UNIVERSIDADE FEDERAL DO RIO DE JANEIRO
INSTITUTO DE ECONOMIA
PROGRAMA DE PÓS-GRADUAÇÃO EM ECONOMIA

PRENATAL EXPOSURE TO VIOLENCE: THE IMPACT OF GUN FIGHTS ON BIRTH OUTCOMES

MARIANA STUSSI NEVES

RIO DE JANEIRO
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Dissertação apresentada ao Curso de do Programa de Pós-Graduação em Economia do da Universidade Federal do Rio de Janeiro, como requisito parcial à obtenção do título de mestre em Economia.

Orientador:
Prof. Ph.D. Eduardo Pontual Ribeiro

Coorientadora:
Profa. Ph.D. Cecilia Machado

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2021

FICHA CATALOGRÁFICA

N518 Neves, Mariana Stussi.
Prenatal exposure to violence: the impact of gun fights on birth outcomes / Mariana Stussi Neves. – 2021.
53 f.; 31 cm.

Orientador: Eduardo Pontual Ribeiro.
Coorientadora: Cecilia Machado.
Dissertação (mestrado) – Universidade Federal do Rio de Janeiro, Instituto de Economia, Programa de Pós-Graduação em Economia da Indústria e da Tecnologia, 2021.
Bibliografia: f. 47-48.

1. Favelas. 2. Violência. 3. Conflitos armados. 4. Peso ao nascer. I. Ribeiro, Eduardo Pontual, orient. II. Machado, Cecilia, coorient. III. Universidade Federal do Rio de Janeiro. Instituto de Economia. IV. Título.

CDD 307.3364

Ficha catalográfica elaborada pela bibliotecária: Luiza Hiromi Arao CRB/7 – 6787
Biblioteca Eugênio Gudin/CCJE/UFRJ

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Aprovada em:

BANCA EXAMINADORA

Prof. Ph.D. Eduardo Pontual Ribeiro (Orientador)
Universidade Federal do Rio de Janeiro - UFRJ

Profa. Ph.D. Cecilia Machado (Coorientadora)
Fundação Getúlio Vargas - FGV

Prof. Dr. Romero Rocha
Universidade Federal do Rio de Janeiro - UFRJ

Prof. Dr. Rudi Rocha
Fundação Getúlio Vargas - FGV

AGRADECIMENTOS

Aos meus pais, por terem criado as condições necessárias para que eu chegasse até aqui, materiais e emocionais. Por sempre terem incentivado o caminho dos estudos, trabalho e conhecimento, com uma mão gentil que acolhe nos tropeços e comemora nas vitórias.

À minha irmã, que sempre caminhou na frente com a lanterna me apontando as várias estradas possíveis.

Aos meus professores orientadores, Eduardo e Cecilia, por apontarem sempre o norte e por suas contribuições valiosas a este trabalho. Eduardo, obrigada pela clareza nas explicações e confiança no meu trabalho. Cecilia, obrigada pelo acompanhamento próximo, sempre cuidadoso e pela inspiração. Sou muito grata pela generosidade de ambos e por seus aconselhamentos imprescindíveis nos últimos meses.

Agradeço aos membros da banca por aceitarem o convite e por seus pareceres construtivos. Aos professores da UFRJ, em especial Pedro e Romero, por alimentarem o gosto pela pesquisa e por terem incentivado este trabalho enquanto ele ainda era apenas um embrião.

Aos meus amigos pelo apoio encorajamento ao longo dos anos. Um agradecimento especial à Duda Perpétuo, que esteve presente em todas as etapas do mestrado. A Isabela e Julio, que mesmo à distância estiveram perto, me acolhendo e me mantendo calma.

A pessoas incríveis que encontrei no percurso, que me ajudaram e acreditaram em mim, em especial Laísa e Nando.

À Alexandra Elbakyan, por fornecer as chaves onde o acesso à ciência permanece trancado.

A todas as mulheres que batalharam antes de mim e permitiram que eu e outras tantas mulheres também pudéssemos seguir o rumo da academia.

Agradeço também à CAPES pelo apoio financeiro ao longo do mestrado. Finalmente, sou grata ao Disque Denúncia e à Secretaria Municipal de Saúde do Rio que me forneceram os dados necessários para a realização desta pesquisa.

"As crianças ricas brincam nos jardins com seus brinquedos predileto. E as crianças pobres acompanham as mães a pedirem esmolas pelas ruas. Que desigualdades trágicas e que brincadeiras do destino." - Carolina Maria de Jesus, 1960

"There are naive questions, tedious questions, il-phrased questions, questions put after inadequate self-criticism. But every question is a cry to understand the world. There is no such thing as a dumb question." - Carl Sagan, 1995

RESUMO

Este artigo examina os efeitos da exposição intrauterina a conflitos armados em favelas do Rio de Janeiro nos resultados ao nascer. Usando dados restritos de endereços de residência materna, sou capaz de ligar o local de ocorrência dos conflitos ao local de residência das mães e mapear a um nível geográfico refinado mães que foram expostas aos conflitos durante a gestação e mães que não foram. Assim, eu exploro variações no tempo e espaço nos dados de violência e nascimentos. Eu encontro recém-nascidos que sofrem exposição intrauterina a tiroteios em um raio de 500 metros da residência da mãe pesam 6,9 a 12,1 gramas menos, em média, e têm maior probabilidade de nascer com baixo peso e de serem pequenos para a idade gestacional. Esses efeitos concentram-se no segundo e terceiro trimestres da gravidez. Os resultados sugerem que o mecanismo por trás desses efeitos é uma diminuição no número de consultas pré-natais.

Palavras-chave: Favelas, Violência, Conflitos Armados, Resultados ao Nascer.

ABSTRACT

This paper examines the effects of intrauterine exposure to armed conflicts in Rio de Janeiro's favelas on birth outcomes. Using restricted data with information on maternal residential addresses, I am able to link the place of occurrence of conflicts to the mothers' residency and identify at fine-grained level mothers who were exposed to conflicts during pregnancy and mothers who were not. I explore variations in time and space in the violence and birth data. I find that newborns who are exposed to shootings while in utero at a 500-meter radius from the mother's residence weigh 6.9 to 12.1 grams less, on average, and have an increased probability of low birth weight and of being small for their gestational age. These effects are concentrated in the second and third trimesters of pregnancy. The results suggest that the mechanism behind these effects is a decrease in the number of prenatal visits,

Keywords: Slum, Violence, Gun Conflicts, Birth Outcomes.

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1 INTRODUCTION

Every year, violence in Rio de Janeiro significantly affects the lives of its citizens, who live with surrounding conflicts. In 2019 alone, more than 4,000 shootings were recorded in the city[1]. It is known that gun violence has direct effects on the well-being of the population, often taking lives and interrupting the operation of daycare centers, schools, health clinics and local businesses, impeding the habitual routine of residents in the most affected regions.

There is evidence that armed conflicts between gangs in the favelas of Rio de Janeiro lower the school performance of students in the years when they are exposed to this type of violence Monteiro e Rocha (2017). The mechanism by which the drop in school results occurs is mainly through school supply since schools experience an increase in teacher abstentions and turnover of principals, as well as the temporary closure of school units in the presence of conflicts.

If the interruption of school activities affects student achievements, it is likely that the same will happen to health outcomes. In the event of intense conflicts in the surroundings, health clinics often close,[2] the community health agents activities are interrupted and the movement of residents is restricted in the neighborhood. The NGO Fogo Cruzado estimated that in 2020 there were 1,556 shots by firearms in a radius of up to 300 meters from public and private health units in the Metropolitan Region of Rio, which translates into 1,742 affected units, or 42% of the total units.[3] But how far do the effects of urban violence go regarding the health of the population? In particular, what are the effects of intrauterine exposure to intense gun conflicts on the health of newborns?

Evidence of intense violent events points to worse health outcomes for babies born to pregnancies that were exposed to these violent situations. Mansour e Rees (2012) showed that during the Al-Aqsa Intifada in Palestine, exposure to fatalities associated with conflict during pregnancy increases the likelihood of low birth weight. Minoiu e Shemyakina (2014) find negative effects on the health of children who were exposed inside the womb and grew up in the most affected regions during the Civil War in Côte d'Ivoire. Camacho (2008)

1 Source: Fogo Cruzado, 2020

2 Clínicas da família fecham as portas por causa da violência no RJ. G1, 11/07/2017. Disponível em: <https://g1.globo.com/rio-de-janeiro/noticia/clinicas-da-familia-fecham-as-portas-por-causa-da-violencia-no-rj.ghtml>. Accessed on: 18/09/2020.

3 https://fogocruzado.org.br/wp-content/uploads/2021/01/Fogo_Cruzado_RIO_RelatorioAnual2020.pdf

exploits the randomness of the landmine explosions as a quasi-experimental approach and found a significant decrease in the birth weight of babies experiencing stress due to terrorist attacks in utero.

Although these results are important findings, they stem from extraordinary events with a rare and extreme nature, making them hard to generalize. Other studies are concerned with assessing whether other situations of violence, found more frequently in day-to-day life, may also have negative implications for the health of newborns. This is the case of urban and domestic violence. Aizer (2011) has estimated a negative and causal relationship between domestic violence during pregnancy and newborn health by exploiting variation in the enforcement of laws. In particular, experiencing severe violence during pregnancy reduces birth weight by 163 grams, with a larger effect for the early months of the pregnancy. Currie *et al.* (2018) have also found costs associated with assault exposure while in-utero. The authors provide evidence that violence during pregnancy leads to increased rates of very low birth weight and decreased health after birth (low 1-minute Apgar scores).

Local evidence also points to greater risks of low birth weight and preterm birth related to prenatal exposure to urban violence. Koppensteiner e Manacorda (2016) estimate this effect by using municipal homicide rates in Brazil as a measure for violence, and find a negative effect on birth weight and gestational length. The authors also conduct a case study for the city of Fortaleza, where they are able to carry out the analysis at the neighborhood level, finding smaller effects. Lautharte (2021) exploits 'quasi-random' shocks in the dates of the pacification policy (UPPs) in the favelas of Rio to look at birth outcomes. The author finds evidence that in-utero exposure to pacifications improves birth weight relative to pregnancies living in the same street but giving birth weeks before police's arrival.

The present study aims to corroborate the evidence of urban violence on birth outcomes by studying the effects of armed conflict on newborn health in the city of Rio de Janeiro. Considering Brazil is among the countries with the highest levels of inequality, studying the effects of violence while in-utero on newborn health is essential to understand the underlying roots of inequality. Once low infant health may have long-term outcomes, and there is increasing evidence of intergenerational transmission of poor infant health at birth (ALMOND; CURRIE, 2011; CURRIE, 2011; AIZER; CURRIE, 2014), understanding the negative externalities on newborn health associated with armed conflicts provides new evidence for policymakers.

I contribute to the literature on violence and health at birth while exploring spatial and time variation in both birth data and violence data. Similar to Currie *et al.* (2018), I create a unique data set linking restrictive identified administrative data from Rio de Janeiro's birth records with information on maternal residential addresses, merged to a restricted data set of reports of gun conflicts between gangs with information on the location and dates of the reported shootings. By using reports of conflicts, I am able to track when and where the conflicts happen at an exceptionally fine-grained level. Official crime data does not keep records of these events, instead, they have data only on homicides, which is a noisy outcome of the shootings.

I focus on mothers who reside in favelas, as they are the places in the city where these conflicts happen the most. I estimate which pregnant women were exposed to violent conflicts by calculating the distance between the mother's residence and the shootings and cross the report dates with the estimated pregnancy period. I use several distances as assignment rules to test different exposition radii and check whether exposition during any particular trimester of pregnancy is key. Following Monteiro e Rocha (2017), the identification strategy relies on exploiting the variation in armed conflicts that occurs across time and space when gangs battle over territories.

By using data with the mother's precise residence location and records with fine-grained level information on the location and time of the conflicts, I am able to identify the effect of exposure to violence on birth outcomes. The richness of the data also allows me to control for a set of maternal characteristics, and test if violence has an impact on the number of prenatal appointments held. I find that newborns who were exposed to gun shootings during pregnancy weigh on average 10 to 12 grams less than babies who are not, a 0.4% decrease in the average birth weight. This effect is concentrated on the exposure during the second and third trimesters of pregnancy. Although this effect does not hold for the within-favela estimates, I find an increase in the probability of low birth weight (< 2500 g) of around 0.6-0.7 percentage points for mothers exposed to conflicts in the second trimester of pregnancy (a 7% increase). This is very similar in magnitude to the reported by Koppensteiner e Manacorda (2016) on the effects of the increase of one extra homicide in the probability of low birth weight in small municipalities, except the authors found this effect for the first trimester of pregnancy. I also find that exposure in the second trimester of pregnancy reduces the number of prenatal visits made.

The remainder of this paper is organized as follows. Section 2 provides a theoretical framework, Section 3 displays the institutional background, Section 4 describes the data, Section 5 presents the empirical design, and Section 6 the results, Section 7 concludes.

2 THEORETICAL FRAMEWORK

Why does intrauterine exposure to violence potentially worsen birth weight and increase the likelihood of preterm births? There are two possible channels through which these outcomes can take place.

The existing literature that investigates the determinants of low birth weight argues that elevated levels of stress and anxiety in the early months of pregnancy restrict the amount of oxygen and nutrients consumed by the fetus, and increase the likelihood of low weight (KRAMER, 1987; WADHWA *et al.*, 1993). In this sense, the underlying hypothesis of the studies that justify low weight as a causal effect of intrauterine exposure to violence is that it increases the stress levels of the pregnant woman and affects the fetus through the biological mechanism.

However, there is little consensus regarding the trimester of pregnancy for which this effect may occur: Kramer (1987) and Wadhwa *et al.* (1993) state that the effect of the elevated stress levels are concentrated in the first trimester of pregnancy, and Aizer (2011) and Koppensteiner e Manacorda (2016) have found low birth weight associated with violence in the early months of pregnancy. On the other hand, some (MANSOUR; REES, 2012; LAUTHARTE, 2021; CAMACHO, 2008; CURRIE *et al.*, 2018) have found that intrauterine exposure to violence effects on birth outcomes are concentrated in the third trimester of pregnancy.

A second channel through which violence could affect birth outcomes is by influencing prenatal health care. This potential mechanism could act either through the supply side, by depressing the number of health services available to pregnant women, as armed conflicts often interrupt the activities of health professionals; or through the demand side, by reducing the demand for prenatal care by pregnant women in violent areas, as they are more likely to stay at home when the conflicts take place. The estimations raised by Fogo Cruzado (2020) that 42% of the total heath units are located in less than 300 meters away from gun shootings reports is of great concern, since services such as prenatal health care and puerperium are offered in the public health system at Family Clinics. It is likely that the functioning of these units is affected by violence, and that there are negative consequences for professionals that work there as well as for the provision of services offered. Lautharte (2021) looks at the effect of the pacification of the favelas in Rio de Janeiro on birth outcomes, and investigates what happens to the supply and demand of health care services and prenatal care after the pacification program. He finds that the number of prenatal visits increases after the pacification, while the supply of health services does not increase, suggesting that the effect on birth outcomes happened through the demand channel.

3 BACKGROUND

3.1 Gun Conflicts

Violence due to drug trafficking in Rio de Janeiro dates back to the '70s, but it was in the '80s that the largest criminal gangs organized themselves and started disputing drug sales points. Cocaine's near-instantaneous profitability restructured the drug trade in terms of scale and organization in the 1980s Dowdney (2003), and the trade experienced a period of rapid expansion. To pursue economic goals and ensure dominance, the use of violence was accepted as a viable tool, and organized groups began to arm themselves heavily to dispute areas controlled by rival factions and expand their markets.

The Comando Vermelho (CV) was the first criminal faction organized in Rio de Janeiro, in 1979, but it was unable to gain local hegemony, as it was always involved in internal conflicts and with rival groups, such as the Terceiro Comando Puro (TCP) and Amigo dos Amigos (ADA) (MARINHO *et al.*, 2019). Disputes over drug sales points between factions led to a rapid process of acquisition of heavy weaponry, such as grenades, machine guns, and rifles, so that the clashes acquired bloodier shades and their consequences spilled over into the homicide rates. The tendency to move large amounts of money through the drug trafficking business has boosted the illegal trade in weapons, which little by little were dumped into an expanding market. Thus, the organization of heavily armed groups aimed at the illegal drug trade, combined with the consequent growth of the illegal arms trade, has significantly altered the dynamics of violence in Rio de Janeiro (CANO *et al.*, 2004).

Gang warfare is an extremely evident type of violence associated with drug trafficking. In Brazil, in 1991, more than half of homicides were associated with drug trafficking (ZALUAR, 1999). The lowest-ranking and consequently the youngest members of gangs are generally those most at risk of life (WINTON, 2004). Dowdney (2003) suggests that children in situations involved in drug trafficking in Rio de Janeiro are worse off than children in situations of political conflict, both because they are less visible and because they face higher mortality rates. The comparison with the Israel-Palestine conflict is striking: while 467 minors died as a consequence of armed violence between 1987 and 2001 in the East, 3,937 youths were killed as a result of small arms injuries during that same period in the State of Rio de Janeiro alone.

In the 2000s, the media drew attention to the rise of another paramilitary group in organized crime, the militias. Militias are commonly identified as the illegal face of the State (MARINHO *et al.*, 2019), as they are normally formed by public security agents who are out of service or active, who act under the allegation of fighting drug trafficking in precarious areas with little supply of public services, extorting vulnerable populations in exchange for supposed security. The logic of militias is comparable to that of the so-called "extermination groups", which act through the use of force, summary execution of anyone who opposes their business and establishing territorial limits.

More recently, the conflict dynamics in the city have undergone significant changes. In November 2008, the government of Rio de Janeiro launched the Pacifying Police Units (UPPs) program which sought to combine ostensible permanent policing with social actions in communities, favelas, and areas most affected by violence in Rio. Since its inception, the program has "pacified" more than 100 favelas through the establishment of 38 pacifying bases, including some of the largest favelas from the city, such as Rocinha, Complexo do Alemão, and Cidade de Deus. Initially, the program showed promising results, with the violent lethality rate (which includes the number of murders and robberies followed by death, for example) falling from 361 in 2007 to its lowest level in 2013, with 76 cases of violent death.[1]

However, over the years the program has gone through de-characterizations and budget cuts, and the rates of violence have increased again. In 2017, the Atlas of Violence pointed out that the homicide rates in the state of Rio de Janeiro returned to pre-UPP levels, that is, 40 per 100,000 inhabitants.[2] The program was criticized due to allegations of corruption and police abuse, which contributed to the general population's lack of confidence in the police. Some specialists point out that the UPPs resulted in a simple police occupation of territories, and in many cases in the continuation of a policy of confrontation, with police being sent to the front lines of a conflict "to kill and be kille".[3]

In fact, a survey carried out in partnership between UOL and *Fogo Cruzado* shows that between 2016 and 2019 there were 2,959 shootings with the presence of security

[1] https://noticias.uol.com.br/cotidiano/ultimas-noticias/2017/01/06/upp-fracassou-porque-so-ela-nao-basta-diz-ex-sub-d htm Accessed on: 22/06/2021

[2] https://extra.globo.com/noticias/brasil/atlas-da-violencia-em-uma-decada-taxa-de-homicidios-do-rio-volta-ao-nivel-pre html Accessed on: 22/06/2021

[3] https://brasil.elpais.com/brasil/2018/03/11/politica/1520769227_645322.html Accessed on: 22/06/2021

agents in the city of Rio[4]. This reveals that the police is an important actor in the scene of armed conflicts in the city, and police operations are often the trigger of these conflicts, contributing to the high number of deaths. In May 2021, a Civil Police operation against drug trafficking left 25 casualties, which stimulated public debate on the state's involvement in these conflicts.[5]

Understanding the causes of conflicts between drug gangs is a tricky task. Monteiro e Rocha (2017) gathered qualitative evidence from various sources in an attempt to make its determinants less hazy. They found evidence supporting the view that drug battles are not strategically planned and often respond to idiosyncratic triggers, influenced by betrayals, revenge, assassinations, and the release (or imprisonment) of an important gang leader, motives with a considerable degree of subjectivity.

The consequences of the conflicts, on the other hand, are more evident. According to the NGO Fogo Cruzado, in 2020 alone, 313 people died among the 413 injured in gun conflicts. The people most affected by gun violence, however, have a clear profile: among the city's 1134 homicide victims in 2019, 83% were male, at least 60% were black or brown, and 53% of the victims with known age were less than 30 years old[6]. Magaloni *et al.* (2015) provide further evidence on this matter, showing that lethal violence predominantly affects young black men living in the favelas. They estimate that between 2002 and 2012, 93% of the victims were young men. A survey carried out by Datafolha and the Fórum Brasileiro de Segurança Pública in 2018 show that the conflicts also have an impact on the psychological well-being of the general population, with more severe effects for favela residents.[7] While 92% of the overall population is afraid of being caught in a crossfire or being a victim of stray bullets, 37% of favela residents report having actually been caught in a crossfire against 26% of favela non-residents.

The spatial dynamics of violence also point to the poorest strata of the population: lethal violence is higher in the favelas and other low-income areas (ibid.). Monteiro e Rocha (2017) raise data from the NGO Disque Denúncia and report that around 92% of the drug battles that happened between 2003 and 2009 took place on favelas. *Fogo*

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[4] https://noticias.uol.com.br/reportagens-especiais/com-milicia-em-expansao-confrontos-policiais-no-rio-miram-trafico-e- #cover Accessed on: 22/06/2021

[5] https://g1.globo.com/rj/rio-de-janeiro/noticia/2021/05/06/tiroteio-deixa-feridos-no-jacarezinho.ghtml Accessed on: 22/06/2021

[6] Source: Instituto de Segurança Pública (ISP)

[7] https://www1.folha.uol.com.br/cotidiano/2018/04/no-rio-negro-e-morador-de-favela-tem-mais-medo-da-policia-diz-dat shtml

Cruzado's 2020 annual report[8] shows that among the top neighborhoods affected by the armed violence, three are favelas or housing sets (Vila Kennedy, Cidade de Deus and Complexo do Alemão). Even if most of the conflicts are concentrated in the favelas, it is worthy to stress that not all of them are constantly under dispute or controlled by drug gangs.

3.2 Rio's Favelas

Rio's favelas comprise 23% of the city's total resident population, or 1,443 thousand inhabitants (IPP, 2010 Census data). Favelas are defined by the municipal government as "predominantly residential areas, characterized by clandestine and low-income occupations, the precariousness of urban infrastructure and public services, narrow roads and irregular alignment, absence of formal installments and unlicensed property and construction bonds, in disagreement with the current legal standards" (IPP, 2012b).

While the 1,018 favelas[9] in Rio are categorized under the same label, they can differ greatly in terms of size and degree of urbanization. Although they typically have low-income rates, they don't always house the worst social situations and are not the exclusive habitat of the poor population (CAVALLIERI, 2009). Access to electricity, water, and garbage collection is nearly universal, but other services such as sanitation and paving are still in need of improvement.

[8] https://fogocruzado.org.br/wp-content/uploads/2021/01/Fogo_Cruzado_RIO_RelatorioAnual2020.pdf. Accessed on 22/06/2021

[9] Source: Instituto Municipal Pereira Passos, 2021

4 DATA

In order to explore spatial and time variations in violence in the municipality of Rio de Janeiro, I use information that identifies precisely the date and place in which the armed conflicts happened. To link the data from the shootings to the exposure of pregnant women to them, I obtained detailed panel data on births and the mother's place of residence as a proxy for the exposure area, as well as the date of birth and the main variables of interest, birth weight and gestation length. Thus, for the present work, I used two main data sets, one referring to armed conflict events, provided by the hotline *Disque Denúncia* (DD), and another from the *Sistema de Informações sobre Nascidos Vivos* (SINASC), which contains administrative data from the Brazilian Ministry of Health.

4.1 Data on Armed Conflicts

Following Monteiro e Rocha (2017), I use Disque Denuncia's reports of conflicts between drug gangs as a measure of armed violence. Official crime data, provided by Instituto de Segurança Pública (ISP) is not available at a sufficiently fine-grained level, since it records information aggregated by police stations, whose coverage areas encompass multiple neighborhoods and are unevenly distributed across space.

The *Disque Denuncia* is an NGO founded in 1995 and operates as a service center for the civilian population that works in partnership with the Rio de Janeiro State Security Secretariat. The DD receives the reports through anonymous calls and records them, then passes them on to the competent authorities. It is open 24 hours a day, 7 days a week, and its phone number is widely disseminated throughout the city.

The reports are recorded in a database containing the date, place, and description of the event, which are categorized by type of occurrence by the entity itself. The DD yielded all the reports mentioning shootings between gangs that happened between 2007 and 2017 in the city of Rio de Janeiro.

Shootings between gangs regard gunfights that occurred between drug factions. Gunfights triggered by police operations are not considered in these reports, although some mention police interference. For this reason, this measure of violence should be interpreted with caution, since it does not encompass all armed conflicts that happened in the city. Nevertheless, it captures violent events that threaten the well-being of the population and is a broader measure of everyday violence than homicide rates, which only capture when there are fatalities.

Since the reports are made by unidentified callers and filed by the DD, some mistakes might occur in the recording process. To reduce noise, I read all of the reports filed in and manually coded them for accuracy. I discarded all the reports that did not mention explicitly that an armed conflict happened, which accounts for 8.5% of the total amount of 3,871 reports in the mentioned period. This procedure is described in detail in the Appendix.

All of the remaining reports were geocoded using the addresses described in the reports. Since most reports do not contain a street number reference, shootings were geocoded at the street level. It is important to notice that there is some noise at this step, since geocoding tools can have a hard time pinpointing precisely favela streets, which are where most of the conflicts take place. Although getting the exact location of conflicts is a difficult task, it is possible to have an idea of the approximate location of where conflicts occurred with a reasonable degree of certainty. In spite of the limited information, 99.6 % of the reports addresses were found by the geocoding tool.

Table 1 presents summary statistics of the reported conflicts. The yearly average of reports is 331 conflicts per year, and the average number of days with reports is 162. There are fewer days with reports because sometimes people call to report the same event more than once, or there are conflicts happening on the same day in different locations. The number of reports fell substantially in the last years of the sample. However, there are reported gunfights in most of the year's weeks, as shown in column 4. This can also be verified in Figure 1, which presents the number of days with reported conflicts by month for all years in the sample. Throughout the months, there is high variability in the number of days with reported conflicts, with all months reporting at least one conflict. The last column of Table 1 shows the number of affected neighborhoods. Most neighborhoods are affected in the first years of the sample, with a downward trend in the last years of the sample.

Figure 2 plots the density of the hours that the reports were registered. The figure shows that most of the reports happened in the afternoon and at night, peaking at 8 p.m. If all of the reports had happened during business hours, one could argue that using the mother's residence as a measure of proximity to the conflicts would not be an adequate measure, as they could potentially be out of home, working, or running errands. However, the figure shows that a lot of the conflicts occur at night hours when people are generally at home.

Table 2 shows the number of reports that fall in the favelas or close to its borders, and the number of favelas exposed to the gunfights on Panel A. When plotting the reports on the map along with favelas, only 22% of the reports fall within favela boundaries. However, when performing a sensibility exercise, 78% of them fall within a radius of 250 meters of a favela border. By increasing this radius progressively, the number of reports falling within 500 meters from a favela border raises up to 92%. This is in line with the evidence that most gang conflicts take place in or near favelas.

Not all favelas experience conflicts. Considering only shootings that fall within favela limits, only 13% of the favelas are exposed. The share of exposed favelas goes up to 67% if a buffer of 500 meters from the favela boundaries is considered. Nonetheless, this share is subject to double-counting, because the same event might fall in a range of 500 meters for more than one favela if the favelas are close to each other.

Figures 3 and 4 plot the reported conflicts spatial distribution and the reported conflicts density map, respectively. The figures reveal there are reported gunfights all over the city but they are more concentrated in certain areas of the city.

4.2 Data on Births

In order to determine the impact of violence on birth outcomes, I use restricted administrative data from the Brazilian Ministry of Health. The *Sistema de Informação de Nascidos Vivos* (SINASC) contains records of all births in Rio de Janeiro between 2007 and 2017. It provides information on birth weight, gestational length, health quality of the newborn, number of prenatal visits, type of birth, the mother's characteristics such as age, education, and occupation, and residence zip codes and address.

Since most conflicts occur in the favelas, I restrict the sample to mothers residing in favelas only. As there are favelas very close to wealthy neighborhoods and the geocoding of the reports is somewhat noisy, restricting the sample to women living in favelas is a way to circumvent the possible lack of accuracy of the measure of exposure to violence. In doing so, we are excluding mothers who live in wealthy neighborhoods with nearby favelas, who would potentially be treated as exposed to conflicts if the linear distance was considered. Although these women may be located close to the shooting sites, and in some cases even hear them, I consider that the effects of violence for these women are essentially different from the effects for women residing in places where the conflicts have actively taken place.

I have geocoded all births that happened in Rio de Janeiro in this period using the mother's residence addresses, including street numbers. I was able to find 874,886 or 93.1% of the total of 939,812 births. Some of the births could not be geocoded due to missingness of data or inaccuracy in filling out the address. Out of the geocoded births, 201,702 (23%) were in favelas, which is in agreement with the percentage of the population residing in favelas (IPP, 2010 Census data). Table 3 provides summary statistics for the births in the favelas sample.

Panel B of Table 2 shows the number of mothers who experienced gun conflicts during pregnancy at different distance radii to where the conflicts happened. At 250 meters from the mother's residence, 20,294 mothers were exposed to conflicts while pregnant. This represents 10% of the total of mothers residing in favelas. Bigger distances increase substantially the number of exposed pregnant women. At a 500-meter distance radius, there are 47,762 pregnant women exposed or 23% of the mothers who reside in favelas. On average, pregnant women in the favelas are exposed to between 0.22 and 0.68 gang conflicts during pregnancy.

4.3 Other Data Sources

To separate mothers who live in favelas from mothers who live in non-favela areas, I intersected the geocoded births with the favela polygons. Favela shapefiles with delimited borders come from Instituto Pereira Passos (IPP). I have also considered housing complex polygons from IPP as favela areas since many housing complexes are similar to favelas in terms of precariousness and violence. It is the case of Cidade de Deus and Vila Kennedy, for instance, the stage of many shootings (Fogo Cruzado, 2020). There are 1,018 favelas and 406 housing complexes, according to Instituto Pereira Passos (2019). Housing complexes that were contained in the favelas shapefile were excluded to avoid polygon overlapping and the remaining polygons were added to the favelas shapefile.

Favela income data comes from the IBGE 2010 Census, the most recent available data set with disaggregated information on income. I use the average household income of the person responsible as a proxy for the favela's sociodemographic characteristics. I calculated the average income of the favelas by averaging the income of the census tracts that were contained in a certain favela weighted by the share of the area that these census tracts cover in that favela.

5 EMPIRICAL DESIGN

Building the measure of exposure to violence. To determine if a mother was exposed to gunfights while pregnant, I calculate the linear distance of the mother's residences to the geocoded reports. I use several thresholds of distance in meters to create different measures of exposure to violence.

Only the births in which close shootings took place during the gestational period are considered to be exposed to violence. Since I do not have exact conception dates, estimating the gestational period involves first estimating the conception dates. Thus, I estimate the approximate conception date by subtracting the actual number of gestational weeks from the birth date. Before 2011, however, SINASC only reported gestational duration in six categories of week intervals. Thus, to calculate the conception date for the years prior to 2011, I consider the duration of gestation as the median of weeks of each week interval category for the years after 2011, when I have the information reported in both ways, that is, in gestation weeks and in gestation week categories.

With the estimated conception dates, I am able to have the approximate gestation interval for each birth. However, the literature points out that intrauterine exposure to violence can affect the duration of pregnancy, so this variable can be endogenous. In this sense, in longer pregnancies, there is more time for the woman to be exposed to armed conflicts while pregnant. (LAUTHARTE, 2021) and (CURRIE *et al.*, 2018) use the expected pregnancy (with the expected date of birth) instead of the actual pregnancy to circumvent this endogeneity problem. Therefore, I define the gestation interval using the expected birth date of a full gestation, adding 39 weeks to the estimated conception date.

Panel B of 2 displays the number of exposed mothers during pregnancy for different distance thresholds. In my most conservative measure, I find that 20,294 (10%) mothers were exposed to conflicts during pregnancy. For the distance of 250 meters, the mean of reports per mother is 0.22. On the greatest measure of distance, 500 meters, I find that 47,762 mothers were exposed to conflict while pregnant, or 23.7% of the mothers residing in favelas. The average number of reports per pregnancy in this group is 0.68.

Empirical Model. In order to estimate the causal impact of gun conflicts on birth outcomes, I follow the literature that exploits spacial and time variations in exposure to violence during pregnancy, discussed on Section 1, and estimate the following equation:

$$y_{ist} = \alpha + \beta GC_{ist} + \sigma X_{it} + \delta_y + \phi_m + \gamma_f + \varepsilon_{ist} \tag{5.1}$$

Where y_{ist} represents the outcome of interest, *i.e.*, birth outcomes, for the individual i on day of birth t and location s, the mother's residence. The analyzed birth outcomes are birth weight measured in grams at the time of birth, low birth weight (< 2500g), preterm births (less than 37 weeks of gestation), and a small for gestational age (SGA) indicator[1]. The coefficient of interest is β, which captures the impact of exposure to gun conflicts during pregnancy, measured by the dummy variable gun conflict (GC) that is defined as follows:

$$GC_{ist} = \begin{cases} 1 & \text{if } \sum 1\{D_s < B\}\vartheta_{(t-gw,t)s} \geq n \\ 0, & \text{otherwise.} \end{cases} \tag{5.2}$$

Where the term $1\{D_s < B\}$ is a function that indicates whether the distance D_s between the mother's residence location s and the reported conflict is smaller than B meters. ϑ_t represents the number of reported conflicts that happened between the date of birth t and the estimated date of conception $t - gw$, which is calculated by subtracting the number of gestational weeks gw from the date of birth t. This interval is the total period in which the fetus could have been exposed to armed conflicts while in utero.

For example, if the mother was pregnant from January (approximate date of conception) to October (date of birth) of a certain year, and there was a report of a conflict that happened during this period within B meters from that mother's residence location s, I consider that this pregnancy was exposed to violence.

One of the difficulties emerging from this identification strategy is that violence experienced in certain areas might be correlated to nonobservable characteristics that are also likely to be correlated both with birth health outcomes and violence. For instance, some favelas that are poorer might experience higher rates of gun conflicts, and children

[1] The SGA indicator was built following the international standards for newborn weight, length, and head circumference by gestational age and sex guidelines villar2014international. I am grateful to Marina Palma for providing the table with SGA values.

born in these areas are also more likely to have negative birth outcomes due to lower socioeconomic characteristics, instead of due to exposure to violent conflicts while in utero. If in this scenario violence was observed and socioeconomic characteristics were not, causality could be wrongly assigned to violence and not to socioeconomic characteristics.

To deal with this problem, I control for time-invariant favela characteristics by including favela γ_f fixed effects, and a set of controls for mother's socioeconomic characteristics X_{it}, like schooling, race and age. Following (CURRIE; SCHWANDT, 2013), I also include conception month ϕ_m and year δ_y fixed effects (rather than birth month and year) in the specification to control for annual trends and seasonality.

In line with the literature presented in Section 1, which points out that exposure to violence can have different results depending on which stage the pregnancy is at, I divide the dummy variable into three time intervals, one for each trimester of pregnancy. Therefore, Equation 1 becomes:

$$y_{ist} = \alpha + \beta_1 GC_{ist}^{T1} + \beta_2 GC_{ist}^{T2} + \beta_3 GC_{ist}^{T3} + \sigma X_{it} + \delta_y + \phi_m + \gamma_f + \varepsilon_{ist} \tag{5.3}$$

Where $T1$, $T2$ and $T3$ in the GC dummies index each of the different trimesters of pregnancy. Table 4 presents the distribution of the exposure to gun conflicts in different trimesters of pregnancy, considering a 500-meter buffer. Column 1 shows the number of births exposed in each of the different trimester combinations. Columns 2, 3, and 4 show how much of the combination represents over the total exposures for each particular trimester alone. Column 5 shows the share of each trimester exposure combination over the total of exposures during pregnancy. Each of the trimesters of pregnancy alone has a similar number of exposed births, around 20 thousand. A total of 153,938 births do not experience gun conflicts while in utero. Surprisingly, most pregnant women (68%) are only exposed to conflicts in only one of the trimesters. Around 25% of the exposed women experience conflicts in at least two trimesters of pregnancy and the remaining 7% experience them in all trimesters. This suggests that there is a high probability of experiencing gun conflicts in more than one trimester of pregnancy. When interpreting trimesters coefficients, one should be aware that they do not capture independent events.

6 RESULTS

6.1 Effects on birth weigth and other birth outcomes

Table 5 presents the estimates of armed conflicts on birth weight for different distance thresholds. Panel A shows the effects of intrauterine exposure to at least one gun conflict, and Panel B reports the impact of the exposure to one additional gun conflict during pregnancy. The first column presents the simplest specification, with year and month fixed effects. Column (2) includes favela income effects, that is, the favela's average household income, in order to capture confounding effects driven by observed differences in favela's socioeconomic characteristics. If favelas with lower income are more likely to experience gunfights, our estimates in column 1 could be capturing those effects instead. In column 3 I add controls for the maternal characteristics, the mothers' age, education, and color. Column 4 presents the full specification, described by Equation (1). It adds favelas fixed effects and presents the within-favela coefficients, controlling for unobserved heterogeneity, that is, favelas' characteristics that do not change over time. The variable of interest captures if the newborn has been exposed to at least one gun conflict during the mother's pregnancy, at a distance of $\boldsymbol{B}$ meters from the mother's residence, in Panel A, or the effect of being exposed to one additional conflict, in Panel B. Each row reports different distance thresholds $\boldsymbol{B}$, that is, if the intrauterine exposure to violence happened within a radius of $\boldsymbol{B}$ meters from the mother's residence.

Panel A shows there is a significant negative correlation between exposure to gun conflicts and birth weight, though this effect is only significant for all distance thresholds conditioned on month and year fixed effects (Column 1) and the favelas average income (Column 2). The point estimates remain stable when we move from Column 1 to Column 2 for all values of $\boldsymbol{B}$. They are slightly bigger in magnitude and become more significant when increasing the distance thresholds, being higher in absolute terms for $\boldsymbol{B} =$ 500 meters and significant at the 1% level. Adding mother controls make most coefficients lose significance, indicating that heterogeneity in maternal characteristics plays a small but significant role in the correlation between exposure to conflicts and birth weight. In this specification, the estimate for $\boldsymbol{B} = 500$ meters is the only estimate who remains significant at the 1% level. Results in columns 1 to 3 point to a weight reduction of between 6.9 and 12.1 grams, on average, for newborns who were exposed to shootings during gestation in comparison to those who were not.

Column 4 presents the within-favela estimates. None of the coefficients remain significant after controlling for favela fixed effects, and all of them shrink in terms of magnitude to 5 grams or less. This suggests that there is no significant negative relationship between being exposed to nearby conflicts during pregnancy and birth weight within favelas. This result should be interpreted with caution, though. While there are likely systematic differences across favelas, this specification is the most saturated of all specifications, considering the high number of favelas to be controlled for.

Taken altogether, results from Panel A point towards a negative and significant effect on the newborns' birth weight for mothers who were exposed to gun conflicts that happened between 300 and 500 meters from the mother's residence during pregnancy. The idea that conflicts that happened within a smaller radius impact less or have no effect on birth weight than conflicts that happened at bigger distances is counter-intuitive at first glance. Nonetheless, the discussion in Section 4.1 regarding the geocoding quality of the shooting reports data brings light into this matter while interpreting results from Table 5.

Considering that 92% of the shootings fall within a 500-meter range for the favela boundaries (Table 1), raising the distance threshold $\boldsymbol{B}$ increases the probability of correctly assigning the exposure variable to mothers who were actually close to where the shootings happened. The intuition behind this statement is that if the geocoding of the reports is not accurate enough, defining a very small radius may (mistakenly) consider mothers who were exposed to violence as mothers who were not exposed to violence, generating a bias in the opposite direction of the coefficient of interest. Defining a bigger threshold, therefore, is a way of dealing, to some extent, with potential measurement errors. Due to that, I stick with the 500 meters specification in the remainder of this paper and perform robustness checks with the 250-meter radius in the Appendix.

Panel B reports the same regressions changing the variable of interest. I regress birth weight on a variable that counts how many conflicts the mother was exposed to during pregnancy so that the coefficient now captures the effects of exposure to one additional gun conflict. Estimates are small and insignificant for all specifications except one, suggesting that increased exposure to an additional conflict does not make a difference in weight, but rather whether if the mother has been exposed or not.

Table 6 presents the effect of exposure to at least one gun conflict at a 500-meter radius during pregnancy on various birth outcomes. For each of the birth outcomes, I run two specifications, one with month and year fixed effects and controlling for the favelas' income, and another adding maternal characteristics and favela fixed effects (equivalent to columns 2 and 4 of Table 5). Panel A shows the estimates for exposure to conflicts during pregnancy as a whole, and Panel B shows estimates for exposure during the different trimesters of pregnancy, as presented in Equation (3).

The first result from Table 6, shown in Panel A, is that experiencing gun conflicts during pregnancy significantly worsens birth weight, which does not hold up in the within-favela estimates. This was already reported in Table 5. Panel B shows that the effects on weight are concentrated in the late stages of pregnancy, that is, the second and third trimesters, which is in conformity with the evidence found by Camacho (2008), Mansour e Rees (2012), Currie *et al.* (2018), Lautharte (2021).

A second finding from Table 6 is that in utero exposure to conflicts increases the probability of low birth weight - i.e., of birth weight less than 2,500 grams - by 0.0037, or 0.37pp. This translates into a 4% increase in the low birth weight incidence in pregnancies exposed to conflicts compared to the low birth weight average incidence in favelas. This effect occurs through exposure in the second trimester of pregnancy, which increases the probability of low birth weight by 0.0058 to 0.0067. The effect on the second trimester holds for within-favela estimates.

Intrauterine exposure to gang shootings during pregnancy also increases the probability of the newborn being born small for his or her gestational age by 0.0001 (columns 5 and 6). Although significant and present both across and within favelas, this effect is small and is not concentrated in any particular stage of the gestational period.

Columns 7 and 8 present the effects on the incidence of premature births. The first panel shows that experiencing conflicts during pregnancy increases the probability of prematurity by 0.30. Once again, the effect is not concentrated in any particular trimester, and the coefficient is not significant for the within-favela estimate.

These results fall more or less midway with the rest of the related literature. Mansour e Rees (2012) find that exposure to an additional fatality during the al-Aqsa Intifada reduces birth weight by only 2.1g and an increase in the probability of low birth weight by 0.19pp on the third trimester of pregnancy. Koppensteiner e Manacorda (2016), on the other hand, find a higher probability of 0.24 increased low birth weight for pregnancies exposed to one extra homicide in small municipalities in Brazil. Lautharte (2021) finds the highest estimates: newborns that experienced police pacifications in favelas in Rio while in-utero weight on average 32-42g more than those living on the same street but giving birth weeks before the police's arrival. The estimates here presented are more closely related to those found by Camacho (2008), who reports a significant decrease of 8.7g in birth weight for pregnancies exposed to landmine explosions.

The literature justifies small coefficients in violent places with the argument that endemic violence leads to smaller effects compared to extreme violent events, and big coefficients with the explanation that in places where violence is rare or clashes are permanent the effects are larger, as in the case of pacifications. One interpretation of the magnitude of the coefficients in Table 6 is that, while shootings are frequent in Rio, and favela residents might no longer consider this kind of violence rare, these events are still violent enough to cause significant adverse effects.

6.2 Prenatal visits

A possible explanation for why the above results are verified is that intense conflicts can reduce the number of prenatal visits made, as argued in Section 2. This mechanism can occur affecting both the supply or demand for these services. It could act through the supply side if shootings affect the provision and quality of health services. On the other hand, if mothers believe that it is unsafe to go outside in the presence of shootings, they might not seek prenatal healthcare or go out less often for the visits. However, it was not possible to separate the analysis between supply and demand in this study, as I am only able to look at the number of prenatal visits made.

Prenatal visits are reported in SINASC in the form of four categories: (1) zero appointments; (2) 1-3 appointments; (3) 4-6 appointments; and (4) 7 or more appointments. In Brazil, the Ministry of Health recommends that at least six appointments are carried out during gestation[1] (one in the first trimester of pregnancy, two in the second, and three in the third). I group the first two categories into a single one and reestimate the previous equations on the outcomes of the top and bottom prenatal visits categories. Therefore I have two mutually exclusive dummy variables indicating if the mother attended up to 3 prenatal appointments, and another indicating if the mother attended 7 or more

[1] Source: https://www.saude.go.gov.br/biblioteca/7637-pre-natal

appointments.

If the presence of conflicts during pregnancy has a negative impact on the number of prenatal visits made, either through a supply or demand shock, an increase in the probability of attending up to 3 visits, and a decrease in the probability of attending 7 or more visits would be expected. Table 10 exhibits the effects of being exposed to conflicts on the top and bottom categories of the number of prenatal visits made. Panel A shows estimates with no significant effects of exposure to gun conflicts during pregnancy on the number of prenatal visits attended. Panel B, however, shows a significant increase in the probability of attending up to 3 prenatal visits by 0.0031-0.0046 and a decrease in the probability of attending more than 7 prenatal visits by 0.0092-0.0095 if the mother was exposed to shootings on the second trimester of pregnancy. The estimates remain significant when controlling for the mothers' characteristics and favela fixed effects. The coefficients for the first and third trimesters of pregnancy are small and with no statistical significance.

6.3 Heterogeneous effects

Figure 7 presents the effects of exposure to gun conflicts at a 500m radius during pregnancy per quantile of birth weight, using the regression specification from Table 6 column (1). Quantile regressions show that intrauterine violence impacts birth weight significantly for all weight quantiles. Coefficients point to a reduction in weight ranging from around 10 grams to 15 grams, with stronger effects for quantiles below 0.3.

Table 8 shows impact coefficients, restricting the sample per maternal characteristic. Regressions are based on specifications from Table 6, for exposure during the whole pregnancy. Results show significant effects for non-white mothers, with an increased probability of low birth weight for this group of mothers both in the across and within-favela estimates. There are also significant effects in birth weight reduction for non-white mothers and mothers without primary education, although they do not hold for the within-favela estimates. There are no significant results for the group of mothers under 20 years old. However, estimates by maternal characteristics should be interpreted with caution, since statistical power is reduced in subgroups.

7 CONCLUDING REMARKS

This study provides evidence that armed conflicts affect negatively the birth outcomes of women who lived close to those conflicts during pregnancy. Previous evidence has shown that extremely violent events such as landmine explosions and exposure to fatalities during wars increased the likelihood of low birth weight. Other studies pointed out that domestic violence and urban violence also have negative implications on the health of newborns, extending the previous findings to violence experienced in day-to-day life. This study fits in the literature that assesses the effects of urban violence on birth outcomes. The previous analysis relied on crime rates at aggregate levels. I provide results based on a unique data set linking precise information on maternal residential addresses merged to reports of gun conflicts between drug gangs. I exploring spatial and temporal variation in the exposure to violence during pregnancy.

I find that newborns who are exposed to shootings at a 500-meter radius while in utero weigh 6.9 to 12.1 grams less, on average. These effects are concentrated in the second and third trimesters of pregnancy. Exposure to an additional conflict during pregnancy does not affect the birth weight. Intrauterine exposure to gun shootings increases the probability of low birth weight by 0.6 percentage points and the probability of being small for gestational age by 0.1 percentage points. Though more investigation is needed, there is evidence suggesting that the mechanism behind these effects is a decrease in the number of prenatal visits, through exposure to violence in the second trimester of pregnancy.

Finding small but significant results on birth outcomes shows that even in cities where violence is endemic, exposure to violence impacts health outcomes negatively even before birth. Furthermore, the estimates are likely to be conservative estimates of the effects of violence on birth outcomes for two reasons. First, I don't observe the effects on selection, that is, if violence affects the probability of abortion and miscarriage, I only observe the newborns who were actually born. Second, the conflict reports data is subject to under-reporting since it relies on people who call to make a report of a conflict and it does not encompass gunfights triggered by police operations, which represent a large fraction of gun shootings in the city (Fogo Cruzado, 2020). Finally, further research is required to better understand the mechanisms by which the effects reported here occur.

FIGURES

Figure 1 – Drug Gangs Conflict Reports

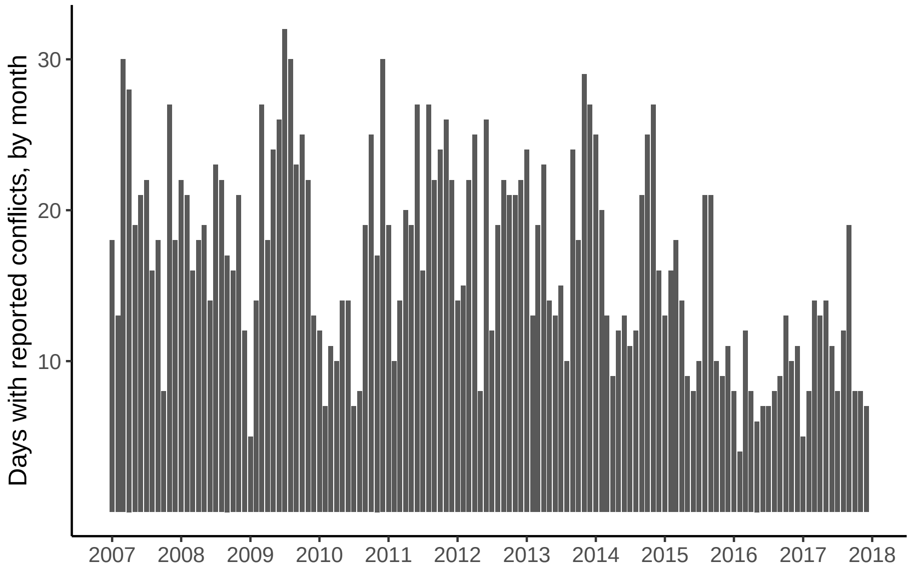


Figure 2 – Density of the Hours of the Reports

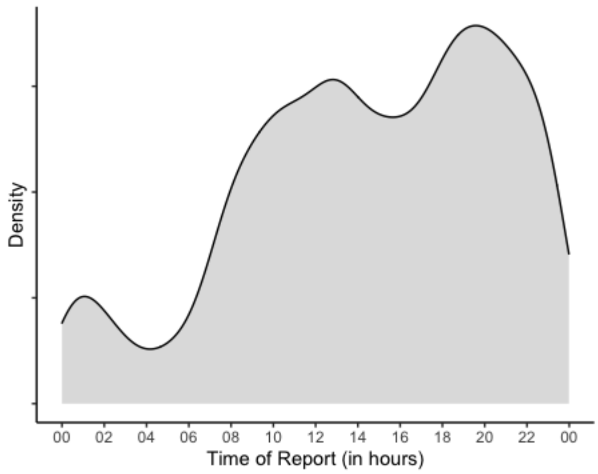


Figure 3 – Reported Conflicts Spatial Distribution

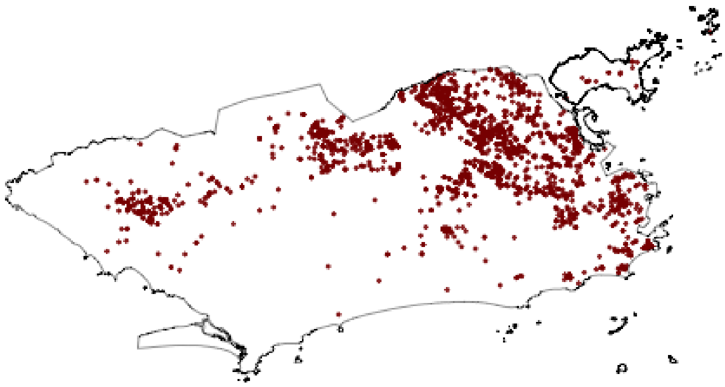


Figure 4 – Reported Conflicts Density Map

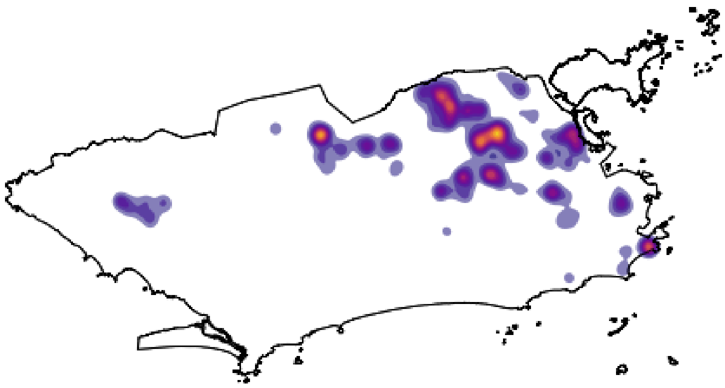


Figure 5 – Favelas in Rio de Janeiro

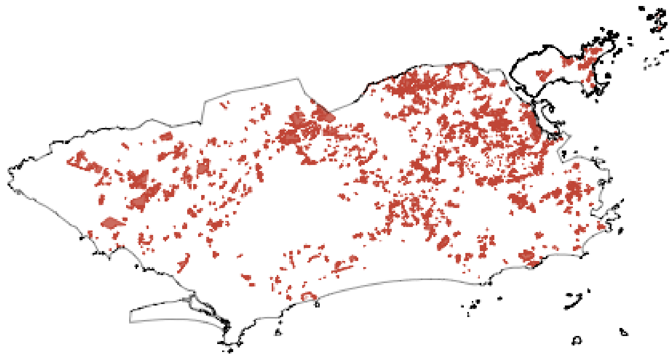
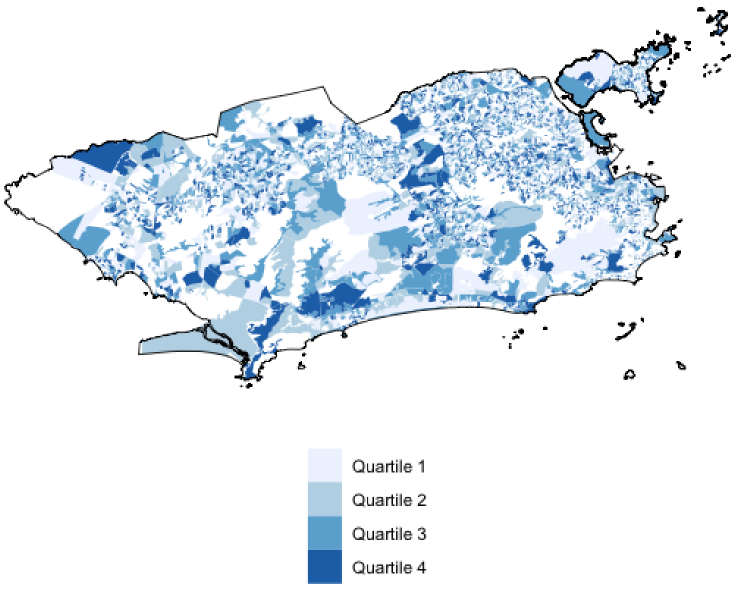
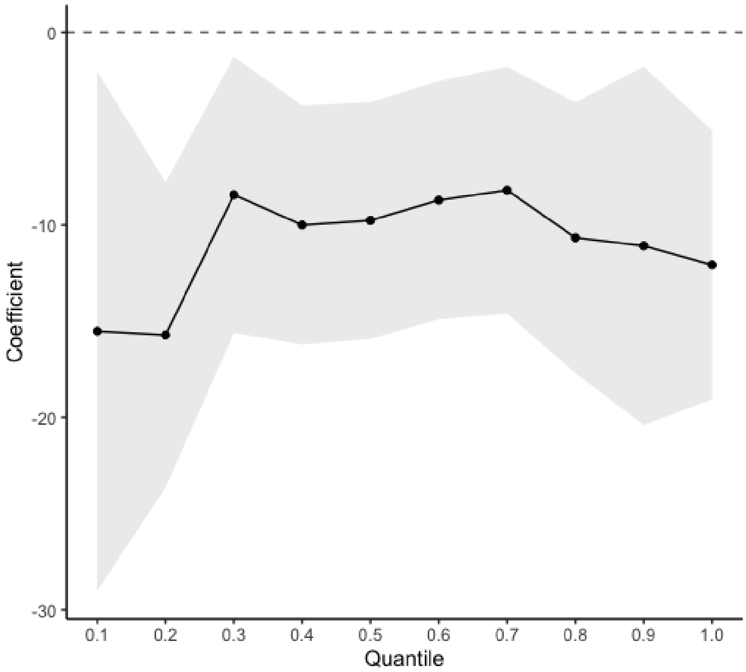


Figure 6 – Share of Low Birthweight Newborns



The figure shows the distribution of the average fraction of low-weight births across Rio de Janeiro's census tracts, the most disaggregated geographic units available.

Figure 7 – Quantile Regressions



The figure shows the effects of exposure to gun conflicts at a 500m radius during pregnancy per quantile of birthweight. The figure uses the regression specification from Table 6 column (1). The gray area represent a 95% confidence interval.

TABLES

Table 1 – Summary Statistics of the Reported Conflicts

Year	Total	Days	Weeks	Weekly Avg.	Neighborhoods
2007	404	188	50	3.69	144
2008	322	175	51	3.37	119
2009	488	213	49	4.26	160
2010	274	140	50	2.75	112
2011	438	195	49	3.9	160
2012	381	194	52	3.66	159
2013	418	180	52	3.4	155
2014	347	173	50	3.39	131
2015	255	137	44	3.04	104
2016	141	88	43	2	51
2017	178	107	46	2.28	80
Mean	331.4	162.7	48.7	3.2	126.4

Notes: The table reports the descriptive statistics for the municipality of Rio de Janeiro. Observations refer to all reported gun conflicts between January 2007 and December 2017. Column 'Total' refers to the total number of reported conflicts in that year, 'Days' and 'Weeks' are the total number of days and weeks in which at least one conflict was reported, and 'Weekly Avg.' is the weekly average number of days with reported conflicts. 'Neighborhoods' is the number of neighborhoods in which there was at least one reported conflict.
Source: Author's own elaboration based on *Disque Denúncia* data.

Table 2 – Summary Statistics of Conflicts Exposure

Panel A: Favelas exposed to conflicts at varying distances to boundaries

	Reports within range		Favelas with reports	
Distance to Favela	N.	%	N.	%
Within Favela Limits	814	22.33	134	13.35
250m	2,833	77.70	486	48.41
300m	3,050	83.65	535	53.29
400m	3,214	88.15	606	60.36
500m	3,367	92.35	672	66.93
Total	3,646	-	1,004	-

Panel B: Mothers within favelas exposed to gun conflicts

	Mothers exposed during pregnancy			
Distance to Conflict	N.	%	Mean	Sd.
250m	20,294	10.06	0.22	(1.16)
300m	25,586	12.69	0.29	(1.41)
400m	36,520	18.11	0.47	(1.99)
500m	47,762	23.68	0.68	(2.60)
Total	201,702	-	-	

Note: Panel A shows in the first two columns the number of reports that fall within favela limits and within different distance ranges to favela borders. Columns 3 and 4 show the number of favelas that are exposed to at least one report. As distance ranges increase, a conflict might fall within the distance radius for more than one favela, so that in some cases, conflicts are subject to double counting.

Table 3 – Birth Descriptive Statistics

Variable	Mean	St. Dev.	Obs.
Panel A: Birth Outcomes			
birth weight *(g)*	3,173.429	583.659	201,702
Low birth weight *(<2,500 g)*	0.094	0.292	201,702
Very Low birth weight *(<1,500 g)*	0.017	0.128	201,702
Gestational Weeks	38.492	2.380	123,464
Less than 37 Gestational Weeks	0.106	0.308	200,647
Less than 32 Gestational Weeks	0.018	0.131	200,647
Less than 28 Gestational Weeks	0.006	(0.077)	935,184
Panel B: Newborns' Characteristics			
Female	0.489	0.500	201,669
Non-white	0.597	0.490	72,117
Panel C: Birth Characteristics			
C-Section	0.454	0.498	201,553
Multiple Birth	0.020	0.139	201,587
Prenatal Visits: Less than 3	0.096	0.295	196,896
Prenatal Visits: 7 or more	0.649	0.477	196,896
Birth Residency Neighborhoods	160	-	933,496
Panel D: Mothers' Characteristics			
Age	25.539	6.613	201,702
Age less than 20	0.209	0.406	201,702
Age 35 or more	0.110	0.313	201,702
Non-White	0.730	0.444	122,548
Single	0.773	0.419	200,754
Education: Some Primary	0.320	0.467	197,222
Education: Some High School	0.569	0.495	197,222
Education: High School or above	0.111	0.314	197,222
Number of Children Alive	1.087	1.345	189,977

Notes: The table reports the descriptive statistics for the births of mother's who reside in the favelas of Rio de Janeiro. Observations refer to all births between January 2007 and December 2017. As of 2011, there was a change in the *SINASC* form, so that some variables are only available from this year onward (*e.g.* 'Gestational Weeks' and 'Non-white Newborn'). Before 2011, the gestational length was only reported in week intervals.

Table 4 – Distribution of Exposure to Gun Conflicts in Different Trimesters, B = 500 m

Trimesters	N.	% T1	% T2	% T3	Gestation %
Only T1	10,133	49.30	-	-	21.22
Only T2	11,245	-	48.30	-	23.54
Only T3	11,515	-	-	52.10	24.11
T1 + T2	4,283	20.84	18.40	-	8.97
T1 + T3	4,448	21.64	-	20.13	9.31
T2 + T3	2,831	-	12.16	12.81	5.93
T1 + T2 + T3	3,307	16.09	14.20	14.96	6.92
Total T1	20,554	100.0	-	-	-
Total T2	23,283	-	100.0	-	-
Total T3	22,101	-	-	100.0	-
Not exposed	153,938	-	-	-	-

Note: The upper panel reports the number of exposed mothers in different trimesters of pregnancy combinations for a distance radius of 500 meters. Each column reports the row shares over the total of expositions to conflicts in a certain trimester. The last column reports the row shares over the total expositions to conflicts during pregnancy.

Table 5 – The effect of gun conflicts on various measures of distance during pregnancy on birth weight

	Dependent variable:			
	birth weight			
	(1)	(2)	(3)	(4)
Panel A: Effect of exposure to at least 1 gun conflict				
B = 200m	−6.91*	−7.19*	−5.49	−0.78
	(3.85)	(3.76)	(3.68)	(4.30)
B = 300m	−10.65**	−10.94**	−9.17*	−4.31
	(4.81)	(4.68)	(4.74)	(5.02)
B = 400m	−10.89***	−11.18***	−9.62**	−4.39
	(4.19)	(4.12)	(4.14)	(3.89)
B = 500m	−11.77***	−12.07***	−10.53***	−5.06
	(3.64)	(3.57)	(3.46)	(3.13)
Panel B: Effect of exposure to an additional gun conflict				
B = 200m	0.39	0.35	0.45	1.13
	(0.59)	(0.59)	(0.63)	(0.72)
B = 300m	0.64	0.61	0.68	1.33**
	(0.66)	(0.65)	(0.68)	(0.64)
B = 400m	−0.01	−0.04	0.04	0.57
	(0.79)	(0.78)	(0.79)	(0.73)
B = 500m	−0.15	−0.17	−0.11	0.33
	(0.58)	(0.56)	(0.54)	(0.51)
Month FE	*Yes*	*Yes*	*Yes*	*Yes*
Year FE	*Yes*	*Yes*	*Yes*	*Yes*
Favela Income	*No*	*Yes*	*Yes*	*No*
Mother Controls	*No*	*No*	*Yes*	*Yes*
Favela FE	*No*	*No*	*No*	*Yes*
Observations	200,584	200,584	200,584	200,584

Note: Standard errors clustered at the favela level are reported in parentheses, significance: *p<0.1; **p<0.05; ***p<0.01

Table 6 – The effect of exposure to gun conflicts < 500m during pregnancy on birth outcomes

	Dependent variable:							
	birth weight		Low birth weight ($\times 10^2$)		Small for Gestational Age		Premature Birth ($\times 10^2$)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Effect of exposure during pregnancy								
Pregnancy	−12.07∗∗∗	−5.06	0.37∗∗	0.20	0.01∗∗∗	0.01∗∗	0.30∗∗	0.17
	(3.57)	(3.13)	(0.16)	(0.15)	(0.00)	(0.00)	(0.14)	(0.15)
Panel B: Effect of exposure during different trimesters of pregnancy								
1st Trimester	−3.37	1.25	0.19	0.09	0.00	0.00	0.21	0.12
	(7.23)	(7.53)	(0.30)	(0.28)	(0.00)	(0.00)	(0.41)	(0.42)
2nd Trimester	−7.76∗	−3.85	0.67∗∗∗	0.58∗∗	0.00	0.00	0.34	0.28
	(4.52)	(3.84)	(0.23)	(0.24)	(0.00)	(0.00)	(0.31)	(0.31)
3rd Trimester	−7.65∗∗	−2.85	−0.14	−0.25	0.00	0.00	0.16	0.08
	(3.68)	(3.95)	(0.19)	(0.19)	(0.00)	(0.00)	(0.25)	(0.27)
Month & Year FE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Favela Income	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*
Mother Controls	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*
Favela FE	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*
Observations	200,584	200,584	200,584	200,584	123,443	123,443	200,584	200,584

Note: Standard errors clustered at the favela level are reported in parentheses, significance: *p<0.1; **p<0.05; ***p<0.01

Table 7 – The effect of gun conflicts <500m during pregnancy on prenatal visits

	Dependent variable:			
	Prenatal Visits, 0-3 ($\times 10^2$)		Prenatal Visits, 7 or more ($\times 10^2$)	
	(1)	(2)	(3)	(4)
Panel A: Effect of exposure during pregnancy				
Pregnancy	0.40	0.17	−0.69	−0.78
	(0.32)	(0.28)	(0.73)	(0.61)
Panel B: Effect of exposure during different trimesters of pregnancy				
1st Trimester	0.41	0.22	−0.44	−0.36
	(0.30)	(0.33)	(0.54)	(0.58)
2nd Trimester	0.46**	0.31*	−0.95*	−0.92**
	(0.23)	(0.17)	(0.52)	(0.42)
3rd Trimester	−0.07	−0.24	−0.27	−0.24
	(0.28)	(0.25)	(0.43)	(0.29)
Month & Year FE	*Yes*	*Yes*	*Yes*	*Yes*
Favela Income	*Yes*	*No*	*Yes*	*No*
Mother Controls	*No*	*Yes*	*No*	*Yes*
Favela FE	*No*	*Yes*	*No*	*Yes*
Observations	195,885	195,885	195,885	195,885

Note: Standard errors clustered at the favela level are reported in parentheses, significance: *p<0.1; **p<0.05; ***p<0.01

Table 8 – Heterogeneous effects of exposure to gun conflicts < 500m during pregnancy on birth outcomes by maternal characteristics

	Dependent variable:								
	birth weight		Low birth weight ($\times 10^2$)		Small for Gestational Age		Premature Birth ($\times 10^2$)		*N.Obs.*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
Maternal characteristics									
Non-White	−11.58*	−8.25	0.61**	0.60***	0.01	0.00	0.23	0.39	32,922
	(6.73)	(6.38)	(0.25)	(0.22)	(0.00)	(0.00)	(0.35)	(0.41)	
No Primary Ed.	−13.4**	−5.52	0.34	0.14	0.01*	0.01	0.50*	0.38	62,754
	(6.27)	(6.34)	(0.3)	(0.34)	(0.00)	(0.01)	(0.27)	(0.27)	
Under 20	−9.60	−6.35	0.16	−0.01	0.01	0.01	0.08	−0.08	41,814
	(8.42)	(9.82)	(0.44)	(0.51)	(0.01)	(0.01)	(0.27)	(0.38)	
Month & Year FE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	
Favela Income	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	
Mother Controls	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	
Favela FE	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	

Notes: Standard errors clustered at the favela level are reported in parentheses, significance: *p<0.1; **p<0.05; ***p<0.01.
The number of observations may vary slightly between regressions due to missing data on some variables.

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8 APPENDIX A - CODING ARMED CONFLICTS REPORTS

This section describes how I coded Disque Denúncia reports to build a measure of violence. Following (MONTEIRO; ROCHA, 2017), I have gathered all reports classified as "gunfight between drug-gangs" (*tiroteio entre quadrilhas*) registered between 2007 and 2017 in the municipality of Rio de Janeiro. All reports contain the date and time of the call, the approximate location of the conflict, and a brief description of the event. Reports are often as straightforward as this:

> *"In the mentioned avenue, inside Vila Kennedy, an intense shooting happens at this moment."*

Sometimes the reports contain detailed information such as the one below:

> *"In the mentioned road, in Morro do Chaves, yesterday (10/04/2012), around 11 p.m., unidentified drug dealers, from the Quitanda community, in Costa Barros, invaded the Morro and shot the drug traffic leader ..., who tried to hide in a house, but the traffickers followed the blood trail he left behind. ... Rival traffickers intend to return to the community without an informed date. Because of that, local trafficking ordered the closure of local trade."*

In order to guarantee that each report describes a gunfight, I have read the content of all the reports and excluded the ones that did not mention the specific event of armed conflict happening. For instance, some of the reports describe a *"baile funk"*, which are traditional parties held in the favelas that often involve the use of drugs and other illicit substances, and are frequented by armed traffickers, who do not necessarily engage in a gunfight. The report below depicts this example:

> *"In the mentioned street, besides number 300, it is located an invaded land, where during the daytime works as a jet washer, and at this time, a baile funk occurs, with the sound on very high volume, playing music that makes apology to trafficking and sex, disturbing the peace of the residents in the neighborhood."*

Another example of noise in the data is the reports that mention the threat of a gunfight that should happen sometime in the future, an event that is not verifiable if happened or not. In these cases, I have also discarded the reports. The following text illustrates this case:

> *"In the mentioned neighborhood, strongly armed traffickers (unidentified), from the Comunidade da Serrinha, on Friday (09/20/13) to Saturday's (09/21/13) dawn, are planning to invade the Morro do Juramento."*

As exemplified above, the calls are not necessarily made while the shootings occur. Most of the time, however, they describe an event that happened in the near past, like the day before or in the same week as the call was made. In this fashion, even though the reports are not all precisely accurate in time, they consist of a very reliable measure for when the conflict took place. However, to increase accuracy in the measure, I identify reports that contain time-related keywords and adjust the date of the report to the day the conflict happened. To be more specific, I look for reports containing the words "yesterday"; "since yesterday"; and "since DD/MM/YYYY" and change the reported date to the date the conflict was reported to have started on. For example:

> *"In the mentioned street, ... next to a feed store, yesterday (11/04/2013), from 22h to 5h there was a shooting between unidentified drug traffickers and militias."*

In the above excerpt, the shooting started on the evening of the 11th and continued until dawn on the 12th. In this case, I consider that the conflict happened on the 11th, and had a duration of one day since it stopped. In other cases, the conflict seems to start the day before and continue until the next day:

> *"On the mentioned hill, since yesterday(19/11), there are shootings going on between drug dealers of rival factions."*

In this case, since I am not able to track if the conflict persisted after the call was made, I consider that it lasted two days, the day before, when it was said to have started, and the day the call was made, when it was said to be still going on. I duplicate the report and adjust the dates, one for each day of reported conflicts.

I also look for a combination of the keyword "since" followed by a string in date format (DD/MM/YYYY or simply DD/MM), in order to look out for shootings that last more than two days:

> *"In the mentioned street, in the Chapéu Mangueira Community, since Friday (22/02), there have been intense shootings between rival drug dealers, placing the whole population at risk."*

This report was registered on February 27th, six days after the shootings were reported to have begun. Not adjusting the dates would generate a downward bias in the measure of violence, since a conflict that lasted for at least six days would be identified as a one-day event only. In this fashion, I multiply the report for the difference in days between the date on the report and the date that the conflict started stated on the description of the event, and set the dates to the sequence of days. In this example, I would have six reports indicating the same event, but with six different dates, ranging from February the 22th to February the 27th, the last day that I have information on the event.

9 APPENDIX B - TABLES

Table 9 – The effect of exposure to gun conflicts < 250m during pregnancy on birth outcomes

	Dependent variable:							
	birth weight		Low birth weight ($\times 10^2$)		Small for Gestational Age		Premature Birth ($\times 10^2$)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Effect of exposure during pregnancy								
Pregnancy	−7.19*	−0.78	0.14	0.00	0.00	0.00	0.28	0.15
	(3.76)	(4.30)	(0.23)	(0.24)	(0.00)	(0.00)	(0.28)	(0.31)
Panel B: Effect of exposure during different trimesters of pregnancy								
1st Trimester	4.59	8.83	−0.35	−0.43	0.00	0.00	−0.16	−0.24
	(12.42)	(12.97)	(0.58)	(0.58)	(0.00)	(0.00)	(0.63)	(0.65)
2nd Trimester	−6.94	−2.44	0.84***	0.73***	0.00	0.00	0.55*	0.45
	(4.48)	(4.35)	(0.20)	(0.19)	(0.00)	(0.00)	(0.29)	(0.29)
3rd Trimester	−3.61	1.31	−0.36	−0.48	0.01	0.00	−0.02	−0.14
	(6.60)	(6.05)	(0.32)	(0.3)	(0.00)	(0.00)	(0.27)	(0.28)
Month & Year FE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Favela Income	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*
Mother Controls	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*
Favela FE	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*
Observations	200,584	200,584	200,584	200,584	123,443	123,443	123,464	123,464

Note: Standard errors clustered at the favela level are reported in parentheses, significance: *p<0.1; **p<0.05; ***p<0.01

Table 10 – The effect of gun conflicts < 250m during pregnancy on prenatal visits

	Dependent variable:			
	Prenatal Visits, 0-3 ($\times 10^2$)		Prenatal Visits, 7 or more ($\times 10^2$)	
	(1)	(2)	(3)	(4)
Panel A: Effect of exposure during pregnancy				
Pregnancy	0.27	−0.02	−1.13	−1.03
	(0.36)	(0.31)	(0.86)	(0.67)
Panel B: Effect of exposure during different trimesters of pregnancy				
1st Trimester	0.55	0.32	−0.85	−0.69
	(0.37)	(0.35)	(0.66)	(0.59)
2nd Trimester	0.57**	0.31	−1.27*	−0.99*
	(0.28)	(0.24)	(0.69)	(0.53)
3rd Trimester	−0.35	−0.62	−0.91	−0.69
	(0.41)	(0.39)	(0.61)	(0.52)
Month & Year FE	*Yes*	*Yes*	*Yes*	*Yes*
Favela Income	*Yes*	*No*	*Yes*	*No*
Mother Controls	*No*	*Yes*	*No*	*Yes*
Favela FE	*No*	*Yes*	*No*	*Yes*
Observations	195,885	195,885	195,885	195,885

Note: Standard errors clustered at the favela level are reported in parentheses, significance: *p<0.1; **p<0.05; ***p<0.01