# Stress and Birth Outcomes: Evidence from Terrorist Attacks in Colombia

*"...I think our whole approach to comprehensive prenatal care today is sort of messed up - a lot of the focus is on the wrong things. We measure a woman's blood pressure, her uterine size, listen to the baby's heart tones, but no one asks how things are going with her life..."*

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January 2007

This paper estimates the impact of random terrorist attacks (landmines) in Colombia on the health of babies born between 1998 and 2003. The results suggest that these types of terrorist activities that occur during a woman's first trimester of pregnancy have a negative and significant impact on child health outcomes such as birth weight and preterm deliveries, and behaviors such as use of prenatal care. These findings persist when mother fixed effects are included, suggesting that neither observable nor unobservable characteristics of the mothers are driving the main results. The paper contributes to the existing literature by identifying yet another important indirect channel through which violence affects economic well being. Given that studies have found a strong link between Low Birth Weight (LBW) and short and long-term socioeconomic outcomes; the negative consequences of violence identified in this paper may have long-term effects on economic activity as they affect the net returns to human capital accumulation of the new generations.

JEL classification: I12

Keywords: birth weight, health, violence, landmine

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## 1. Introduction

Terrorism is on the rise world wide, and Colombia is not an exception. Colombia has suffered a very long internal conflict over the past 50 years, and terrorism appeared in this war with an increasing intensity during the last two decades. Illegal groups[1] have widely used a variety of terrorist activities such as kidnappings, landmine explosions, massacres, attacks to infrastructure, and car-bombs to fight, to persuade, and impose their political views to the Colombian government. A broad definition of terrorism encompasses violent or harmful acts committed (or threatened) against civilians by groups that want to force political changes[2]. Terrorism as its name suggests, intends to create fear or "terror" to the general population by affecting random victims. While terrorist attacks may still be relatively infrequent, recent evidence by Becker and Rubinstein (2005) suggest that attacks generate a disproportionate amount of stress and fear, suggesting that the indirect effects may be far more wide-reaching than the direct effects. This paper uses Colombian terrorism as a case study to find the negative health consequences of prenatal stress on child birth outcomes. The fact that Colombia reported being the country with the highest number of landmine victims in 2005, exceeding Cambodia's and Afganistan's case, makes this country a very good one to study this type of terrorist activities.

Terrorism is considered one of the biggest threats to human rights, with tremendous social costs. While there exist calculations of the cost of terrorism in Colombia in terms of reduction in corporate investment due to kidnappings (Pshisva and Suarez, 2006), damage to infrastructure (Mejia and Posada, 2003), and reduction in private investment and consumption (Arias, 2003); these previous studies have focused predominantly on the direct economic costs of terrorism. However they have not considered the indirect economic costs of terrorism on variables such as human capital in the form of health. Some of these indirect costs include reduction in quality of life, disabilities, psychological stress, among other illnesses that deteriorate the

[1] Revolutionary Armed Forces of Colombia (FARC), National Liberation Army (ELN), and United Self-Defense Forces of Colombia (AUC)
[2] http://en.wikipedia.org/wiki/terrorism

human capital accumulation capacity. A study done by the international organization MSF[3] reports that the armed conflict physiological effects are the worse Colombian public health problem, evidenced in constant anxiety, depression, sadness and fear. This paper is the first attempt to measure the effect of prenatal psychological stress due to terrorism on child birth outcomes[4]. Quantifying effects over child birth outcomes has gained significant importance in the economics literature, given that the link between birth weight and both, later life socioeconomic outcomes and human capital accumulation, has been well established by Behrman and Rosenzweig (2004) and Black et al. (2005). These two studies use different twin samples data sets but similar techniques to show that marginal increases in birth weight are a strong predictor of more years of schooling, higher future income, and general improvements in human capital accumulation. This paper will link the effect of prenatal stress on birth outcomes, but it cannot explicitly address their effect on socioeconomic outcomes.

Using Vital Statistics Records for Colombia from 1998 to 2003 and merging them with quarterly data on landmine explosions by municipality, I run *department*[5], municipality and mother fixed effects regressions of birth weight, preterm deliveries, and prenatal care visits on a set of variables of interest determining if on indicators for whether a terrorist attack happened in the first, second, and third trimester of the pregnancy. The mother fixed effects specification compares how many grams less a baby weights relative to her siblings that had a different level of prenatal stress. I find a very significant and robust effect of terrorism on birth outcomes; in the case of birth weight there is a reduction in 8 grams of weight with respect to a sibling´s weight that did not suffer from terrorist attacks inutero. These findings are very similar and robust under different specifications.

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[3] In Spanish: Medicos Sin Fronteras

[4] A study by Urdinola (2004) estimates the effect of violence on infant mortality.

[5] A *departmento* is the Colombian jurisdiction equivalent to a state, it is a bigger geographical area compared to municipalities. A *departamento* contains several municipalities. Colomibia has 32 *departamentos* and 1120 municipalities.

This paper makes three main contributions to the existing literature. First, the violence that exists all over the country with different levels of intensity, specifically terrorist attacks - in particular, land mine explosions - can be used as exogenous stress shocks to the population. This leads to an appropriate quasi-experimental design to test the effects of stress on birth outcomes, overcoming both the difficulty of doing an experiment that would be unethical to pursue and issues of non-random residence during pregnancy. Second, the strength of this paper compared to others that have tested this hypothesis relies on to its large sample size. It uses all live births in Colombia from 1998 to 2003, comprising approximately 4 million births, which allows me to find very robust and estimate very precise results. Third, the data allows me to link the date of the terrorist attack with the trimester of the pregnancy. This way, I can not only determine the effect of stress on health outcomes, but also identify the exact time when pregnant woman are the most vulnerable to stress.

The effect of stress turns out to be interesting not only because of the consequences that these poor birth outcomes generate over human capital accumulation, but in terms of life expectancy. It is very well know that Low Birth Weight (LBW) is directly related to higher risk of neonatal, infant mortality, and long-term health problems. Research done by Janet Rich-Edwards and a group of epidemiologists at Harvard Medical School state that a baby: "weighing between 2.3-2.5 kg at birth will be 23% higher risk of heart disease and 80% higher risk of type II diabetes than someone weighing 3.2-3.9 kg."[6] Langley-Evans and Dodic et al. (1998) have also found high blood pressure to be a consequence of prenatal stress. Preterm babies are susceptible to a range of additional complications including: chronic lung disease, developmental delays, learning disorders, cognitive deficits, behavioral problems and hyperactivity. Evidence from epidemiological and animal research finds that babies who experience prenatal stress are more likely to show signs of depression. They are

[6] Couzin, J. (2002).

also slower to "habituate" or tune out repeated stimuli, an important predictor of IQ in infants.[7]

The finding of my current research, of the small but significant indirect effect of violence on birth outcomes, is the first step one can take to measure the consequences of prenatal stress in terms of health and well being as a whole. The probability of having certain diseases and the reduction in cognitive abilities that result from being a LBW or premature baby will be a determinant factor that gets translated into lower life expectancy and a reduction of overall human capital accumulation and productivity.

This paper is organized as follows. Section 2 reviews the relevant literature in medicine, epidemiology, and economics. Section 3 describes the vital statistics records and violence data from Colombia used in my analysis. Section 4 discusses the theoretical framework and empirical specifications. Section 5 reports and analyzes the main results and section 6 concludes.

## 2. Literature Review

### 2.1. Stress and birth outcomes

During the last two decades theories of stress as a determinant of LBW and premature gestational age have been very well studied in the areas of epidemiology,[8] medicine,[9] and psychology.[10] The medical literature indicates that very high levels of prenatal stress increase the risk of adverse birth outcomes. Low Birth Weight, which is defined as birth weight less than 2500 grams, and preterm delivery, which are births that occur before the 37th week of gestation, are among the most recognized adverse birth outcomes, and are highly associated with poor short- and long-term health. LBW has been widely used as an indicator of reproductive and

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[7] WebMD Feature. Fetus to Mom: You're Stressing Me Out!. January 1 2005 www.medicinenet.com

[8] Schneider ML. et al. (1999), Lauderdale (2006), Dole(2002).
[9] Wadhwa PD. et al. (1993,1998,2004), Sandman et al. (2005), Mancuso et al. (2004).
[10] Lobel M. et al. (1992), Paarlberg KM, et al.(1999).

population health[11]. It could even be considered a development indicator. LBW could be a consequence of a premature birth or Intra Uterine Growth Restrictions (IUGR), which lead to babies that are small relative to what is expected for their gestational term. Studies suggest that babies of women who suffer from high levels of stress and anxiety are more likely to be born LBW even when born at full term. So this paper will test for LBW arising from IUGR due to stress.

There are two biological channels that work to generate poor health outcomes due to prenatal stress. The first one has been studied by Wadhwa et al. (2004), Sandman et al. (2005), Hobel (1999) and Mancuso et al. (2004),[12] among others. These studies found higher levels of Corticotrophin-Releasing Hormone (CRH) in the blood for women who reported high levels of stress during early pregnancy. CRH is the hormone that regulates the duration of pregnancy and fetal maturation. The second channel, much less studied, explains that stress hormones like epinephrine and norepinephrine may constrict blood vessels reducing the blood flow of nutrients and oxygen to the placenta. This latter channel requires a very significant decrease in blood flow to compromise the baby's development.

In terms of the timing, most of the studies agree that stress in early pregnancy is the most influential on birth outcomes. Moreover, Schneider's et al. (1999) research on primates suggests that the effect of stress in late pregnancy should not be neglected. A study by Glynn et al. (2001) is the first human research that suggests that the impact of stress is attenuated throughout the pregnancy. They look at women who were affected by an earthquake in different stages of their pregnancy, and find that the first trimester has by far a bigger negative effect on birth outcomes.

Papers in the epidemiology literature by Lauderdale (2006) and Collins and David (1997)[13] have tested for the effects of stress via discrimination on birth weight.

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[11] U.S. Department of Health and Human Services (2000).

[12] Mancuso et al. (2004) are the first ones to link both psychosocial and neuroendocrine factors to birth outcomes.

[13] Studies the effect of urban violence against African-American women on their birth outcomes.

Lauderdale's paper uses a difference in difference approach, sampling different women with Arabic last names giving birth before and after September 11. Unfortunately, this paper's approach does not eliminate concerns about heterogeneity in health endowments across women or differences in perceptions of stress or in behavior during pregnancy. My current research can partially solve these concerns by comparing sibling outcomes.

### 2.2. Birth outcomes and economic status later in life

A substantial body of literature confirms the relationship and benefits of good health on productivity and good economic outcomes. In this review, I will refer specifically to papers that study birth weight as a predictor of socioeconomic outcomes and long-term health. The first group of papers by Currie and Hyson (1998) and Case et al. (2004) use a panel to compare outcomes across unrelated populations, while the second group of paper by Almond, Chay and Lee (2005), Behrman and Rosenzweig (2004), and Black et al. (2005) use twin samples to compare outcomes across identical twins.

Currie and Hyson (1998) find a relationship between birth weight and educational attainment, employment, wages, and health status. Case et al. (2004) finds that low birth weight babies have lower educational attainments, poorer health and lower Socio Economic Status as adults. However, most current literature admits that birth weights might be correlated with unobservable socioeconomic characteristics and exogenous genetic endowments that could bias the results. This problem has been overcome by looking at outcomes within the family, specifically using samples of identical twin who share exactly the same genes.

The following three papers use twin samples to avoid the concern described above. On the one hand, Almond, Chay and Lee (2005) study the effect of birth weight on infant mortality in the U.S. and Behrman and Rosenzweig (2004) study long-term outcomes in the U.S. Black et al. (2005), on the other hand, use administrative data from Norway and find very small effects of intrauterine nutrient intake between twins on infant mortality, although there are much bigger and significant effects on height, IQ, earnings, and education. Almond et al. and Black et al. agree, suggesting that cross-sectional estimations will overstate the true effect of birth weight on infant mortality. On the other hand, Behrman and Rosenzweig find that cross-sectional estimates without controlling for genetic and family background will underestimate the effect of increasing birth weight on schooling.

Berham and Rosenzwieg show a considerable variation in the incidence of LBW across countries, and a negative relationship with respect to GDP per capita. Trying to find the role that health conditions play over the world's income distribution, they estimate that Indian and Malaysian income would increase by 8.6% and 4.1% respectively if birth weights increased to U.S. levels.[14] Using their estimates, Colombia's income would increase by approximately 5.5%.

### 2.3. Violence and Birth outcomes

Lastly I want to mention Urdinola's (2004) study of the effect of violence on infant mortality in Colombia from 1990 to 2000; she finds an increase in 2 deaths per 1000 births with respect to an increase of one homicide per 1000 habitants. This is the only study to date on the effect of violence on health outcomes for the Colombian case. It uses as an indicator of violence the homicides by municipality. This indicator might not be as exogenous as landmines, given that there are characteristics common to areas with high levels of homicides that could be known by the population. Therefore, some other unobservable characteristics of these residents might be correlated with poor health outcomes. In other words, populations living in those areas might be self-selected. Furthermore, and in a new strategy for collecting data, in 1998 the questionnaire and methodology to record deaths changed. More importantly, new Vital Statistics Records was also implemented. [15] To construct the Infant Mortality Rate (IMR) before 1998, the "old" death records and births reported by the National Registry are used, and to construct the IMR after 1998, the "new"

[14] Assuming that all the observed correlation between mean birth weight and earnings corresponds to the causal effect of birth weight on earnings.
[15] See Data Description section for more details on the Vital Statistics Records

death records and births reported in the Vital Statistics are used. Hence Infant Mortality Rate, the dependent variable, has a break in the numerator and denominator before and after 1998. Furthermore, births reported by the National Registry data are very different from Vital Statistics because the former is an underreported and self-selected sample. Only parents who care to take their child to a notary to be registered will appear on the records under this system, a child who was not taken to be registered does not show up in her sample. Due to this selection problem in the National Registration system, the Vital Statistics Records seem to be a much more appropriate data set for these types of studies, even though they cover a much shorter period of time.

## 3. Data Description

### 3.1. Vital Statistics Records

The Vital Statistics were collected by the Administrative Department of Statistics (DANE) in January 1998. They contain 4.3 million births up to December 2003. The Vital Statistics Records correspond to the birth certificates filled out at the moment of birth usually in hospitals within the 1120 municipalities in Colombia. Ninety four percent of the births recorded in these files have taken place in a hospital or health service institution. However, two thirds of births occurring at home do not have birth weight recorded. An advantage of this data is that weight, length, Apgar score,[16] and gestation time recorded at the time of the delivery in the hospital should be accurately measured variables.

As a general description of the sample the average birth weight in Colombia is 3153 grams, length is 49.4 centimeters, 7.74% of births are Low Birth Weights (LBW) and 0.81% are Very Low Birth Weights (VLBW)[17]. As for preterm deliveries, 12.58% of

[16] Apgar score is a composite index of a child's health at the first and fifth minute of birth. It takes into account 5 factors: activity and muscle tone, heart rate, grimace, skin coloration, and respiration. Each of this factors is worth 2 points.
[17] Very Low Birth Weight is defined as birth weight less than 1500 grams.

babies are born before week 37, 0.3% of them are born before week 27. Table 1 summarizes the main statistics that characterize the outcome variables.

Some medical care inputs have increased over time. Colombia reformed its national health system by extending coverage in 1993 and witnessed an increase medical prenatal care attention, as well as higher numbers of deliveries in hospitals and by doctors, instead of home deliveries by midwives or nurses. Current calculations using Vital Statistics indicate that 93% of births are attended by a doctor, 27.5% of deliveries end in a cesarean procedure, and the average mother goes to 5.1 prenatal care visits. Graph 1 shows the trend of some of these indicators. From this evidence one can see an increase in the quantity of inputs, but nothing can be said about quality. Thus, there is no guarantee to definitively know that there would be an improvement in health resulting from these health care reform.

The data contains information that will be included to use as controls such as: sex of the baby (51.34% male), urban dummy (79.6 % of the population is urban), place of delivery (96.6% of births occur in a hospital or health service institution while 3.3% occur at home) type of insurance (contributive 36%, subsidized 30%, vinculado 27.5%, private 5.4%, other) [18], splines for age[19] and education of the mother and father[20], parity (39.58% of the sample which are first born children, 28.9% second, 16.5% third, and 15% fourth or more), multiple births (98% are single births), and marital status (27.3% of married mothers, 15.84% single and 55.8% live in cohabitation). Table 2 summarizes these control and demographic variables.

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[18] The description of different types of insurance is as follows: Contributive is a payroll system; Subsidized, covers people who get health insurance for free, using resources form the government and from the contributive system; Vinculado, covers uninsured population that in case of emergency can go to a public hospitals and the government will pay for the service; and, lastly, Private insurance.

[19] Splines for age: teenager, 20-29, 30-34, 35-39, 40 plus

[20] Splines for educations: no education (noedu), incomplete primary (ltprim), primary, incomplete high school (lths), high school (hs), some or all college (somc)

## 3.2 Identifying repeated mothers

The 1998 to 2003 Vital Statistics records include 3,550,170 births with mother identifier and type of identification, 78% of them are unique births. I am left with 781,000 births that correspond to mothers that had more than one birth in this period of time and could be used to create a panel of mothers. Mothers have an average of 2.2 children and 2.4 pregnancies, but during the period included in the Vital Statistics, a woman in the sample has an average of 1.2 children between 1998 and 2003, as described by the variable *totbir* shown in Table 3.

Critical to my analysis is the correct identification of mothers giving birth more than once. In order to double check the mother's match I use the following information also included in the birth records: date of previous birth, number of live births, age, and education of the mother. I either correct or drop mothers when there is an inconsistency between two births: first, when the date of the first birth does not coincide with the date of birth of the older sibling in the following birth record. Second, if there is a reduction in the level of education,[21] a change in age bigger or smaller compared to the time elapsed between births, or a reduction in the number of live births. Table 3 reports dummy variables these types of inconsistencies[22], given that they are small, by eliminating these mothers the sample size is not significantly reduced.

In most cases I can use the national identification and type of identification to link mothers. However, a drawback of the identification system in Colombia is that the identification type and number changes before and after the eighteenth birthday, from TI (Targeta Identidad) to CC (Cedula Ciudadanía). Thus, a mother that had a baby when she was a teenager cannot be linked as the same mother when she becomes eighteen or older. Nevertheless, this is not a very big concern, because only 5.4% of mothers have TI and a big portion of the sample, 93.5%, reports a CC.

[21] Education is reported in levels (none, incomplete primary, primary, incomplete high school, high school, some college and college or more) not in years of schooling.

[22] (*badmomedu*) in education of 1.4%, (*badmomage*) in age of 0.3%, (*badmomkid*) in number of children of 0.8% and (*baddate*) in date of birth of a sibling 3.8%.

### 3.3 Violence data

There is substantial variation across municipalities' violence levels over the period 1998-2004. I have access to quarterly data on kidnappings, number of internally displaced population, and landmine explosions by municipality in Colombia from year 1996 to 2004. This information is administered by the National Department of Planning (DNP). From death records collected by the DANE I can construct a series of quarterly counts of homicides by municipality. Naively, all of these violence indicators could be used to check whether they impact child birth outcomes, but it is important to be able to argue the exogeneity of the violence indicator used given that we want to measure a shock of violence and not persistent levels of violence in a given area. It is for this reason that landmine explosions are the most credible violence indicator that can generate an exogenous stress shock. Graph 2 and table 4.B present evidence of the variation that exists across municipalities and over time for landmine explosions. For robustness checks of the findings from this paper, in future work I will use information on massacres, terrorist attacks to the civilian population and to infrastructure (blowing of oil ducts and energy towers) by perpetrator group (ELN, FARC, or Paramilitaries).

A landmine is an explosive "planted" underground that is activated when a person or animal steps on it or when a vehicle touches it. They are designed to injure or kill people. Many victims of mines lose their extremities. Thirty percent of victims are children and 10% are women. Landmines are very durable, and so they can remain functional for years until triggered. In Colombia, illegal groups manufacture these mines with very common materials (plastic balls, tubes,etc) that are very difficult to recognize and are generally laid in vital community areas, such as paths, wells or sources of water, or in combat areas, abandoned houses, electric towers, bridges, etc. There have been 4,322 accidents with mines in the country since 1990. Landmines have been laid all over the country, they have been found in 422 out of 1120 municipalities and 31 out of 32 departments. Worldwide the severity of its landmine problem has been compared to that of Cambodia and Afghanistan. For this reason, although the number of mines exploded within a given municipality could seem very small, as the statistics reflect in Table 4.A., landmine explosions are a common, regular, and well known event. The explanation for finding a strong effect from terrorism even though terrorist attacks seem to be very few comes back to Becker and Rubinstein´s (2005) point; they find a disproportionately huge behavioral effect relative to the magnitude of the terrorist attack. These findings lead them to conclude: first, that people seem to overreact, and, second, that what is being measured is fear of terrorist attacks (overstated priors that people have about being affected by terrorist attack) instead of the terrorist attack itself, precisely what terrorism intends. In that sense, it does not matter whether a mother or the family is directly affected by the attack, but whether an attack is observed and generates some fear of stepping into a landmine given that others in their same area of residence have suffered from it.

### 3.4. Merging the data

An advantage of birth records is that they include the place of birth and place of residence (department and municipality). I merge the number of landmine explosions in the place of residence during a certain trimester with the births that occurred in that same period of time. In many cases the place of birth and of residence is not the same: 96% of births occur in urban areas while only 79% of the population lives in those areas.

Beyond the number of landmines for each trimester, I will also include lags of these variables, in order to measure the effect of violence during different trimesters of pregnancy.

## 4. Theoretical Framework and Empirical Specifications

### 4.1. Theoretical Framework

Grossman and Joyce (1990) and Rosenzweig and Schultz (1983) are the two seminal papers in the literature that estimate a birth weight production function. A general health production function in the economics literature was first introduced by Grossman (1972). Basically the output, health, is a function of the following inputs:

- Baseline health status: corresponds to genetic factors and investment (accumulation or depreciation) in health from previous periods.
- Leisure: understood as time spent on activities that increase health such as exercise, cooking, sleeping, time to go to visits to the doctor, etc.
- Medical care: basically corresponds to goods and services that one can buy in the market to improve health, such as medicines, vaccines, food, physicians and, hospital services.

In the specific case of the birth weight production function, baseline health status depends on genetic endowments, health of the mother prior to the pregnancy like body-mass and nutritional status, and her health during pregnancy as measured, for instance, by blood pressure levels. It is difficult to measure the exogenous health endowment, or genetic factors which will display heterogeneity among individuals. Few papers using identical twins samples can sort that out.[23] Twins will not be a reasonable sample to use for this paper given that I need different levels of exogenous violent shock to be experienced by those two babies. Instead, by comparing siblings, this paper will get as close as possible to identify the exogenous health endowment.

The cross sectional samples of births approach can lead to some biases because of unobserved heterogeneity with respect to genetics, parental behavior, and differences in perception of stress. Many times this heterogeneity is what makes health providers

[23] Identical twins share exactly the same genes. Siblings share approximately 50% of the genes.

so reluctant to emphasize the connection between stress and poor health outcomes, given that differences are also attributed to women's personalities and how well they cope with stress.[24] By creating a panel of mothers, there should be less concern for this unobserved heterogeneity since genetic endowments of the mother, child-rearing behavior, and the propensity to get stressed presumably do not change over time. This way it is possible to compare siblings instead of only comparing children related by the place of birth as it is done in cross sectional studies. The only assumption needed is that a mother's unobservable characteristics that affect birth outcomes are not changing through time. This assumption will be much more appropriate for mothers than for all unrelated women within a department or municipality.

Coming back to other inputs in the birth weight production function, one of the most important factors is the quantity of food intake; with other major determinants being alcohol and cigarettes consumption. An additional component that can be added to the standard health production function and that is tested in this paper is the environmental factors that cause stress. These environmental factors can be perceived differently among mothers. Other factors that the literature has found to be important to birth weight are: sex of the baby, parity, and race and demographic characteristics of the parents. All of these characteristics are included in the regressions.

Observing several inputs will be needed to estimate a structural form of the health production function. Therefore, this paper will not try to estimate a structural form; instead it will estimate a reduced form. Within the reduced form it is important not to include certain inputs that depend on individuals choices, and which would create endogeneity problems. Some examples of these types of inputs are the decision to go to prenatal care visits, the type of nutrition, and time spent for exercise. All these individual choice inputs are correlated with good maternal behavior; including

[24] www.medicinenet.com Fetus to Mom: You're Stressing Me Out!

them in the regressions will end up overstating their true effect. An instrument will be needed to include them in the regressions.

### 4.2. Empirical Specification

Take the following health production function:

$$h_{imj} = \Gamma(Y_{imj}, l_{imj}, \mu_{mj}, v_{imj})$$

Where the subscript *i* refers to the child, *m* to the mother, and *j* to the area of residence. *h* corresponds to the health outcome, *Y* are goods that can affect health, $l$ are health inputs that require time, $\mu$ is a family-specific exogenous health endowment, and the additional input $v$ is an environmental factor that causes stress, such as ambient stress specific to child *i.*

In order for this study to be thought of as a quasi-experiment (that is, for the violence shock to be exogenous) it is necessary to assume orthogonality between the last term, $v$, and the other inputs of the production function and the error term. This approach assumes that people know the prevalence level of violence in their area of residence. However, it takes advantage of the uncertainty about the time, magnitude, and exact place of the terrorist attack. By controlling for characteristics at the municipal level (using municipality fixed effects) there should be very little concern about systematic variation between violence and other characteristics that will bias the estimates of the coefficient of interest. Thus landmine explosions can be considered an exogenous shock on birth outcomes.

The reduced form linear relation of the health production function will be given by:

$$h_{imjt} = \beta_0 + \beta_1 v_{j(t)} + \beta_2 v_{j(t-1)} + \beta_3 v_{j(t-2)} + \beta_4 v_{j(t-3)} + \beta_5 X_{imjt} + \gamma_{year} + \gamma_{month} + \gamma_j + \mu_{mj} + \varepsilon_{imjt}$$

where $v_{j(t-2)}$ corresponds to the violence shock specific to place *j* in quarter *t-2,* and similarly for the second, third and fifth terms. The purpose of using number of landmine explosions $v_{j(t)}$ and lags for the previous three trimesters is to find exactly when during pregnancy stress has the most impact. If the findings are consistent with medical literature, the strongest effect will be found in the variable of interest $v_{j(t-2)}$, where first trimester of pregnancy $\beta_3$ is therefore the coefficient of interest. The matrix $X_{ijt}$ contains control variables. For the birth weight production function, variables included as controls like parental education can be a proxy for income or purchasing power of medical expenses, food, and/or leisure. Prenatal care visit are investments in health during pregnancy. This would be part of the production function in a structural estimation, but will not be included here to avoid endogeneity problems. I will include year $\gamma_{year}$ and month $\gamma_{month}$ dummies to control for unobservables changing over time, such as seasonal patterns of birth weight.[25] $\gamma_j$ are fixed effects that will control for all unobservables varying at *j* level (*departmento*, municipality or mother) but constant over time. The error term $\varepsilon_{imjt}$ is assumed to be orthogonal to birth weight, and $\mu_{mj}$ is the family-specific health endowment that will only be absorbed when using a mother fixed effects specification. In department or municipality fixed effects specifications, $\mu_{mj}$ should have a mean equal to zero and no systematic correlation with the variables of interest in order for the model to have unbiased estimates. In other words, getting unbiased estimates from a cross-sectional study using municipality or department fixed effects requires a strong assumption about the shock being equally perceived or homogenous across all births within the geographical area of study *j*. That is, if $m \neq \hat{m}$, the following should hold:

$$\mu_{mjt} = \mu_{\hat{m}jt}$$

Since the data permits the construction of a panel of mothers, this will be a better way to deal with heterogeneity among exogenous health endowments within the area of residence. I of course have to assume that siblings share the same health

[25] Babies that are born in the last quarter of the year are the heaviest ones.

endowments, and that mother fixed effects will account for all family-specific heterogeneity. The reduced form may therefore be written in the following way:

$$h_{1jt} - h_{2jt} = \sum_{a=0}^{3} \beta_{a+1}(v_{1jt-a} - v_{2jt-a}) + \beta_2(X_{1jt} - X_{2jt}) + \varepsilon_{1jt} - \varepsilon_{2jt}$$

This mother fixed effects regression compares the health outcome of sibling number 1 to sibling number 2, who lived in the same municipality but were exposed to different levels of stress shocks during pregnancy. I can reduce the sample to non-migrant mothers to mitigate concerns about unobserved lifetime exposure to violence and the endogeneity of migration. I can also exclude multiple births, since these births are affected by the same terrorist attacks.

Somewhere stress that your

Furthermore there might also be changes in other factors, such as health services coverage and differences across municipalities in birth outcomes that change by municipality and over time, It is impossible to capture these unobservables given that violence variation will be absorbed by a municipality*time fixed effects, but given that my unit of time is the quarter, any confounders would have to vary at the municipality*quarter level to affect my results. The best one can do to eliminate this concern is to include both municipality and time fixed effects separately. Municipality fixed effects will capture characteristics varying by municipalities but constant over time, and time fixed effects will capture characteristics varying over time but constant at the geographic area.

## 5. Analytical Results

There are different measures of birth weight that have been used in the literature. These include birth weight, logarithm of birth weight, fetal growth (birth weight divided by weeks of gestation), and binary variables for LBW (LBW<2500 grams) and VLBW (VLBW<1500 grams). I run regressions using each of these measures, except for fetal growth which cannot be constructed due to the discontinuous way the gestational period is reported in the data. Results for logarithm of birth weight are very similar to birth weight, so in Table 5 I only report results for the latter.

The variable of interest, landmine exposure, was constructed in three different ways to check whether the results will be sensitive to the following specifications: the number of landmine explosions per trimester within a municipality, a dummy for existence of landmines in a trimester within a municipality, and a rate of landmine explosions as a proportion of the population per trimester within a municipality.[26] Section A in Tables 5 to 8 presents the regressions using the variable of interest defined as a dummy variable. The variable *dmines* corresponds to a dummy variable for having mines in the trimester of birth, while *dmines1*, *dmines2* and *dmines3* capture if there were mine explosions for one, two and three lagged trimesters respectively. Section B of these same tables presents the regressions using the variable of interest defined as the number of landmines exploded in the trimester of birth and the three previous trimesters. To test for non-linearity given the wide variation in violence data, I have also constructed a quadratic term to represent landmines only during early pregnancy (mines2sq) that will be reported in Section B.

All the regressions include the following controls: an urban residence dummy, place of delivery, type of insurance, splines of the age of the mother and father, splines of the education of the mother and father[27], sex of the baby, multiple births, marital status, parity and a constant term. All regressions include month and year dummies and report cluster at the municipal level and robust standard errors.

Beginning with a naive approach, I first assume that the "true" effect of exposure to violence at a certain time is homogeneous across infants who are born within a

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[26] Using DANE's population counts projections for rural and urban areas in each municipality, for year 1995 to 2005 based on 1993 census.

[27] Given the amount of data in the sample I can do splines and check where there is a significantly different effect of different levels of education and parental age affecting birth weight.

geographic area. Columns 1 and 2 from Table 5 report coefficients of the variables of interest for department fixed effects[28], and columns 3 to 8 report for municipality fixed effects specifications.

The different models and empirical specifications consistently find a negative effect of landmine explosions during pregnancy on birth weight. Children born in a department with at least one landmine explosion in each trimester of pregnancy compared to no landmine explosions will differ in their birth weights by -27.76 grams. Landmines exploding during early pregnancy have the strongest effect compared to other trimesters, contributing in a reduction of -11.6 grams. The department fixed effects estimates overstate the impact of stress on health outcomes compared to municipality fixed effects. In fact, the municipality fixed effects regressions are much more appropriate, given that resources for public health investments and health care subsidies are administered at the municipal level.

Looking exclusively at municipal fixed effects models, the average difference in birth weight for children born in a municipality with and without landmine explosions during early pregnancy will be 7.5 grams, as shown in column 4. Interestingly, there is no significant effect of stress in periods other than early pregnancy. This finding supports the stress hypothesis instead of a nutritional channel, given that if I was observing a reduction in the amount of food caused by violence, the strongest effect will be seen in the third trimester.

Columns 5 and 6 only include landmine explosions lagged by two periods, finding an effect of -7.7 grams. Looking at section B in the municipality fixed effects estimation, the effect appears to be of -2.2 grams for each landmine explosion during early pregnancy in the municipality of residence. The difference in these results could be a sign of non linear effects due to variation in number of landmine explosions. To check for these, columns 7 and 8 include a quadratic term for landmines during early

[28] Column 1 does not include controls, column 2 does.

pregnancy. This term appears to be statistically significant, thus confirming the existence of non-linearities in the effect of stress.

Mother fixed effects are reported in columns 9 to 12. These findings are a little bigger but very similar to the ones found with municipality fixed effects. The randomness of landmines is evidenced by the stability of the coefficients between the municipality and the mother fixed effects models. A mother who experienced landmine explosions during pregnancy compared to one without explosions will have babies which differ in -8.7 grams. There is no evidence of non-linearities for the mother fixed effects model, as shown in column 12.

As noted previously, Black et al. (2005) used Norwegian data to estimate the effect of birth weight on infant and neonatal mortality, finding that an average increase of 1 gram at birth will reduce infant mortality by 0.00967 per thousand. Norway's IMR rate is 4 per 1000 births, while Colombia's IMR is around 20 per 1000 births. Reducing a higher mortality rates like Colombia's should be much easier on the margin than reducing it for Norway. Therefore, using Norwegian estimates will give a lower bound of the effect of birth weight on infant mortality. Applying Norwegian estimates, having no mines will reduce the neonatal mortality by 0.38% and infant mortality by 0.67%, which in Colombia represents 59 lives per year.

Low Birth Weight findings, reported in Table 6, are consistent with those found previously using birth weight as the dependent variable; a violence shock increases the probability of LBW. Experiencing landmine explosions compared to not experiencing them increases the LBW rate by 3%. However, there are no significant results using mother fixed effects, therefore it might be necessary to run logit or probit models when using dependent binary variables. Or as Black et al. (2005) notes, the <2500 grams cutoff may not be appropriate for this analysis, and that could be the reason for the LBW model to fit poorly. Table 7 indicates that women experiencing stress due to a landmine explosion during their early pregnancy have an increased probability of giving birth earlier than week 37. The estimates suggest that a landmine explosion increases the rate of preterm deliveries by 3.56%. There are no significant effects on preterm deliveries using mother fixed effects.

Finally, results are presented for the effect of landmines on the number of prenatal care visits to which a woman goes. Experiencing a violence shock during early pregnancy reduces the number of prenatal care visits by -0.1. On average women go to 5.1 visits, so landmine stress will reduce prenatal care visits by 1.96%. As noted previously similar to Becker and Rubinstein's paper, this last outcome could be reflecting a behavioral effect,

As a final exercise I consider the possible sign of the bias for the estimated parameters of interest. It could be argued that the estimates reported will be a lower bound for two main reasons. First, births occurring outside medical institutions which do not report birth weight are mainly occurring in rural areas. People living in these areas are be the most vulnerable to and affected by landmine explosions. Second, in presence of measurement error in the variable of interest, running fixed effects will generate attenuation bias of the coefficient of interest.

## 6. Conclusions

There is a great interest in identifying the most important determinants of low birth weight and preterm delivery because of their strong correlations with infant mortality and poor adult health respectively. Stress as a determinant for LBW and preterm deliveries has been studied in medical and epidemiological literature since the early 1990´s. The quasi-experimental approach provided by the landmine explotions and their variation over time and between areas is a very effective and convincing way of testing for an effect of the stress on birth outcomes. One can argue that landmine explosions are essentially randomly assigned, and act as a convincing exogenous shock due to their terrorist nature. This quasi-experimental approach and the sample size of the study gives the present research a considerable advantage over previous work in terms of the robustness of its findings.

Past economics literature has studied birth weight production functions and included some traditional inputs, but has never measured the effect of environmental shocks such as stress. The study of birth outcomes is currently of particular interest to economists due to the strong link that exits between birth outcomes and cognitive development, socioeconomic and long-term health outcomes. These translate into higher life expectancy and increases in human capital accumulation. A significant decrease of 8.7 grams in weight is found for a sibling experiencing stress proxied by landmine explosions in the municipality of residence. This paper's findings about the negative relationship between stress during early pregnancy and birth outcomes is consistent with previous findings from the medical literature.

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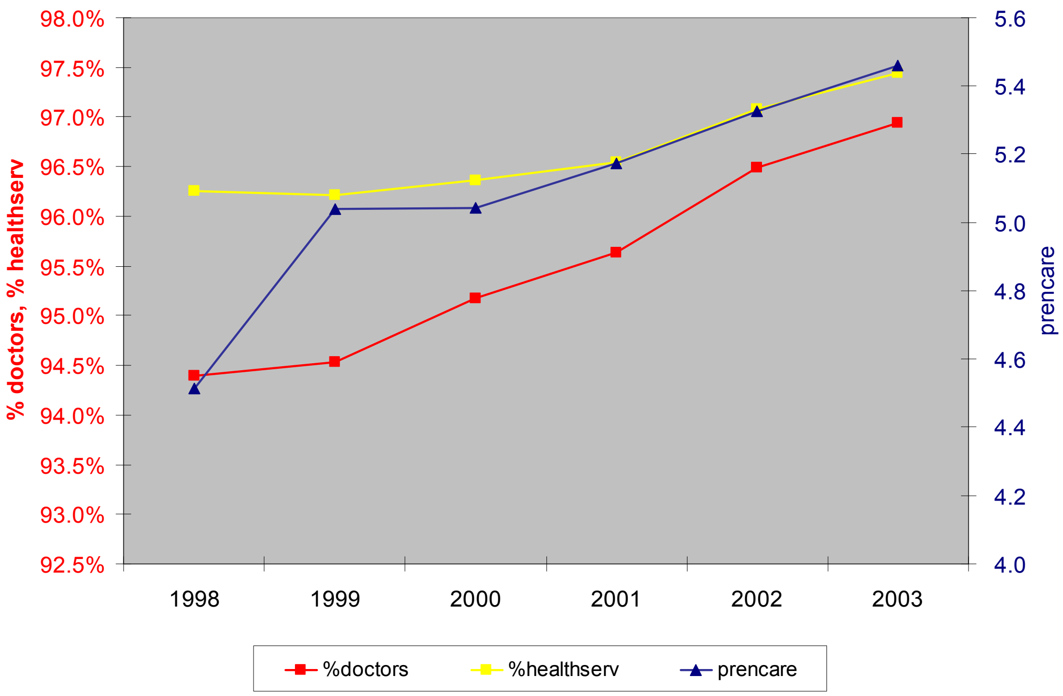
**Table 1.**
**Summary Statistics-Outcome Variables**

| Var. Name | Obs | Mean | St. Dev | Min | Max |
|---|---|---|---|---|---|
| weight | 4,151,625 | 3,153.194 | 522.97 | 145 | 8,750 |
| height | 4,132,762 | 49.437 | 2.81 | 11 | 71 |
| prencare | 3,359,560 | 5.105 | 2.86 | - | 42 |
| lbw | 4,151,625 | 0.077 | 0.27 | - | 1 |
| vlbw | 4,151,625 | 0.008 | 0.09 | - | 1 |
| lweight | 4,151,625 | 8.040 | 0.19 | 5 | 9 |
| preterm27 | 4,107,886 | 0.003 | 0.06 | - | 1 |
| preterm37 | 4,107,886 | 0.129 | 0.34 | - | 1 |

lbw=birth weight below 2500, vlbw=birth weight below 1500, preterm 27= birth before week 27,preterm 37= birth before week 37,lweight is the logaritm of birth weight, prencare is number of prenatal care visits

**Graph 1**




Doctor: proportion of deliveries attended by doctors.
Healthserv: proportion of deliveries attended in a health service institution.
Prencare: average number of prenatal care visits

**Table 2.**
**Summary Statistics-Control and Demographic Variables**

| Var. Name | Obs | Mean | St. Dev | Min | Max |
|---|---|---|---|---|---|
| **Urban residence** | | | | | |
| urban | 4231470 | 0.79 | 0.41 | 0 | 1 |
| **Place of delivery** | | | | | |
| healthsev | 4325414 | 0.94 | 0.23 | 0 | 1 |
| home | 4325414 | 0.06 | 0.23 | 0 | 1 |
| **Type health insurance** | | | | | |
| contributivo | 3946122 | 0.36 | 0.48 | 0 | 1 |
| subsidiado | 3946122 | 0.30 | 0.46 | 0 | 1 |
| vinculado | 3946122 | 0.27 | 0.45 | 0 | 1 |
| private | 3946122 | 0.05 | 0.23 | 0 | 1 |
| **Mother's age** | | | | | |
| teenmom | 4290581 | 0.22 | 0.42 | 0 | 1 |
| mom20_29 | 4290581 | 0.52 | 0.50 | 0 | 1 |
| mom30_34 | 4290581 | 0.16 | 0.36 | 0 | 1 |
| mom35_39 | 4290581 | 0.09 | 0.29 | 0 | 1 |
| mom40plus | 4290581 | 0.02 | 0.15 | 0 | 1 |
| **Father's age** | | | | | |
| teendad | 3994830 | 0.06 | 0.24 | 0 | 1 |
| dad20_29 | 3994830 | 0.49 | 0.50 | 0 | 1 |
| dad30_34 | 3994830 | 0.21 | 0.40 | 0 | 1 |
| dad35_39 | 3994830 | 0.15 | 0.36 | 0 | 1 |
| dad40plus | 3994830 | 0.11 | 0.32 | 0 | 1 |
| **Mother's education** | | | | | |
| momnoedu | 4114653 | 0.02 | 0.14 | 0 | 1 |
| momltprim | 4114653 | 0.17 | 0.38 | 0 | 1 |
| momprim | 4114653 | 0.16 | 0.37 | 0 | 1 |
| momlths | 4114653 | 0.23 | 0.42 | 0 | 1 |
| momhs | 4114653 | 0.30 | 0.46 | 0 | 1 |
| momsomc | 4114653 | 0.11 | 0.31 | 0 | 1 |
| **Father's education** | | | | | |
| dadnoedu | 3652624 | 0.03 | 0.17 | 0 | 1 |
| dadltprim | 3652624 | 0.18 | 0.38 | 0 | 1 |
| dadprim | 3652624 | 0.16 | 0.37 | 0 | 1 |
| dadlths | 3652624 | 0.26 | 0.44 | 0 | 1 |
| dadhs | 3652624 | 0.24 | 0.43 | 0 | 1 |
| dadsomc | 3652624 | 0.13 | 0.33 | 0 | 1 |
| **Marital Status** | | | | | |
| married | 4185305 | 0.27 | 0.44 | 0 | 1 |
| single | 4185305 | 0.16 | 0.37 | 0 | 1 |
| cohabit | 4185305 | 0.56 | 0.50 | 0 | 1 |
| **Parity** | | | | | |
| first kid | 4199047 | 0.39 | 0.49 | 0 | 1 |
| kid2 | 4199047 | 0.29 | 0.45 | 0 | 1 |
| kid3 | 4199047 | 0.17 | 0.37 | 0 | 1 |
| kid4plus | 4199047 | 0.15 | 0.36 | 0 | 1 |
| **Other demographics** | | | | | |
| Multiple birth | 4206274 | 1.02 | 0.14 | 1 | 4 |
| Num. kids | 4199047 | 2.24 | 1.52 | 1 | 30 |
| Num. preg. | 4199876 | 2.43 | 1.69 | 1 | 24 |
| Male | 4340830 | 0.51 | 0.50 | 0 | 1 |

momsomc/dadsomc refers to mother/ father with some college or more

**Table 3.**
**Summary Statistics-Checking the mother match**

| Var. Name | Obs | Mean | St. Dev | Min | Max |
|---|---|---|---|---|---|
| totbir | 3550170 | 1.2898 | 0.55 | 1 | 7 |
| badmomed | 3505901 | 0.0140 | 0.12 | 0 | 1 |
| badmomage | 3539543 | 0.0031 | 0.06 | 0 | 1 |
| badmomkid | 3521559 | 0.0079 | 0.09 | 0 | 1 |
| baddate | 3550170 | 0.0383 | 0.27 | 0 | 1 |

totbir=average number of births for mothers in the sample during 1998 and 2003
badmomed=dummy for mothers with inconsistent education
badmomage=dummy for mothers with inconsistent age
badmomkid=dummy for mothers with inconsistent number of kids ever born
baddate=dummy for mothers with inconsistent between dates of birth of sibling

**Table 4.A**
**Summary Statistics-Variables of Interest**

| Var. Name | Obs | Mean | St. Dev | Min | Max |
|---|---|---|---|---|---|
| landmines 96-2004 | 347 | 8.22 | 11.13 | 1.00 | 80.00 |
| landmines trimester | 12,492 | 0.23 | 1.11 | - | 25.00 |

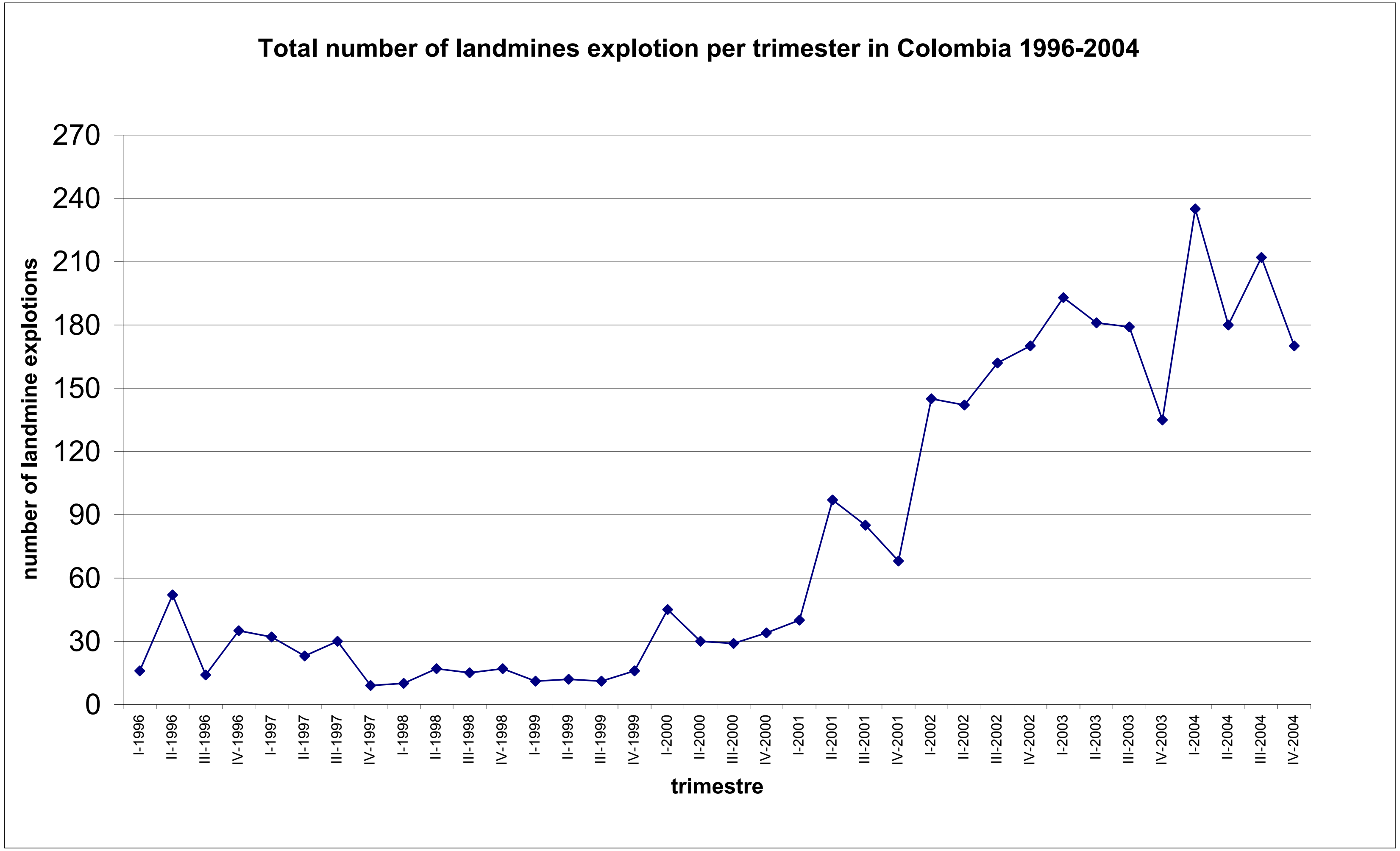
Source: DNP. Calculations by the author

**Table 4.B**
**Municipalities with highest number of landmines**

| landmines 1996-2004 | landmines per trimester |
|---|---|
| 80 | 25 |
| 71 | 21 |
| 70 | 20 |
| 57 | 19 |
| 57 | 15 |

Source: DNP. Calculations by the author

**Graph 2**




Source:DNP and authors calculations

| | Table 5. BIRTH WEIGHT (grams) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Department FE | | Municipality FE | | | | | | Mother FE | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| **SECTION A** | | | | | | | | | | | | |
| **dmines** | -4.5323 | -4.824 | -0.09882 | -1.79576 | | | | | -1.38317 | -4.95789 | | |
| | -5.10756 | -4.92475 | -1.78332 | -2.15217 | | | | | -3.25089 | -3.10499 | | |
| **dmines1** | -7.53989 | -8.58807 | -2.71058 | -3.9416 | | | | | -3.12386 | 0.60174 | | |
| | (3.37524)** | (3.23529)*** | -2.53099 | -2.63552 | | | | | -3.96028 | -6.87564 | | |
| **dmines2** | -11.3178 | -11.59177 | -7.94552 | -7.53007 | -7.91583 | -7.71062 | | | -9.73454 | -8.32269 | -8.70405 | |
| | (3.24483)*** | (3.10954)*** | (2.48859)*** | (2.45601)*** | (2.08791)*** | (2.25689)*** | | | (2.64316)** | (3.42185)* | (3.28253)*** | |
| **dmines3** | -5.65963 | -7.58476 | -4.37047 | -6.17871 | | | | | -0.93835 | -3.57677 | | |
| | (3.42890)* | (3.58697)** | -3.09506 | -4.02427 | | | | | -2.86522 | -3.7582 | | |
| **Observations** | 4141665 | 2890417 | 4141665 | 2409122 | 4141665 | 2890417 | | | 518924 | 390837 | 390837 | |
| **R-squared** | 0.03 | 0.09 | 0.03 | 0.11 | 0.03 | 0.1 | | | 0.67 | 0.74 | 0.74 | |
| **SECTION B** | | | | | | | | | | | | |
| **mines** | -1.68264 | -1.60605 | -0.54021 | -0.35333 | | | | | -0.94152 | -2.11116 | | |
| | (0.91206)* | (0.84402)* | -0.3836 | -0.40862 | | | | | -1.18433 | -1.26442 | | |
| **mines1** | -2.46093 | -2.3695 | -1.12753 | -0.80589 | | | | | 0.30516 | 0.59895 | | |
| | (0.86238)*** | (0.81097)*** | (0.49279)** | -0.6198 | | | | | -0.95726 | -1.67983 | | |
| **mines2** | -3.30424 | -3.47504 | -2.16746 | -2.0204 | -2.06015 | -2.21242 | -4.24333 | -4.16428 | -2.99117 | -2.84461 | -2.83716 | -2.41818 |
| | (0.92454)*** | (0.83779)*** | (0.55711)*** | (0.55762)*** | (0.53336)*** | (0.58263)*** | (0.77174)*** | (0.89973)*** | (0.82923)** | (1.04887)** | (1.06864)*** | -2.69064 |
| **mines2sq** | | | | | | | 0.29979 | 0.26249 | | | | -0.05926 |
| | | | | | | | (0.08045)*** | (0.09339)*** | | | | -0.32071 |
| **mines3** | -2.39271 | -2.76838 | -1.49419 | -1.66797 | | | | | -0.54119 | -0.926 | | |
| | (0.55157)*** | (0.65037)*** | (0.72946)** | -1.02948 | | | | | -0.71912 | -0.85668 | | |
| **Observations** | 4141665 | 2890417 | 4141665 | 2409122 | 4141665 | 2890417 | 4141665 | 2890417 | 518924 | 390837 | 390837 | 390837 |
| **R-squared** | 0.03 | 0.09 | 0.03 | 0.11 | 0.03 | 0.1 | 0.03 | 0.1 | 0.67 | 0.74 | 0.74 | 0.74 |
| include controls | N | Y | N | Y | N | Y | N | Y | N | Y | Y | Y |

Robust standard errors in parentheses and clustering at the municipal level

* significant at 10%; ** significant at 5%; *** significant at 1%

dmines is a dummy variable for having landmines in the trimester of the birth, dmines1(2,3) is a dummy variable for having landmines 1 (2,3) trimester(s) prior to birth

mines is the numeber of landmines that exploited in the trimester of the birth, mines1(2,3) is the numeber of landmines that exploited 1 (2,3) trimester(s) prior to birth,

mines2sq is the numeber of landmines squared that exploited 2 trimesters prior to birth

controls: urban, place delivery,type insurance, age mother/father (splines),

edu mother/father (splines), sex, twin, marital stat, birth order and constant

all regresions include month and year dummies

| | Table 6 -LBW (<2500 grams of birthweight) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Department FE | | Municipality FE | | | | | | Mother FE | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **SECTION A** | | | | | | | | | | |
| **dmines** | 0.00215 | 0.00179 | 0.00061 | 0.00127 | | | | | 0.00151 | 0.00373 |
| | (0.00127)* | -0.00118 | -0.0008 | (0.00070)* | | | | | -0.00236 | -0.00274 |
| **dmines1** | 0.00294 | 0.00322 | 0.00122 | 0.00185 | | | | | -0.00079 | -0.00189 |
| | (0.00083)*** | (0.00096)*** | (0.00070)* | (0.00105)* | | | | | -0.0022 | -0.00352 |
| **dmines2** | 0.00449 | 0.00325 | 0.00297 | 0.00171 | 0.00297 | 0.00212 | | | 0.00065 | -0.0006 |
| | (0.00101)*** | (0.00109)*** | (0.00112)*** | -0.00122 | (0.00097)*** | (0.00094)** | | | -0.0017 | -0.0019 |
| **dmines3** | 0.00222 | 0.00302 | 0.00107 | 0.00252 | | | | | 0.00008 | 0.00051 |
| | (0.00085)*** | (0.00117)*** | -0.00077 | -0.00157 | | | | | -0.0019 | -0.00251 |
| **Observations** | 4141665 | 2890417 | 4141665 | 2409122 | 4141665 | 2890417 | | | 518924 | 390837 |
| **R-squared** | 0 | 0.06 | 0.01 | 0.07 | 0.01 | 0.06 | | | 0.57 | 0.65 |
| **SECTION B** | | | | | | | | | | |
| **mines** | 0.00053 | 0.00037 | 0.00009 | 0.00013 | | | | | 0.00051 | 0.00068 |
| | (0.00023)** | (0.00017)** | -0.00019 | -0.00016 | | | | | -0.00057 | -0.00072 |
| **mines1** | 0.00092 | 0.0008 | 0.00045 | 0.0004 | | | | | -0.00013 | -0.00013 |
| | (0.00025)*** | (0.00025)*** | (0.00017)*** | -0.00025 | | | | | -0.00064 | -0.00081 |
| **mines2** | 0.00102 | 0.00092 | 0.00059 | 0.00046 | 0.00056 | 0.00057 | 0.0018 | 0.00142 | 0.00082 | 0.00002 |
| | (0.00030)*** | (0.00028)*** | (0.00032)* | (0.00024)* | (0.00032)* | (0.00026)** | (0.00042)*** | (0.00038)*** | -0.00044 | -0.00045 |
| **mines2sq** | | | | | | | -0.00017 | -0.00011 | | |
| | | | | | | | (0.00004)*** | (0.00004)*** | | |
| **mines3** | 0.00068 | 0.00089 | 0.00028 | 0.00062 | | | | | 0.00021 | -0.00006 |
| | (0.00022)*** | (0.00033)*** | -0.00028 | -0.00048 | | | | | -0.00056 | -0.00076 |
| **Observations** | 4141665 | 2890417 | 4141665 | 2409122 | 4141665 | 2890417 | 4141665 | 2890417 | 518924 | 390837 |
| **R-squared** | 0 | 0.06 | 0.01 | 0.07 | 0.01 | 0.06 | 0.01 | 0.06 | 0.57 | 0.65 |
| include controls | N | Y | N | Y | N | Y | N | Y | N | Y |

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

dmines is a dummy variable for having landmines in the trimester of the birth, dmines1(2,3) is a dummy variable for having landmines 1 (2,3) trimester(s) prior to birth

mines is the numeber of landmines that exploited in the trimester of the birth, mines1(2,3) is the numeber of landmines that exploited 1 (2,3) trimester(s) prior to birth,

mines2sq is the numeber of landmines squared that exploited 2 trimesters prior to birth

controls: urban, place delivery,type insurance, age mother/father (splines),

edu mother/father (splines), sex, twin, marital stat, birth order and constant

all regresions include month and year dummies

| | Table 7-Preterm37 (gestational age below 37 weeks) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Department FE | | Municipality FE | | | | | | Mother FE | |
| **SECTION A** | | | | | | | | | | |
| **dmines** | 0.0037 | 0.0021 | 0.00254 | 0.00241 | | | | | 0.00678 | 0.0083 |
| | (0.00180)* | -0.00155 | -0.0016 | (0.00144)* | | | | | (0.00288)* | -0.00437 |
| **dmines1** | 0.00132 | 0.00004 | 0.00013 | 0.00033 | | | | | -0.00097 | -0.00266 |
| | -0.00126 | -0.00127 | -0.00116 | -0.00124 | | | | | -0.00259 | -0.0047 |
| **dmines2** | 0.00489 | 0.003 | 0.00399 | 0.00344 | 0.00407 | 0.00457 | | | 0.00193 | 0.00148 |
| | (0.00141)** | -0.00161 | (0.00101)*** | (0.00154)** | (0.00098)*** | (0.00109)*** | | | -0.00432 | -0.00363 |
| **dmines3** | -0.00053 | -0.00072 | -0.00132 | -0.00035 | | | | | -0.00191 | -0.00018 |
| | -0.00203 | -0.00143 | -0.00158 | -0.00134 | | | | | -0.00381 | -0.00576 |
| **Observations** | 4065687 | 2393929 | 4065687 | 2393929 | 4065687 | 2849716 | | | 510842 | 385699 |
| **R-squared** | 0.01 | 0.04 | 0.01 | 0.05 | 0.01 | 0.04 | | | 0.55 | 0.64 |
| **SECTION B** | | | | | | | | | | |
| **mines** | 0.00135 | 0.00121 | 0.0008 | 0.00093 | | | | | 0.00244 | 0.0032 |
| | (0.00060)** | (0.00070)* | -0.0005 | -0.00066 | | | | | (0.00115)* | (0.00143)* |
| **mines1** | 0.00086 | 0.00055 | 0.00028 | 0.00017 | | | | | -0.0004 | -0.00087 |
| | (0.00035)** | -0.00035 | -0.00032 | -0.00035 | | | | | -0.00083 | -0.00119 |
| **mines2** | 0.00137 | 0.00155 | 0.0009 | 0.00109 | 0.0009 | 0.00136 | 0.00187 | 0.00214 | 0.00073 | 0.00119 |
| | (0.00028)*** | (0.00038)*** | (0.00034)*** | (0.00046)** | (0.00035)** | (0.00046)*** | (0.00052)*** | (0.00062)*** | -0.00092 | -0.00071 |
| **mines2sq** | | | | | | | -0.00013 | -0.0001 | | |
| | | | | | | | (0.00006)** | -0.00008 | | |
| **mines3** | 0.00011 | 0.00003 | -0.00043 | -0.00012 | | | | | -0.00093 | -0.00053 |
| | -0.00062 | -0.00054 | -0.00044 | -0.0004 | | | | | -0.00101 | -0.00152 |
| **Observations** | 4065687 | 2849716 | 4065687 | 2393929 | 4065687 | 2849716 | 4065687 | 2849716 | 510842 | 385699 |
| **R-squared** | 0.01 | 0.04 | 0.01 | 0.05 | 0.01 | 0.04 | 0.01 | 0.04 | 0.55 | 0.64 |
| include controls | N | Y | N | Y | N | Y | N | Y | N | Y |

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

dmines is a dummy variable for having landmines in the trimester of the birth, dmines1(2,3) is a dummy variable for having landmines 1 (2,3) trimester(s) prior to birth

mines is the numeber of landmines that exploited in the trimester of the birth, mines1(2,3) is the numeber of landmines that exploited 1 (2,3) trimester(s) prior to birth, mines2sq is the numeber of landmines squared that exploited 2 trimesters prior to birth

controls: urban, place delivery,type insurance, age mother/father (splines),edu mother/father (splines), sex, twin, marital stat, bir

all regresions include month and year dummies

| Table 8- Number of Prenatal Care Visits | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Department FE | | Municipality FE | | | | Mother FE | |
| **SECTION A** | | | | | | | | |
| **dmines** | 0.04283 | -0.012 | | | | | -0.01876 | 0.01814 |
| | -0.06515 | -0.02603 | | | | | -0.04382 | -0.05075 |
| **dmines1** | -0.01768 | -0.07107 | | | | | -0.03355 | -0.00638 |
| | -0.04506 | (0.02630)*** | | | | | -0.03978 | -0.03754 |
| **dmines2** | -0.06483 | -0.12702 | -0.09518 | -0.08362 | | | -0.0994 | -0.03379 |
| | -0.04094 | (0.02754)*** | (0.03326)*** | (0.03249)** | | | (0.03366)** | -0.03611 |
| **dmines3** | 0.04999 | -0.03194 | | | | | 0.02847 | 0.02685 |
| | -0.0778 | -0.05187 | | | | | -0.07648 | -0.07014 |
| **Observations** | 3351291 | 2439901 | 3351291 | 2439901 | | | 429485 | 333996 |
| **R-squared** | 0.06 | 0.21 | 0.09 | 0.22 | | | 0.7 | 0.76 |
| **SECTION B** | | | | | | | | |
| **mines** | 0.01345 | -0.00652 | | | | | -0.00476 | 0.00619 |
| | -0.00985 | -0.00507 | | | | | -0.00714 | -0.01078 |
| **mines1** | -0.00122 | -0.01627 | | | | | -0.01261 | -0.00638 |
| | -0.00891 | (0.00713)** | | | | | -0.00759 | -0.00775 |
| **mines2** | -0.01559 | -0.0312 | -0.02775 | -0.02727 | -0.04713 | -0.04388 | -0.02729 | -0.0145 |
| | -0.0149 | (0.01223)** | (0.01161)** | (0.01029)*** | (0.01891)** | (0.01736)** | (0.01003)** | -0.00987 |
| **mines2sq** | | | | | 0.00263 | 0.00221 | | |
| | | | | | -0.002 | -0.00172 | | |
| **mines3** | 0.00992 | -0.00937 | | | | | -0.00284 | 0.00396 |
| | -0.01828 | -0.01327 | | | | | -0.0197 | -0.01582 |
| **Observations** | 3351291 | 2439901 | 3351291 | 2439901 | 3351291 | 2439901 | 429485 | 333996 |
| **R-squared** | 0.06 | 0.21 | 0.09 | 0.22 | 0.09 | 0.22 | 0.7 | 0.76 |
| include controls | N | Y | N | Y | N | Y | N | Y |

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
dmines is a dummy variable for having landmines in the trimester of the birth, dmines1(2,3) is a dummy variable for having landmines 1 (2,3) trimester(s) prior to birth
mines is the numeber of landmines that exploited in the trimester of the birth, mines1(2,3) is the numeber of landmines that exploited 1 (2,3) trimester(s) prior to birth,
mines2sq is the numeber of landmines squared that exploited 2 trimesters prior to birth
controls: urban, place delivery,type insurance, age mother/father (splines),
edu mother/father (splines), sex, twin, marital stat, birth order and constant
all regresions include month and year dummies