



## Regular Article

Violence and birth outcomes: Evidence from homicides in Brazil<sup>☆</sup>Martin Foureaux Koppensteiner<sup>a</sup>, Marco Manacorda<sup>b,c,d,e,\*</sup><sup>a</sup> University of Leicester, United Kingdom<sup>b</sup> Queen Mary University of London, United Kingdom<sup>c</sup> CEP (LSE), United Kingdom<sup>d</sup> CEPR, United Kingdom<sup>e</sup> IZA, Germany

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## ABSTRACT

This paper uses microdata from Brazilian vital statistics on births and deaths between 2000 and 2010 to estimate the impact of in-utero exposure to local violence – measured by homicide rates – on birth outcomes. The estimates show that exposure to violence during the first trimester of pregnancy leads to a small but precisely estimated increase in the risk of low birthweight and prematurity. Effects are found both in small municipalities, where homicides are rare, and in large municipalities, where violence is endemic, and are particularly pronounced among children of poorly educated mothers, implying that violence compounds the disadvantage that these children already suffer as a result of their households' lower socioeconomic status.

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## 1. Introduction

In this paper we analyze birth outcomes of children whose mothers were exposed to violence in their local environment during pregnancy. Exposure to violence is likely to induce fear and psychological stress, and the medical literature suggests that an increase in mother's psychological stress, especially in the first trimester of pregnancy, can lead to prematurity and low birthweight. Evidence though remains elusive and calculations of the cost of crime typically ignore this margin.

For the purpose of this exercise we link microdata from Brazilian birth statistics over eleven years to microdata from mortality vital statistics. Importantly, birth records provide information on the mother's place of residence while death records provide the place of occurrence as well as the precise cause of death, including death as a result of a homicide. This allows us to measure how birth outcomes vary when a homicide – our measure of violence – occurs in the mother's area of

residence, and to estimate how the effect varies at different stages of pregnancy.

In particular, in the empirical analysis we exploit information available in the vital statistics on the precise municipality of occurrence of a homicide and the municipality of residence of the mother. We focus on small municipalities for which municipality-level homicide rates provide a localized measure of violence. We complement the analysis with a study of the city of Fortaleza – one of the most violent cities in Brazil, or for that matter in the world – for which the data provide detailed information on the mother's neighborhood of residence and the neighborhood of occurrence of homicides. This also allows us to contrast the effects of homicides in a setting where these are rare and presumably largely unexpected, and perhaps more traumatic events to a setting where homicides are frequent and violence is endemic.

The information available in the vital statistics data allows us to measure the effect of homicides on a variety of outcomes, including birthweight and gestational length, as well as potential margins of selection due to fertility, abortion, and miscarriage. The richness of the data also allows us to investigate how these effects vary across a number of mothers' characteristics, among which, educational level, and hence to study whether high socio-economic status provides a buffer to the effects of local violence.

Other papers before ours, which we discuss at length below, investigate the effects of violence on birth outcomes. Some of these papers (Brown, 2014; Mansour and Rees, 2012; Torche and Villarreal, 2014), though, exploit large secular rises in violence in connection to the onset of conflict or to large escalation in violence, raising the possibility

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that other behavioral responses, which can result from conflict or a secular upsurge in violence (e.g. falls in living standards), might be at work. By converse, other papers (Camacho, 2008; Eccleston, 2012; Quintana-Domeque and Rodenas, 2014) focus on extreme events such as landmine explosions, bomb casualties, or even the 9/11 attacks in New York City. Again it is possible that, given their rare nature, in addition to instilling fear, these events also have additional indirect immediate effects on birth outcomes (e.g. disrupting access to medical services or to the workplace, or affecting, as in the case of 9/11, the level of environmental pollution). The rare and extreme nature of these events also makes it hard to generalize these results to the effect of homicides, let aside day-to-day violence and crime, on birth outcomes. It seems plausible a priori to speculate that extreme violent events might have larger adverse effects compared to single homicides, especially when violence is endemic. In this respect, our paper has the potential to generalize to many other countries and settings, as a much higher number of women worldwide are exposed to everyday violence and homicides compared to those who are exposed to events such as terrorist attacks or landmine explosions.

Even if not as extreme as bombs and terrorist attacks, homicides are known to instill fear and induce anxiety. A large literature in criminology and psychology investigates the determinants of the fear of crime, i.e. the perceived risk of victimization. Not only exposure to crime and violence through direct victimization or witnessing of a crime but also exposure to the news of crimes and violence through friends, neighbors and coworkers are known to considerably raise the fear of crime (Skogan and Maxfield, 1981) and to cause mental distress (Dustmann and Fasani, in press). In part due to the amplifying role of the media, violent crimes, and in particular homicides, are believed to instill the strongest response, despite the fact that the risk of being a victim of a homicide may be objectively small compared to other crimes (Warr, 2000).

The analysis focuses on Brazil, a country with one of the highest levels of violence worldwide (UNODC, 2011), with a homicide rate of 21 per 100,000 population as of 2011, approximately five times the rate in the United States and more than 20 times the rate in the United Kingdom. Sixteen among the top 50 cities in the world ranked based on murder rate are in Brazil and 43 out of 50 are in Latin America and the Caribbean (with the remaining seven cities being either in the USA or in South Africa; Citizens' Council for Public Security and Criminal Justice, 2014). Homicide is the leading cause of death in men aged 15–44 (Reichenheim et al., 2011), and day-to-day violence is a top concern among citizens of Brazil. According to Latinobarometer (2010), about 16% of Brazilian respondents list violence and public security as the most important problem, and existing estimates put the direct costs of violence and crime at between 3 and 5% of annual GDP (Heinemann and Verner, 2006; World Bank, 2006). As uniform crime reports are not publicly available for Brazil, homicide rates from death records constitute a unique source of information on violence and crime that is uniform across space and time.

In order to proceed with our exercise, we adopt a difference-in-differences strategy across small geographical areas and time. In practice, we net out common time effects across areas and we compare mothers who were exposed to a homicide during pregnancy to otherwise similar mothers residing in the same area, who happened not to be exposed, as they were pregnant at times when a homicide did not occur. Rather than using large changes in homicide rates over time, we exploit within area variation in the precise timing of homicides. As these mothers are likely to live in similar environments, including in terms of the level of endemic violence, by exploiting the precise timing of homicides we attempt to disentangle the causal effect of homicides from other correlated effects, most notably changes in local economic conditions that might affect both birth outcome and the onset of violence.

Our main results show that gestational length and birthweight fall considerably among newborns exposed to a homicide during the first

trimester of pregnancy. This is consistent with a large body of medical literature claiming that stress-inducing events affect birth outcomes through an increased rate of prematurity and that these effects act largely in the first trimester of pregnancy (see Section 2).

In particular, in small municipalities, one extra homicide during the first trimester of pregnancy leads to an increase in the probability of low birthweight ( $\leq 2.5$  kg) of around 0.6 percentage points (an 8% increase). This effect is largely ascribable to increased prematurity rather than intrauterine growth retardation. The estimated effect is economically meaningful, being approximately ten times the effect estimated for the United States of being a recipient of Food Stamps (Almond et al., 2011).

Estimates of the effect of one extra homicide during pregnancy for Fortaleza are around 15% of what is found for small municipalities. This is consistent with our hypothesis that the effects of violence are relatively less pronounced when violence is endemic. Despite this, a much larger fraction of pregnant women is exposed to homicides in large versus small municipalities. In the conclusions to the paper, we calculate that homicides are a relatively more important contributor to adverse birth outcomes in Fortaleza compared to small municipalities.

In the analysis we also show that homicides have no effect on birth rates, implying that our estimates are unlikely to be affected by margins of endogenous fertility or selective fetus survival, through abortion or miscarriage, which might bias our estimates.

In order to bring ammunition to our claim that the estimated effects are causal, we show that homicides at different leads and lags from pregnancy have no effect on birth outcomes. The absence of significant effects of lagged homicide rates helps us rule out endogenous selection effects, which could mechanically explain our impact estimates if mothers with a lower propensity to give birth to low weight children tended to be more responsive to homicides in terms their fertility rates. Similarly, the absence of significant effects on leaded homicide rates tends to rule out potential selection effects acting through anticipation of future homicides.

As an additional check, and for the purpose of lending further credibility to our identification assumption that – absent a homicide, treatment and control mothers would have had similar pregnancy outcomes – we also show that our results are robust to the inclusion in the regressions of a large array of observable mother, newborn, pregnancy and time-varying local characteristics, as well as to area (i.e., municipality or neighborhood of Fortaleza) specific time trends, which subsume differential trends in outcomes across areas with different homicide rates. These checks tend to rule out that our results are driven by underlying changes in local economic or other conditions that simultaneously lead to a rise in violence and a deterioration in birth outcomes.

Importantly, we find that both socio-economic and biological factors, such as mothers' low levels of education and previous stillbirths appear to magnify the adverse consequences of violence on birth outcomes, implying that mother's high socio-economic status acts as a buffer to the effects of violence on birth outcomes and that violence compounds the disadvantage that low SES newborns already suffer.

The rest of the paper proceeds as follows. In Section 2 we discuss the literature on early life health and previous work in economics on maternal stress and birth outcomes. In Section 3 we provide information on the data used in the rest of the paper. Section 4 introduces the methodology. Section 5 presents the results of the empirical exercise while Section 6 concludes.

## 2. Maternal stress, violence and birth outcomes

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. Low-birthweight and premature infants display a greater risk of neonatal or infant death and are more likely to

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