.157	2500	0.016
	[0.062]**		[0.012]
1600	-0.011	2600	0
	[0.044]		[0.016]
1700	-0.017	2700	-0.026
	[0.053]		[0.010]**
1800	0.005	2800	0.001
	[0.058]		[0.011]
1900	-0.033	2900	-0.002
	[0.026]		[0.011]
2000	-0.002	3000	-0.016
	[0.021]		[0.006]***

Std errors clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: 100 gram bandwidth around each cutoff chosen; Covariates: Region of birth, Mother's age, Mother's education, Mother's marital status, Type of birth service, Year of birth, 100 gram heap fixed effects. Infants above 32 weeks (inclusive of 32 weeks) of gestational age used in analysis. Triangular weights used in all specifications. Births from 1992-2001 in sample.

Table 11 - Infant Mortality Estimates around 1500 Grams

100 gram band width around 1500	1	2	3	4	5	6
Birth Weight<1500	-0.041	-0.043	-0.038	-0.058	-0.064	-0.06
	[0.017]**	[0.012]***	[0.016]**	[0.017]***	[0.020]***	[0.033]*
(Birth Weight - 1500) X Birth Weight<1500	-0.001	0	0	0	0	0
	[0.000]***	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
(Birth Weight - 1500) X Birth Weight>=1500	0	-0.001	-0.001	-0.001	-0.001	-0.001
	[0.000]*	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Covariates included		1+Triangular weights	2+Mother's age, education, marital status; type of birth service, region of birth and year of birth	3+100 gram heap fixed effect	4+Municipality of birth fixed effect	5+Hospital of birth fixed effect
Constant	0.138	0.153	0.077	0.101	0.108	-0.071
	[0.011]***	[0.005]***	[0.046]	[0.045]**	[0.038]***	[0.146]
Observations	6726	5648	5232	5232	5232	1615

Standard errors in brackets, clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: Hospital of birth information is only available for 2002-2005 and 2007. Table estimated only for infants greater than or equal to 32 weeks of gestational age. Births from 1992-2007 in sample.

Table 12 - Infant Mortality around 1500 grams by Gestational Age

Mortality esitmates	All gestational ages	Gestational age >=32 weeks	Gestational age < 32 weeks
Birth Weight<1500	-0.03	-0.056	0.003
	[0.015]**	[0.019]***	[0.023]
(Birth Weight - 1500) X Birth Weight<1500	0	0	0
	[0.000]	[0.000]	[0.000]
(Birth Weight - 1500) X Birth Weight>=1500	-0.001	-0.001	0
	[0.000]***	[0.000]***	[0.000]
Constant	0.173	0.126	0.227
	[0.037]***	[0.048]***	[0.060]***
Observations	9085	4971	4114

Std errors clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: 100 gram bandwidth chosen; Covariates: Municipality of birth, Mother's age, Mother's education, Mother's marital status, Type of birth service, Year of birth, 100 gram heap fixed effects. Triangular weights used in all specifications. Births from 1992-2007 in sample.

Table 13 - Neonatal and 7 day Mortality Estimates around 1500 Grams

100 gram band width around 1500 Coefficient on Birth Weight<1500	1	2	3	4	5	6
Neonatal Mortality	-0.029	-0.029	-0.021	-0.037	-0.042	-0.024
	[0.017]*	[0.013]**	[0.016]	[0.020]*	[0.019]**	[0.032]
7 day Mortality	-0.027	-0.025	-0.017	-0.034	-0.04	-0.009
	[0.016]*	[0.012]**	[0.017]	[0.018]*	[0.018]**	[0.031]
Covariates included		1+Triangular weights	2+Mother's age, education, marital status; type of birth service, region of birth and year of birth	3+100 gram heap fixed effect	4+Municipality of birth fixed effect	5+Hospital of birth fixed effect
Observations	6431	5409	5013	5013	5013	1551

Standard errors in brackets, clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: Hospital of birth information is only available for 2002-2005 and 2007. Table estimated only for infants greater than or equal to 32 weeks of gestational age. Births from 1992-2007 in sample.

Table 14 - Examining Cutoffs at Multiples of 50 between 1100-3000 grams

Infant mortality used as outcome			
Cutofff point	Coefficient on cutoff	Cutofff point	Coefficient on cutoff
1100	0.011	2100	0.005
	[0.017]		[0.005]
1200	0.05	2200	0.005
	[0.046]		[0.003]*
1300	0	2300	0.003
	[0.000]		[0.003]
1400	0.01	2400	-0.005
	[0.027]		[0.002]**
1500	-0.058	2500	-0.002
	[0.017]***		[0.002]
1600	-0.007	2600	-0.003
	[0.010]		[0.001]*
1700	0.005	2700	-0.001
	[0.014]		[0.001]
1800	-0.011	2800	0
	[0.013]		[0.001]
1900	0.006	2900	-0.001
	[0.006]		[0.001]
2000	-0.004	3000	0
	[0.006]		[0.001]

Std errors clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%
Notes: 100 gram bandwidth around each cutoff chosen; Covariates: Region of birth, Mother's age, Mother's education, Mother's marital status, Type of birth service, Year of birth, 100 gram heap fixed effects. Infants above 32 weeks (inclusive of 32 weeks) of gestational age used in analysis. Triangular weights used in all specifications.

Table 15 - Robustness to Heaping

Infant Mortality	Fixed effects for heaps			Removing points at heaps		
	10	50	100	10	50	100
Birth Weight<1500	-0.04	-0.043	-0.058	-0.089	-0.058	-0.057
	[0.016]**	[0.016]***	[0.017]***	[0.038]**	[0.017]***	[0.017]***
(Birth Weight - 1500) X Birth Weight<1500	0	0	0	-0.001	0	0
	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]
(Birth Weight - 1500) X Birth Weight>=1500	-0.001	-0.001	-0.001	-0.002	-0.001	-0.001
	[0.000]***	[0.000]***	[0.000]***	[0.001]***	[0.000]***	[0.000]***
Constant	0.098	0.084	0.101	0.019	0.093	0.09
	[0.049]**	[0.047]*	[0.045]**	[0.109]	[0.059]	[0.054]*
Observations	5232	5232	5232	786	4068	4754

Std errors clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%
Covariates: Region of birth, Mother's age, Mother's education, Mother's marital status, Type of birth service, Year of birth. Infants above 32 weeks (inclusive of 32 weeks) of gestational age used in analysis. Triangular weights used in all specifications.

Table 16 - Donut RD Design

	Size of donut around 1500 grams							
Infant Mortality used as outcome	0	1	2	3	4	5	6	7
Birth Weight<1500	-0.057	-0.057	-0.058	-0.058	-0.059	-0.057	-0.056	-0.054
	[0.017]***	[0.017]***	[0.018]***	[0.018]***	[0.018]***	[0.019]***	[0.019]***	[0.019]***
(Birth Weight - 1500) X Birth Weight<1500	0	0	0	0	0	0	0	0
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
(Birth Weight - 1500) X Birth Weight>=1500	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Constant	0.09	0.09	0.085	0.086	0.082	0.082	0.083	0.086
	[0.054]*	[0.054]*	[0.054]	[0.054]	[0.054]	[0.054]	[0.054]	[0.054]
Observations	4754	4754	4745	4742	4725	4694	4688	4684

Std errors clustered at the gram level
* significant at 10%; ** significant at 5%; *** significant at 1%
Covariates: Region of birth, Mother's age, Mother's education, Mother's marital status, Type of birth service, Year of birth, 100 gram heap fixed effects. Infants above 32 weeks (inclusive of 32 weeks) of gestational age used in analysis. Triangular weights used in all specifications.

Appendix Table 1: Sensitivity to Bandwidth and Polynomial Selection in Test Score Regressions

Average over 8 years of test scores											
Bandwidth	50	60	70	80	90	100	110	120	130	140	150
Polynomial											
1	0.269	0.22	0.2	0.198	0.187	0.181	0.167	0.156	0.144	0.138	0.128
	[0.068]***	[0.038]***	[0.041]***	[0.046]***	[0.050]***	[0.051]***	[0.051]***	[0.051]***	[0.050]***	[0.049]***	[0.049]***
2	0.514	0.421	0.375	0.285	0.266	0.25	0.237	0.24	0.238	0.226	0.226
	[0.137]***	[0.131]***	[0.113]***	[0.087]***	[0.058]***	[0.046]***	[0.041]***	[0.043]***	[0.045]***	[0.048]***	[0.050]***
3	0.253	0.549	0.534	0.537	0.432	0.381	0.328	0.294	0.271	0.276	0.255
	[0.268]	[0.174]***	[0.156]***	[0.165]***	[0.156]***	[0.145]**	[0.119]***	[0.104]***	[0.079]***	[0.065]***	[0.057]***
Observations	1007	1366	1551	1763	2010	2178	2713	2887	3190	3405	3653

Appendix Table 2: Sensitivity to Bandwidth and Polynomial Selection in Infant Mortality Regressions

Average over 8 years of test scores											
Bandwidth	50	60	70	80	90	100	110	120	130	140	150
Polynomial											
1	-0.061	-0.06	-0.058	-0.057	-0.059	-0.058	-0.041	-0.036	-0.034	-0.033	-0.032
	[0.027]**	[0.021]***	[0.019]***	[0.017]***	[0.017]***	[0.017]***	[0.018]**	[0.017]**	[0.017]**	[0.016]**	[0.015]**
2	-0.027	-0.049	-0.055	-0.057	-0.053	-0.058	-0.048	-0.04	-0.035	-0.033	-0.031
	[0.047]	[0.044]	[0.040]	[0.035]	[0.029]*	[0.027]**	[0.019]**	[0.017]**	[0.017]**	[0.018]*	[0.019]*
3	-0.069	-0.014	-0.024	-0.037	-0.053	-0.045	-0.023	-0.011	-0.005	-0.008	-0.013
	[0.073]	[0.064]	[0.055]	[0.053]	[0.051]	[0.047]	[0.033]	[0.027]	[0.022]	[0.021]	[0.020]
Observations	2530	3293	3778	4246	4813	5232	6309	6750	7401	7912	8466

Notes: 100 gram bandwidth chosen; Covariates: Region of birth, Mother's age, Mother's education, Mother's marital status, Type of birth service, Year of birth, 100 gram heap fixed effects. Infants with gestation age greater than or equal to 32 weeks in sample. Triangular weights used in each specification. Table 1 uses birth from 1992-2001, while Table 2 uses births from 1992-2007.