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The effect of violence on birth outcomes

Evidence fromhomicides in rural Brazil

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This paper uses micro data from Brazilian natality andmortality vital statisticsbetween 2000 and 2010 to estimate the impact of in-utero exposure to local violence - measured by homicide rates - on birth outcomes. Focusing on small communities, for which it is more credible that local homicide rates reflect actual exposure to violence, the analysis shows that exposure to violence during pregnancy leads to deteriorationin birth outcomes: one extrahomicide during the first trimester of pregnancy increases the probability of low birthweightby around 6 percent. Results are particularly pronounced among children of poorly educated mothers, implying that violence adds up to the disadvantage that these children already suffer as a result of their household’s lower socio-economic status.

**1.Introduction**

In this project we analyze birth outcomes of children whose mothers were exposed to high levels of violence in their local environment during pregnancy. There is considerable evidence showing that the nine months in utero are critical in shaping a person’s life, affecting a variety of economic and non-economic outcomes even in adulthood. Although there is a small but growing literature in economics showing that maternal stress and exposure to extreme events, includingconflict and terrorist attacks, during pregnancy affect birth outcomes, the impact of day-to-day violence is, by and large, understudied.

Exposure to violence in utero might affect birth outcomes directly through mother’s fear of victimization and psychologicalstress,which is in turn known to lead to worse birth outcomes. Violence can also directly affect mothers and hence the health of the fetus directly through victimization, withits ensuing negative economic, physical and psychological consequences. Indirect effects might also be at play, such as changes in labor supply, with ensuing effects on household income, increased difficulties in, or higher costs of, accessing local health services, due to safety concerns, or even changes in fertility, possibly affecting observed birth outcomes through selection. Additionally, resource diversion, both on the part of households and communities, in order to prevent or counteract violence, might lead to reductions in expenditures associated with children’s well-being.

In the analysis we focus on Brazil, one the countries with the highest level of violence worldwide (UNODC 2011), as witnessed by a homicide rate of 21 deaths per 100,000 people (as of 2011), approximately five times what is found in the USA and almost twenty times the rate in the UK.Homicide is the leading cause of death for men aged 15-44 (Reichenheim et al. 2011) andday-to-day violence is a top concern among citizens of Brazil. In the 2010 Latinobarometer about 16 percent of Brazilian respondents listed violence and public security as the most important problem(Latinobarometer, 2010) and existing estimates put the direct costs of violence and crime at between 3 and 5 percent of annual GDP (Couttolene, Cano, Piquet Carneiro and Phebo 2000, Kahn 1999, Heinemann and Verner 2006, Velasco Rondon and Viegas 2003, World Bank 2006).[[2]](#footnote-3)

In order to assess the impact of violence on birth outcomes, we combine micro data on all births for eleven years (2000 to 2010) from official birth records with information on all homicides that occurred over the same periodobtained from official death records. Vital statistics provide the date of birth and the place of residence of the mother up to the municipality level. Similarly, for homicides, the data provide information on the date and municipality of occurrence of the death. This allows us to identify the incidence of homicides during different stages of pregnancy in the mother’s municipality of residence.

Homiciderates are often used as crime and violence indicators (UNODC 2011). What evidence existsfor Brazil, in particular, shows a close correlation between different forms of violent crime and homicides (World Bank 2006).[[3]](#footnote-4)Because of their severity, underreporting is not generally a concern (Heinemann and Verner 2006) and homicides are more likely to be followed up by police investigations and media coverage relative to other types of crime, making them particularly visible to the public.As uniform crime reports are not publicly available for Brazil, homicide rates from birth records constitute a unique source of information on violence that is uniform across space and time.

The rich information available in the vital statistics data allows us to measure the effects of violence on a variety of outcomes, including birthweight, APGAR scores, gestational lengthand infant mortality, as well as potential margins of selection due to fertility, abortion and miscarriage.

Identification is based on a difference-in-differences strategy across geographical areas and time (conditional, in some specifications, on municipality linear trends). This allows us to obtain credible estimates of causal impact and provides the opportunity for a falsification test. The sheer amount of data helps us obtain precise estimates: this is crucial as some of these phenomena (e.g. infant mortality) are rare events and their statistical - although not necessarily their economic – magnitude might be very small and hard to detect in sample surveys.

In most of the analysis we focus on small, primarily rural, municipalities (with population less than 5,000), for which municipality-level homicide rates provide a very localized measure of violence.

To preempt our results, we show that in small municipalities one extra homicide during pregnancy leads to an increase in the probability of low birthweight (<2.5 kg.) of around half a percentage point, a 6 percent increase relative to baseline (8 percent). Consistent with findings elsewhere in the literature, the effect seems to be concentrated in the first trimester of pregnancy. The estimated effect is economically meaningful, being approximately ten times the effect estimated for the USA of being a recipient of Food Stamps (Almond, Hoynes and Whitmore Schanzenbach 2011) (although clearly a much larger fraction of households are in receipt of Food Stamps compared tothose exposed to homicides). The effect seems to be largely driven by increased prematurity rather than intrauterine growth retardation. We find no effect on child mortality or margins of endogenous fertility.

**2. Birth outcomes and in utero experiences: the effect of exposure to violence**

The consequences of low birthweight and fetal health more generally on long-run outcomes, such as educational attainment, later life health, mortality and labor market performance have been established in a large body of literature (Alderman and Behrman 2006, Almond, Chay and Lee 2005, Almond and Currie 2011b, Currie 2011, Currie and Moretti2007, Royer2009, Victora, Kirkwood, Ashworth, Black, Rogers, Sazawal, Campbell and Gore 1999).Low birthweightinfants display a substantially increased risk of neonatal or infant death and are more likely to require additional outpatient care and hospitalization during childhood, adding to the private and social costs of poor birth outcomes. Of those living into adulthood, some may suffer from cognitive and neurological impairment, conditions typically associated with lower productivity in a range of educational, economic, and other activities, as well from increased morbidity (e.g. risk of cardiovascular disease, diabetes and hypertension).

The importance of fetal shocks and of the circumstances in utero on birth and later life outcomes has only been recently acknowledged by economists, leading to a resurgent interest both in the theoretical as well in the empirical literature. There are now numerous empirical studies showing that, consistent with Baker’s fetal origin hypothesis, the nine months in utero constitute a critical periodfor a person’s life, shaping subsequent health, educational and labor market outcomes (Almond and Currie 2011a, Almond and Currie 2011b, Currie 2011).

Almond and Currie (2011a) categorize factors affecting the prenatal environment into three groups: those affecting maternal and thereby fetal health (such as nutrition and infection), economic shocks, and environmental pollution.A number of studies, in particular, have established a link between household maternal nutrition and birth outcomes, especially birthweight, one of the most important and easier to measure predictors of economic and non-economic outcomes in adulthood. Some studies focus on the role of redistributive policies (see for example Almond, Hoynes and Whitmore Schanzenbach 2011 on the USA food stamps and Amarante, Manacorda, Miguel and Vigorito 2011 on the Uruguayan PANES) while others focus on the role of famines, natural disasters or even fasting during pregnancy (Almond 2006, Almond and Mazumder 2011, Banerjee, Duflo, Postel-Vinay and Watts 2010). For Brazil, Rocha and Soares (2012) show that negative weather shocks during pregnancies lead to a significant reduction in gestational length and birthweight. Other studies focus instead on the disease environment during pregnancy(see Almond 2006 and Kelly 2011 on maternal influenza and Barreca 2010 for maternal exposure to malaria) andon pollution (Currie and Walker 2011, Chay and Greenstone 2003 on air pollution, Almond, Edlund and Palme 2009 on nuclear fallout and Reyes 2007 and Nilsson 2011 on leaded gasoline), showing that both play substantial roles in affecting birth and later outcomes.

Despite evidence that maternal stress during pregnancy negatively affects cognition, health and educational attainment of childrenthrough elevated levels of the stress hormone cortisol (Aizer, Stroud and Buka 2009),presumably because of data limitations, the effect of exposure to crime and violence on birth outcomes has received considerable less attention.

A stream of literature focuses on terrorist attacks and conflict. Camacho (2008) findsthat landmine explosions during the first trimester of pregnancy have a significant negative effect on birthweight in Colombia, with one extra landmine explosion during pregnancy leading to a decrease in birthweight by 8.7 grams.Ecclestone (2012) shows that exposure to the 9/11 terror attacks among pregnant women in New York City led to a reduction in birthweight of between 12 and 14 grams and an elevated level of prematurity. In a setting closer to ours, Mansour and Rees (2012) find a modest and imprecisely estimated increase in the fraction of low birthweightinfants in response to an increase in noncombatant fatalities in the West Bank and Gaza during the second Intifada.[[4]](#footnote-5)

Although clearly related to our paper, these studies though focus on the effect of rare, extreme events, implying that their findings may not necessarily be applied to other settings where violence is endemic.

**3. Background, trends and data**

**3.1 Births and birth outcomes**

In order to characterize the distribution of birthweight and other birth outcomes, in the rest of the paper we use micro data from birth certificates, which are collected by the BrazilianMinistry of Health through *DATASUS*, literally the *Departamento de Informática do Sistema Único de Saúde* (SUS).[[5]](#footnote-6)The data provide a large array of information on pregnancy and newborns’ outcomes as well as on mothers’ characteristics. Coverage is practically universal: data from the 2010 population Census show that more than 99 percent of children born between 2000 and 2010 indeed have a birth certificate.

Summary statistics for the period 2000-2010 are reported in top panel of Table 1. The data provide information on more than 30 million births over the period. As said, the primary units of observation in the analysis are municipalities, relatively small geographicalunits roughly equivalent to a US county. In the table we have information on 5,508 municipalities.[[6]](#footnote-7)At total population of just over 181 million, each of these municipalities accounts on average for 33 thousand individuals.Obviously, however, population size varies tremendously across municipalities: whileSão Paulo and Rio de Janeiro account for more than 10 and 6 million inhabitantsrespectively, more than 20 percent of municipalities have less than 5,000 inhabitants. For this reason, in the table we presentresults for all of Brazil (column 1) and separately for the different classesof municipalities based on population size. For this we use the standard classification from the National statistical office (IBGE) (population1 to 5,000; 5,001 to 20,000; 20,001 to 100,000; 100,001 to 500,000 and 500,001 or more). Smaller municipalitiesaccount for around 2% percent of all births.

The table illustrates that, with an incidence of low birthweight (less than 2.5 kg.) of around 8 percent, Brazil ranges above the average for OECD countries but considerably below the highest rates in some low-income countries (UNICEF 2006). Around respectively one and half a percent of children are born very low (<1.5 kg.) and extremely low (<1 kg.) birthweight. The data also provide information on APGAR scores, gestational length, gender and race and a number of mother’s characteristics. Roughly speaking, birth outcomes are worse the greater the municipality size, although children in very large municipalities (>500,000) seem to perform better than children in large municipalities (100,000 to 500,000) among a number of dimensions.

Figure 1, left-hand side panel, reportsaverage (acrossthe entire period) low-birthweight rates inall Brazilian municipalities: darker areas correspond to municipalities with greater incidence of low birthweight. The municipalities with the highest rates of low birthweight are clustered mainly in a number of states, Maranhão and Amapá, respectively in the Northeast and North, as well in the Southeastern states of Minas Gerais, São Paulo and Rio Grande do Sul in the South.

**3.2 Infant mortality**

The middle panel of the Table reports data on infant mortality. Datacomefrom death certificates, which are also collected by *DATASUS*, and record very detailed causes of death, including non-natural deaths classified ashomicides that we use below, as well as the date and municipality of occurrence of the death.The data also provide information on infant mortality. Infant mortality data refer to children born alive for which a birth certificate has been produced, and hence exclude fetal deaths.

The data allowus to estimatefour rates: early neonatal mortality (within the first seven days since birth), neonatal mortality (within the first twenty-eight days since birth), perinatal mortality (within the first twenty-two weeks since birth) and infant mortality (within the first year since birth). At 9 deaths per 1,000 children, early neonatal mortality accounts for the bulk of deaths within the first year of life. Infant mortality is on average 14 per 1,000 children. Again, there is a clear gradient across municipalities, with larger municipality size being associated to worse outcomes, and with very large municipalities being somewhat below trend.

**3.3Homicides**

The third panel of Table 1 reports data on homicides.These and all other aggregate statistics in the rest of the table that vary only by municipality and time are weighted by the number of births, meaning that municipality X time means receive a weight proportional to the number of births in that cell.

For the period 2000–2010 more than 528,000 homicides are recorded, equivalent to a yearlyhomicide rate of around 26 per 1,000,000 individuals.Again, homicide rates tend to be higher the greater is municipality size.Still, even in small municipalities the homicide rate is9 per 100,000 individuals. The data also provide location of death. This can be in a health institution, in one’s home, in the street, or elsewhere. Clearly when the death occurred in a health institutionthehomicide might have been committed elsewhere, possibly even in another municipality, inducing considerable error in the measure of local violence that we use. The subsequent rows of the table show that around 40 percent of deaths resulting from homicides happen in the street and around 50 percent either in the street or in one’s residence. Interestingly, this latter is only 44 percent in very large municipalities, where hospitals are typically located. This suggests that a fraction of homicides for which the death occurs in hospitals arelikely to be committed in other municipalities. Because of this, inmost of the analysiswe focus on homicides for which the death occurred in the street. These are also likely to be the most visible and hence stress-inducing homicides, which might possibly affect pregnancy outcomes.

The middle panel of Figure 1 reportsthe distribution of homicide rates (in the street) acrossBrazilianmunicipalities. Municipalities with higher incidence of homicides are in the more densely populated and more urbanized areas along the coastline, as well as in the state of Bahia in the Northeast of Brazil. Municipalities with high rates of homicides are also to be found in less densely populated states of Mato Grosso and Pará, covering some of the Amazon region.

Although this is not immediately evident in Figure 1, once one takes in account differences in population size across municipalities, a clear positivecorrelation between local homicide rates and low birthweight emerges. This is evident in Figure 2, left hand-side panel, whichplots the cross-sectionalrelationship between the fraction of low weight births and the annual homicide rate (in the street) across all Brazilian municipalities. A predicted regression line is also superimposed and larger circles correspond to larger cities. The data clearly show that, across municipalities, higher homicide rates are associated to worse birth outcomes: the estimated coefficient is 1.6 per thousand births and highly significant at conventional levels, implying that 1 extra homicide out of 100,000 people leads to 1.6 extra low weight births out of 1,000 births. It is also clear that larger municipalities tend to outperform smaller municipalities along both of these two dimensions. One possible interpretation of these correlations is that higher homicides rates are responsible for worse birth outcomes. This conclusion might be unwarranted though as different municipalities vary in characteristics which are potentially associated to both birth outcomes and mortality rates.

Indeed, the bottom part of Table 1 shows that municipalities of different sizes vary along a number of dimensions, such as income, literacy rate and rates of urbanization. These data (like most of the municipality level data that we use in the regressions) come from decennial population censuses.[[7]](#footnote-8)Indeed, there is evidence that largermunicipalities outperform smaller ones among most-socio-economic indicators, such as literacy rate and income per-capita.

Differences in socio-economic status and living standards across areas are also evident in the right-hand side panel of Figure 1, which displays average household income by municipality, with higher income being represented by darker areas. The South-eastern states of São Paulo, Rio de Janeiro and parts of Minas Gerais are those with the highest average household income.

**4. Econometric methodology**

As already emphasized, the difficulty in estimating the causal effect of violence on birth outcomes is that characteristics of different residential areas are unobservable to the econometrician. Some of these unobservable characteristics might be correlated with both newborns’ health outcomes as well as with homicide rates, even in the absence of a causal effect of violence on birth outcomes. For example, children born in poorer areas are more likely to display both negative birth outcomes due to the lower socio-economic characteristics of their parents or worse provision of health services in their neighborhood, as well as, possibly, to be exposed to a higher (or lower) degree of violence. In this case one would erroneously conclude that higher homicide rates lead to worse (or better) birth outcomes, a classic case of failed inference based on observational data.

In order to circumvent this problem, we propose to use a simple differences-in-differences identification strategy that relies on differential changes in homicide rates across municipality and time: this allows to control for unobserved time invariant municipality characteristics andto subsume aggregate time effects.

In formulas we estimate the following model:

*Ymt=0+1 HOMmt+ Xmt3+ dm +dt +umt* (1)

where *Ymt*is the average outcome variable (birthweight, still birth, infant mortality, APGAR scores, gestational length, etc.) in municipality*m*at time e *t*, *HOMmt* is the local homicide rate, *Xmt*are vectors of average (across all individuals in each cell) individual characteristics as well as time-varying municipality-level characteristics, *dm* and *dt*are respectively municipality and time fixed effects and *u* an error term. We estimate equation (1) on aggregate month X municipality level data, which is the level of variation of the homicide data (rather than on individual data), for computational purposes. All regressions are estimated using WLS, with weights given by the number of births in each cell.

In the empirical analysis we estimate the effect of the homicide rate at different stages of pregnancy (i.e. 1st, 2nd and 3rd trimester) and test for the validity of the identification assumption by introducing in the regressions additional post-birth homicide rates as additional regressors.One would expect homicide rates post-birth not to affect birth outcomes: finding a significant coefficient on the latter would point to a violation of the identification assumption.

In the following, we measure trimesters of pregnancy starting from the date of conception. We recover the latter based on the child’s date of birth minus the length of gestation. As the length of gestation is recorded in intervals in our data (<22, 23-27, 28-31, 32-36, 37-41, >41 weeks), we use the mid-point of each interval.This approach has multiple advantages. First, it allows us to correctly measure exposure in differenttrimesters of pregnancy, which would not be possible if we countedretrospectively since the time of birth (as typically done in this literature) and ignored the variation in the length of gestation across pregnancies. Second it allows us to directly estimate the effect of homicides on the length of gestation, a potentiallyinteresting outcome in itself. Third, and related to the latter, it allows us to obtain estimates of program impact on other outcomes (e.g. birthweight) that are correlated with length of gestation that are free of potential selection bias.

**5. Empirical results**

**5.1 Birthweight**

Table 2 present estimates of equation (1) for small municipalities (<5,000 individuals). Small municipalities are concentrated in a few states (Tocantins, Piauí, Goiás, Minas Gerais, São Paulo, Rio Grande do Sul) and geographically rather dispersed (see Figure 3).The table reportsresults on average birthweight (in grams), and on the fraction of low, very low and extremely low weight births (per 1,000 births). Column (1) of Table 2 reports a simple diffs-in-diff estimate for the effect of the homicide rate on average birthweight in trimesters 1, 2 and 3 since conception. Regressions includeonly municipality andmonth of conception fixed effects.Homiciderates here are computed at the quarterly level (i.e. number of homicides per quarter over total population). The data show a negative and very precisely estimated effect of the homicide rate in the first trimester of gestation on birthweight. The estimated effect of an increase by one in the number of quarterlyhomicides per 100,000 individuals in column 1is just below half a gram (-0.43 grams.)This implies that in an average municipalityin this class (around 3,700 individuals)one extrahomicide will lead to a reduction in average birthweight among children exposed to that homicide in their first trimester of pregnancy of around 12 grams (=(0.43 X 100,000) /3,700 x). This is a small effect, on the order of 0.4 percent relative to an average birthweight of 3.210 kg.For comparison, for Colombia, Camacho (2008) finds that one landmine explosion during early pregnancy reduces low birthweight by 7.5 grams.

The estimates for the second and third trimester are positive, much smaller in magnitude but not significant at any conventional levels.This is in line with findings elsewhere in the literature that stress induced by extreme event matters mostly during the first trimester of gestation (Camacho 2008, Torche 2011, Mansour and Rees 2012).

Column (2) controls for a very rich set of mother and child characteristics(see notes to Table 2) including municipality specific linear timetrendsandmunicipality x calendar month (January to December) effects. Results are essentially unchanged relative to column (1), lending credibility to the identification assumption that - conditional on time and municipality fixed effects- the variation in the homicide rate across municipalities and time is almost as good as random. In column (3) we additionallyinclude homicide rates in the fourth, fifth and sixthtrimestersinceconception, i.e.- for pregnancies of normal gestational length - in the first, second and third trimestersince birth. The inclusion of these variables makes virtually no difference to the results while we find no significant coefficients on the different lead variables, lending support to our identification assumption.

Results in the following columns of the table confirm these findings and show that homicides have a particularly pronouncedeffect atthe bottom tail of the birthweight distribution. We find significant effect of homicide in the first trimester the fractionof low, very low and extremely low weight births of, respectively, 0.17, 0.06 and 0.04 per 1,000 births. In turn this means that one extra homicide in a small municipality will lead to an increase in the fraction of low, very low and extremely low birthweight children of 0.5 (=(0.17/10) X 100,000 / 3,700), 0.2 and 0.1 percentage points, i.e.,respectively a 6, 16 and 21 percent increase (relative to a baseline incidence of 0.078, 0.010 and 0.005).[[8]](#footnote-9)

**5.2 Additional outcomes**

Table 3 reports regression results on a number of additional outcomes. For brevity, we report onlyspecifications with the entire set of controlsas in column (2) of Table 2. Column (1) reports the effect of homicides on gestational length. Indeed, homicides in the first trimester increase prematurity, by lowering gestational length. Column (2) reports the effect on APGAR scores. We use the average score one minute and five minutes post birth in an attempt toboost precision: still we find no evidence of asignificant effect of increased levels of violence on this outcome.

Columns (3) to (6) report the effects on mortality rates at differentintervals since birth. The dependent variable here is the fraction of deaths per thousand children born alive. Again, there is no evidence of violence affecting child mortality rates.

Columns (7) and (8) report estimates of impact onbirthweight and low birthweight only for pregnancies of normal gestational length, defined as pregnancies of 37 weeks or more. We report results on birthweight and the fraction low birthweight children (as in columns (2) and (5) of Table 2). Interestingly, results on birthweightdisappear. Combined with the findings in column (3) of Table 3, this suggests that violence leads to greater rates of prematurity and, via this, to increased risk of low birthweight.

The last concern we have pertains to selective fertility. Violence might affectbirth outcomes through the selection that it operates on the number of children who are eventually born. This can happen through a variety of margins: selective sexual activity or contraception use, selective fetal mortality, abortion and miscarriage. In order to study thesecombined effects, in column (9) of Table 3 we report a regression of the log number of births by municipality and time on the same variables as in columns (1) to (8) with the exception of mother characteristics. As in the other regressions we control for the age and gender structure of the population in each municipality X time cell. The latter allows us tocontrol for differences in the population at risk (women of fertile age) across cells. We find very small and statistically insignificant effects on fertility, implying that selection along this margin is unlikely to explain our results.

**5.3 Alternative definitions of homicide**

In Tables 2 and 3 we restrict to homicides for which the death occurred in the street. Table 4 reports results using respectively homicides in the street and on one’s residence (columns (1) to (5)) and all homicides, i.e. also those when the death occurred in health institutions (columns (6) to (10)). Using additionally homicides for which the death occurred in residences makes virtually no difference to our results. Results though become attenuated and less precise when we use all homicides: this is consistent with the notion that homicides for which the death occurred in hospital do not have the same impact on outcomes as those when the death occurred in the street. Homicides when the death occurred in hospital might be less visible and hence less stress inducing and that they might not reflect local violence, as deaths occurring in health institutions are more likely to be associated to homicides committed in other municipalities.

**5.4 Heterogeneous effects by mother’s education**

To conclude, in Table 5 we report separate regression results for infants born to mothers with incomplete and complete primary education (8 years of schooling) respectively. Each of these two groups account, roughly, for 50 per cent of births. The effect seems to manifest largely among children of poorly educated mothers. Although results for highly educated mothers are qualitatively similar, point estimates are typically attenuated and statistical significance is lower. It appears that violence adds up to the disadvantage that children of poorly educated mothers already suffer as a result of their household’s lower socio-economic status.

**6. Summary of findings and conclusions**

Using a very rich dataset on the universe of births and homicides from vital statistics data over the period 2000-2010 we estimate the effect of in-utero exposure to homicides in on a range of birth outcome in small Brazilian municipalities. We find a significant negative effect of exposure to violence during the first trimester on birthweight, which is in line with findings on the effect of other stress-related shocks during pregnancy elsewhere in the literature. We also find significant and large positive effects of homicides on the probability of low birthweight, implying that the effects are particularly pronounced at the bottom tail of the birthweight distribution. Our results are robust to the introduction of maternal and municipal socioeconomic controls, including municipality specific linear time trends. A falsification exercise, consisting in testing for the effect of post-birth homicide rates on birth outcomes, lends further credibility to our identification assumption.

We show that violence in the first trimester of pregnancy affects birth outcomes through reduced gestational length. Increased prematurity hence, rather than intrauterine growth retardation, seems to explain the pronounced effect on low birthweight that we have documented in the paper.

As violence might affect the probability of appearing in the data set through changes in fertility or possibly via abortion or miscarriage, one concern in that our results might be driven by selection, i.e. a differential response to increased level of violence among women with differential propensity to give birth to low weight infants. Despite this concern, we find no evidence of homicides affecting fertility outcomes.

Finally, we show that results are largely concentrated among poorly educated mothers, i.e. those with less than completed primary education. This suggests that violence adds up to the mechanisms that affect the transmission of socioeconomicstatus between parents and theiroffspring.

Although our estimates for the effect of one extra homicide in small municipalitiesare economically meaningful, high homicide rates are not responsible for the high level of low birthweight in Brazil. This is because overall, homicides are rather rare events. At current rates, and if one is willing to extrapolate the estimates from small municipalities to the whole of Brazil, our back of the envelope calculations show that homicide rates account only for a minimal fraction (0.01%) of total low birthweight incidence in the country.

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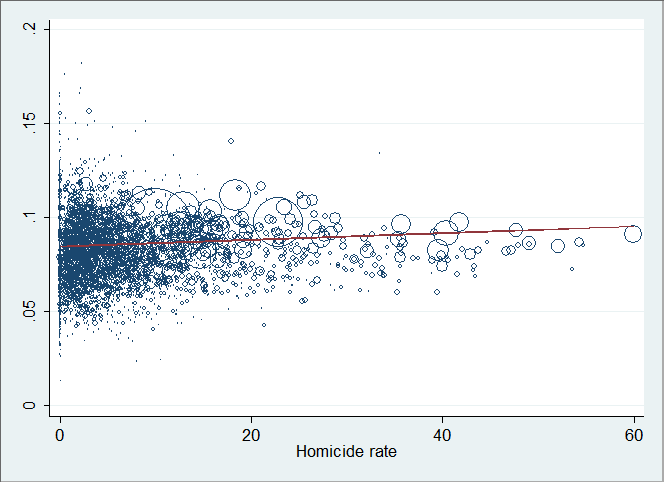
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Figure 1: Municiplity characteristics

|  |  |  |
| --- | --- | --- |
| Fraction low weight births | Homicide rate (in the street) | Average household income |
|  |  |  |

Notes. The pictures report, respectively, the average fraction low weight births (<2.5 kg), the homicide rate in public places and household income between 2000 and 2010.

Figure 2: Incidence of low birthweight and homicide rate across municipalities

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Notes. The figure reports the relationship between the fraction of low weight births and the annual homicide rate (in the street) across all Brazilian municipalities. A predicted regression line is superimposed and larger circles correspond to larger cities.

Figure 3: Small municiplity characteristics

|  |  |  |
| --- | --- | --- |
| Fraction low weight births | Homicide rate (in the street) |  |
|  |  |  |

Notes. The pictures report, respectively, the average fraction low weight births (<2.5 kg) and the homicide rate in public places for municipalities of average size no greater than 5,000 inhabitants.

Table 1: Descriptive statistics

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | All | By municipality size | | | | |
|  |  | <5000 | 5,000-19,999 | 20,000-99,999 | 100,001-500,000 | >500,000 |
| Number of municipalities | 5,508 | 1,289 | 2,648 | 1,320 | 215 | 36 |
|  |  |  |  |  |  |  |
| Number of births | 30,367,939 | 616,733 | 4,491,073 | 8,808,710 | 7,254,770 | 9,106,653 |
| Birthweight | 3184.190 | 3,210.62 | 3,222.315 | 3,207.675 | 3,164.246 | 3,156.751 |
| Low birthweight | 0.087 | 0.078 | 0.080 | 0.082 | 0.092 | 0.082 |
| Very low birthweight | 0.012 | 0.010 | 0.011 | 0.011 | 0.013 | 0.011 |
| Extremely low birthweight | 0.006 | 0.005 | 0.005 | 0.005 | 0.006 | 0.004 |
| Gestational length | 38.690 | 38.751 | 38.755 | 38.748 | 38.659 | 38.622 |
| APGAR – 1 minute | 8.144 | 8.143 | 8.073 | 8.109 | 8.185 | 8.176 |
| APGAR – 5 minutes | 9.235 | 9.300 | 9.226 | 9.242 | 9.250 | 9.216 |
| Female | 0.512 | 0.514 | 0.513 | 0.513 | 0.512 | 0.512 |
| White | 0.502 | 0.598 | 0.471 | 0.459 | 0.561 | 0.508 |
| Prenatal visits | 5.705 | 5.803 | 5.446 | 5.458 | 5.889 | 5.920 |
| Mother’s age | 26.168 | 26.022 | 26.223 | 25.744 | 25.933 | 26.754 |
| Mother never married | 0.613 | 0.563 | 0.633 | 0.657 | 0.622 | 0.601 |
| Mother’s years of schooling | 7.826 | 7.745 | 7.256 | 7.695 | 8.865 | 7.736 |
|  |  |  |  |  |  |  |
| Early neonatal mortality (1 wk.) | 9.121 | 8.000 | 8.832 | 9.110 | 11.881 | 7.042 |
| Neonatal mortality (4 wks.) | 11.211 | 9.767 | 10.625 | 10.901 | 14.486 | 9.184 |
| Perinatal mortality (22 wks.) | 13.595 | 11.973 | 13.129 | 13.441 | 16.923 | 11.316 |
| Infant mortality (1 year) | 14.706 | 12.951 | 14.446 | 14.746 | 17.986 | 12.170 |
|  |  |  |  |  |  |  |
| Homicide rate | 26.284 | 9.102 | 12.832 | 19.381 | 32.650 | 36.613 |
| Homicide rate, in the street | 10.972 | 2.498 | 4.284 | 7.903 | 14.574 | 15.330 |
| Homicide rate, in the street and in homes | 13.888 | 4.691 | 6.855 | 10.794 | 17.999 | 18.067 |
|  |  |  |  |  |  |  |
| Population | 1,170,281 | 3,703 | 12,638 | 49,120 | 250,081 | 3,887,465 |
| Urbanization rate | 0.822 | 0.531 | 0.574 | 0.721 | 0.937 | 0.984 |
| HH income 2010 $R | 1,100.41 | 582.53 | 571.05 | 752.81 | 1,150.36 | 1,663.70 |
| Literacy rate | 0.817 | 0.758 | 0.723 | 0.755 | 0.848 | 0.878 |

Notes. Source: *DATASUS*and IBGEpopulation census.All entries are weighted by the number of births. Neonatal and infant mortality rates are expressed as a fraction per 1,000 live births. Homicide rates are expressed as a fraction per 100,000 population.

Table 2: The effect of homicides during pregnancy on birthweight by trimester since conception – Small municipalities

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | (1) | | (2) | (3) | | (4) | | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| Trimester | Birthweight  (grams) | | | | | Low birthweight  (x 1,000) | | | | Very low birthweight  (x 1,000) | | | Extremely low birthweight  (x 1,000) | | |
| 1 | -0.4276\*\* | -0.4519\*\*\* | | | -0.4563\*\*\* | 0.1478\* | 0.1699\*\* | | 0.1727\*\* | 0.0554 | 0.0595\* | 0.0606\* | 0.0396 | 0.0405 | 0.0426\* |
|  | (0.1723) | (0.1629) | | | (0.1628) | (0.0891) | (0.0836) | | (0.0840) | (0.0355) | (0.0344) | (0.0342) | (0.0258) | (0.0255) | (0.0253) |
| 2 | 0.0242 | 0.0563 | | | 0.0503 | 0.0679 | 0.0605 | | 0.0644 | -0.0318 | -0.0348 | -0.0330 | -0.0156 | -0.0201 | -0.0178 |
|  | (0.2029) | (0.1922) | | | (0.1925) | (0.0956) | (0.0892) | | (0.0893) | (0.0341) | (0.0336) | (0.0336) | (0.0239) | (0.0241) | (0.0239) |
| 3 | 0.0277 | -0.0491 | | | -0.0527 | -0.0283 | 0.0055 | | 0.0073 | 0.0389 | 0.0414 | 0.0423 | 0.0212 | 0.0200 | 0.0215 |
|  | (0.1975) | (0.1892) | | | (0.1910) | (0.0883) | (0.0858) | | (0.0861) | (0.0416) | (0.0408) | (0.0414) | (0.0315) | (0.0306) | (0.0314) |
| 4 |  |  | | | -0.0956 |  |  | | 0.0539 |  |  | 0.0387 |  |  | 0.0290 |
|  |  |  | | | (0.1812) |  |  | | (0.0850) |  |  | (0.0382) |  |  | (0.0316) |
| 5 |  |  | | | -0.0309 |  |  | | 0.0114 |  |  | 0.0060 |  |  | 0.0273 |
|  |  |  | | | (0.1905) |  |  | | (0.0843) |  |  | (0.0461) |  |  | (0.0375) |
| 6 |  |  | | | -0.1027 |  |  | | 0.0826 |  |  | 0.0293 |  |  | 0.0485 |
|  |  |  | | | (0.2091) |  |  | | (0.0942) |  |  | (0.0403) |  |  | (0.0374) |
|  |  |  | | |  |  |  | |  |  |  |  |  |  |  |
| Municipality f.e. | Yes | Yes | | | Yes | Yes | Yes | | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Month f.e. | Yes | Yes | | | Yes | Yes | Yes | | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Pregnancy controls | No | Yes | | | Yes | No | Yes | | Yes | No | Yes | Yes | No | Yes | Yes |
| Mother controls | No | Yes | | | Yes | No | Yes | | Yes | No | Yes | Yes | No | Yes | Yes |
| Municipality controls | No | Yes | | | Yes | No | Yes | | Yes | No | Yes | Yes | No | Yes | Yes |

Notes: Each column reports the results from a separate regression of the dependent variable on the local quarterly homicide rate in different trimesters since the month of conception. Homicide rates are expressed as fraction per 100,000 individuals. Fraction birthweight is expressed per 1,000 live births. Regressions are run on cells defined by municipality and time of conception with weights equal to the number of births by cell. Controls include number of newborns by gender and race (black, white, mixed, Asian, indigenous) and number of multiple births (twins, triplets, more than three children). Mother controls include age (10-19, 20-39, etc.), marital status (single, married, divorced, widowed), years of completed education (no education, 1-3, 4-7, 8-11, 12 and more), average number of previously born alive children and of still births.Municipality controls include fraction of households with possession of radio, TV, washing machine, telephone, computer and fraction with access to piped water, waste collection, electricity, fraction of the population by gender and age, fraction of adult population literate, average years of schooling in the population, fraction of families with *Bolsa Família*, health establishments and nurses per capita, unemployment rate, urbanization rate, fraction of children in work, interaction of municipality with calendar month and municipality trends. Clustered standard errors by municipality in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Number of cell observations: 136,711 (616,733 births).

Table 3: Homicide rates and additional birth outcomes by trimester since conception – Small municipalities

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|  | Gestational length  (weeks) | APGAR score  (avg. 1 & 5 minutes) | Child mortality rates  (x 1,000) | | | | Only pregnancies of normal gestation length  (37 weeks or more) | | Log number of births |
| Trimester |  |  | Early neonatal  (1 week) | Neonatal  (4 weeks) | Perinatal  (22 weeks) | Infant  (1 year) | Weight | Low birthweight  (x 1,000) |  |
| 1 | -0.0011\* | -0.1007 | -0.0162 | -0.0017 | 0.0065 | 0.0164 | 0.0004 | 0.0205 | 0.0000 |
|  | (0.0006) | (0.4777) | (0.0276) | (0.0332) | (0.0386) | (0.0396) | (0.0736) | (0.0226) | (0.0003) |
| 2 | 0.0004 | 0.1102 | 0.0311 | 0.0212 | 0.0429 | 0.0357 | -0.0121 | -0.0005 | -0.0004 |
|  | (0.0005) | (0.4714) | (0.0331) | (0.0355) | (0.0374) | (0.0397) | (0.0728) | (0.0227) | (0.0004) |
| 3 | -0.0004 | -0.1505 | -0.0023 | -0.0228 | -0.0232 | -0.0317 | 0.0001 | 0.0102 | 0.0004 |
|  | (0.0005) | (0.4868) | (0.0281) | (0.0296) | (0.0346) | (0.0352) | (0.0751) | (0.0232) | (0.0004) |
|  |  |  |  |  |  |  |  |  |  |
| Municipality f.e. | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Month f.e. | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Pregnancy controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No |
| Mother controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No |
| Municipality controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Notes: Dependent variable in columns 3 to 6 is fraction of children dead per 1,000 live births. See also notes to Table 2.

Table 4: The effect of homicides during pregnancy on birthweight by trimester since conception –Alternative homicide rates - Small municipalities

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) |  | (6) | (7) | (8) | (9) | (10) |
|  | Homicides in the street and in one’s home | | | | |  | All homicides | | | | |
| Trimester | Birthweight  (grams) | Low birthweight  (x 1,000) | Very low birthweight  (x 1,000) | Extremely low birthweight  (x 1,000) | Gestational length (weeks) |  | Birthweight  (grams) | Low birthweight  (x 1,000) | Very low birthweight  (x 1,000) | Extremely low birthweight  (x 1,000) | Gestational length (weeks) |
| 1 | -0.3308\*\*\* | 0.0816 | 0.0588\*\* | 0.0480\*\* | -0.0007\* |  | -0.1674\* | 0.0156 | 0.0179 | 0.0177 | -0.0002 |
|  | (0.1250) | (0.0616) | (0.0279) | (0.0218) | (0.0004) |  | (0.0904) | (0.0464) | (0.0193) | (0.0143) | (0.0003) |
| 2 | -0.0039 | 0.0731 | -0.0206 | -0.0113 | 0.0004 |  | -0.0133 | 0.0259 | -0.0329\* | -0.0226 | 0.0005\* |
|  | (0.1331) | (0.0619) | (0.0247) | (0.0196) | (0.0003) |  | (0.1070) | (0.0499) | (0.0183) | (0.0141) | (0.0003) |
| 3 | -0.0272 | 0.0046 | 0.0309 | 0.0170 | -0.0002 |  | 0.0327 | -0.0380 | 0.0054 | -0.0019 | -0.0001 |
|  | (0.1389) | (0.0635) | (0.0277) | (0.0203) | (0.0003) |  | (0.1003) | (0.0487) | (0.0198) | (0.0146) | (0.0003) |
|  |  |  |  |  |  |  |  |  |  |  |  |
| Municipality f.e. | Yes | Yes | Yes | Yes | Yes |  | Yes | Yes | Yes | Yes | Yes |
| Month f.e. | Yes | Yes | Yes | Yes | Yes |  | Yes | Yes | Yes | Yes | Yes |
| Pregnancy controls | Yes | Yes | Yes | Yes | Yes |  | Yes | Yes | Yes | Yes | Yes |
| Mother controls | Yes | Yes | Yes | Yes | Yes |  | Yes | Yes | Yes | Yes | Yes |
| Municipality controls | Yes | Yes | Yes | Yes | Yes |  | Yes | Yes | Yes | Yes | Yes |

Notes:.See also notes to Table 2.

Table 5: Homicide rates and additional birth outcomes by trimester since conception – by mother’s education – Small municipalities

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | | (4) |  | (5) | | (6) | (7) | | (8) | |
|  | Incomplete primary education | | | | |  | Completed primaryeducation | | | | | | |
| Trimester | Birthweight  (grams) | Low birthweight  (x 1,000) | | Gestational length (weeks) | APGAR score  (avg. 1 & 5 minutes) |  | Birthweight  (grams) | Low birthweight  (x 1,000) | | | Gestational length (weeks) | | APGAR score  (avg. 1 & 5 minutes) |
| 1 | -0.4644\*\*\* | 0.1623 | | -0.0011\* | -0.2928 |  | -0.2899 | 0.1206 | | | -0.0008 | | 0.0518 |
|  | (0.2178) | (0.1183) | | (0.0007) | (0.6188) |  | (0.2608) | (0.1220) | | | (0.0008) | | (0.5863) |
| 2 | 0.2180 | 0.1225 | | 0.0009 | 0.1165 |  | -0.1294 | -0.0566 | | | 0.0001 | | 0.5136 |
|  | (0.2459) | (0.1150) | | (0.0006) | (0.5798) |  | (0.2723) | (0.1281) | | | (0.0008) | | (0.5920) |
| 3 | -0.0205 | -0.0949 | | -0.0003 | 0.3100 |  | -0.1572 | 0.1729 | | | -0.0008 | | -0.7598 |
|  | (0.2492) | (0.1131) | | (0.0006) | (0.6163) |  | (0.2563) | (0.1208) | | | (0.0007) | | (0.5483) |
|  |  |  | |  |  |  |  |  | | |  | |  |
| Municipality f.e. | Yes | Yes | | Yes | Yes |  | Yes | Yes | | | Yes | | Yes |
| Month f.e. | Yes | Yes | | Yes | Yes |  | Yes | Yes | | | Yes | | Yes |
| Pregnancy controls | Yes | Yes | | Yes | Yes |  | Yes | Yes | | | Yes | | Yes |
| Mother controls | Yes | Yes | | Yes | Yes |  | Yes | Yes | | | Yes | | Yes |
| Municipality controls | Yes | Yes | | Yes | Yes |  | Yes | Yes | | | Yes | | Yes |

Notes: Incomplete primary educationcorresponds to less than 8 years of completed education.Number of observationsincolumns 1 to 4 is 115,922 while in columns 5 to 8 this is 109,510. See also notes to Table 2.

Table A1: The effect of homicides during pregnancy on birthweight by trimester since conception – By municipality size

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | | (4) | (5) | (6) | (7) | (8) |
| Trimester | 5,001-20,000 | | 20,001-100,000 | | | 100,001-500,000 | | >500,000 | |
| 1 | 0.0967 | 0.0951 | -0.1752 | -0.0917 | | 0.0537 | -0.0069 | 0.5085 | 0.5224 |
|  | (0.0985) | (0.0948) | (0.1092) | (0.1060) | | (0.2235) | (0.2064) | (0.3360) | (0.3284) |
| 2 | -0.0613 | -0.0854 | -0.0052 | 0.0798 | | 0.1453 | 0.1047 | 0.2970 | 0.3277 |
|  | (0.1041) | (0.0994) | (0.1116) | (0.1070) | | (0.2079) | (0.1724) | (0.3820) | (0.3549) |
| 3 | 0.0615 | 0.0363 | -0.0913 | 0.0089 | | -0.3106\* | -0.2942\* | -0.7921\* | -0.7246\*\* |
|  | (0.0994) | (0.0948) | (0.1165) | (0.1005) | | (0.1863) | (0.1765) | (0.4345) | (0.3416) |
| 4 |  | -0.0751 |  | -0.1045 | |  | -0.1011 |  | 0.0757 |
|  |  | (0.0956) |  | (0.1019) | |  | (0.2033) |  | (0.3375) |
| 5 |  | 0.0422 |  | -0.0972 | |  | 0.2410 |  | -0.3730 |
|  |  | (0.0936) |  | (0.0953) | |  | (0.2470) |  | (0.4403) |
| 6 |  | 0.0385 |  | -0.0900 | |  | -0.4177 |  | -0.1971 |
|  |  | (0.0970) |  | (0.0983) | |  | (0.2787) |  | (0.4468) |
|  |  |  |  |  | |  |  |  |  |
|  |  |  |  |  | |  |  |  |  |
| Municipality f.e. | Yes | Yes | Yes | Yes | | Yes | Yes | Yes | Yes |
| Month f.e. | Yes | Yes | Yes | Yes | | Yes | Yes | Yes | Yes |
| Pregnancy controls | No | Yes | No | Yes | | No | Yes | No | Yes |
| Mother controls | No | Yes | No | Yes | | No | Yes | No | Yes |
| Municipality controls | No | Yes | No | Yes | | No | Yes | No | Yes |
| Number of cell observations |  |  |  |  | |  |  |  |  |
| Number of individuals observations |  |  |  |  | |  |  |  |  |
|  |  |  |  |  | |  |  |  |  |
| Number of cell observations | 300,436 | 300,436 | 150,358 | 150,358 | | 24,500 | 24,500 | 3,978 | 3,978 |
| Number of individuals observations | 4,491,073 | 4,491,073 | 8,808,710 | 8,808,710 | | 7,254,770 | 7,254,770 | 9,106,653 | 9,106,653 |

Notes. See notes of Table 2.

1. Preliminary non official version. This document is not an official publication of the IDB. The opinion and data presented by the authors are personal and not compromised an official position of the Bank.  [↑](#footnote-ref-2)
2. Methodologiessuch as contingent valuation surveys, and willingness-to-pay methods (see Soares 2010 for a description of the methods and a survey of the findings) have not been applied in the Brazilian context. [↑](#footnote-ref-3)
3. A significant proportion of murders in Brazil is associated with drug trafficking and the ensuing disputes over territory, distribution and leadership (UNODC 2005). Murders based on drug trafficking – but not exclusively those- are related to a wide variety of other violent activities, such as robberies, kidnapping, assaults and muggings (Heinemann and Verner 2006). [↑](#footnote-ref-4)
4. There is very little evidence on the effect of mother’s victimization. One exception is Aizer (2011), which shows that mother’s domestic-violence-induced hospitalization considerably reduces birth weight. [↑](#footnote-ref-5)
5. The information on births is first collected by the health institution where the birth took place and then forwarded to the State’s health secretariat (via means of the Municipal health secretariat), which in turn is responsible for entering the information into the central database (FUNASA 2001). In the rare case of a home birth this information is submitted by medical staff attending the birth. [↑](#footnote-ref-6)
6. We have excluded the few municipalities that split into newer municipalities between 2000 and 2010. [↑](#footnote-ref-7)
7. The majority of the data come from *DATASUS* (http://www2.datasus.gov.br/DATASUS/index.php?area=0206

   andVObj=http://tabnet.datasus.gov.br/cgi/deftohtm.exe?ibge/censo/cnv/crianpobr). Additional variables have been obtained directly from population censusmicro-data. Data are available for 2000 and 2010 and we have then interpolated linearly across these two dates to estimate their value in every intervening month. [↑](#footnote-ref-8)
8. Results are quite different as we move to larger municipalities, in Table A1. Results are mixed. For municipalities between 5,000 and 100,000 population we find insignificant effectsfor homicides in the first trimester of a magnitude much smaller to the effect estimated in small municipalities. For larger municipalities we find an effect of homicide in the last trimester. However, we also find significant coefficients on the lead variables. This points to a violation of theidentification assumption. [↑](#footnote-ref-9)