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Signe Svallfors, Sunnee Billingsley, Gudrun Østby
and Siddartha Aradhya

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Stockholm University
Demography Unit

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[1]Signe Svallfors, [2]Sunnee Billingsley, [3]Gudrun Østby and [2]Siddartha Aradhya

[1]Department of Sociology, Stanford University

[2]Department of Sociology, Stockholm University

[3]Peace Research Institute Oslo

Abstract

Armed conflict has been linked to adverse pregnancy outcomes such as low birthweight, stillbirth and neonatal mortality. This study analyzes birthweight in the unique context of Colombia, where a long-standing conflict has created multiple stressors that may impair maternal and child health. Pathways suggested to account for this relationship include mother's stress, nutritional deficiencies, lack of adequate health care, and intimate partner violence. We further contribute with novel analyses of the impact of anti-coca fumigation that has been harmful to health. Combining micro-level survey data with spatiotemporal information about organized violence and anti-coca fumigation, we explore how intrauterine exposure to these stressors are related to birthweight. We find that a mother's exposure to violence and fumigation is detrimental to the intrauterine growth of her children, net of gestational length, parity, and mother's characteristics such as age, location or genetics. The relationship between conflict and birthweight was stratified by mother's age, residence, and educational level. The findings are indicative of a scarring effect from armed conflict on live-born children that may impair their future health and socioeconomic status outcomes. The results add to knowledge about maternal and child health during crises, and the importance of context for individuals' health.

Keywords: Birthweight, armed conflict, glyphosate, maternal health, child health, Colombia

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Introduction

Armed conflict has been linked to adverse pregnancy outcomes (Buitrago and Moreno-Serra 2021; Camacho 2008; Mansour and Rees 2012; Oskorouchi 2019) and we know that *in utero* shocks may have negative health consequences with long-term repercussions for health and socioeconomic status (SES) throughout the lifecourse (Almond and Currie 2011; Currie and Vogl 2013). Because violent conflict has dramatically increased in the last decade, the need to understand potentially long-lasting consequences for the most vulnerable population is a pressing public-health issue. But most of the work on maternal and child health in violent conflict is focused on universal effects, i.e., assuming that all segments of the population are affected in the same way. This leads to a gap in understanding which groups in the population are more vulnerable to security risks. Without this knowledge, policymakers may develop interventions that are not well-suited to address women's and children's health needs.

The story of conflict and how it plays out for reproductive and maternal health is broader than counting deaths, events, or explosions. In Colombia, coca cultivation has been intrinsically connected to conflict, since armed actors have used narco trafficking as an informal taxation system to finance further fighting (Jansson 2008). Aerial spraying of anti-coca fumigation has been used as a strategy to combat illicit armed groups by strangling their income. Both coca cultivation and eradication have thus been at the center of the political economy of the Colombian conflict. Anti-coca fumigation has been empirically linked to harmful effects on the health of pregnant women and their unborn children (Camacho and Mejía 2017).

This study aims to take a comprehensive and context-specific approach to the effect of local armed conflict in Colombia. Specifically, we assess the consequences of conflict on birthweight. We take an intersectional approach, by looking at heterogeneous effects to examine the extent to which conflict is a driver of health inequalities at birth. We assess exposure to organized violence and anti-coca fumigation, which are separate but interlinked dimensions of armed conflict in Colombia. The focal research questions are: *How does exposure to armed conflict in terms of violence and fumigation correlate with birthweight in Colombia? Which groups of the population are more vulnerable to the impact of conflict on birthweight?*

Colombia is a unique setting that provides useful methodological and theoretical characteristics. First, it has had a uniquely longstanding conflict with extensive variations across space and time in terms of violence intensity since the mid-20th century. Second, data on individual women's health and pregnancies is available for the past twenty years, even during continued conflict. Third, the link between armed conflict and the cultivation of illicit drugs has created multiple pathways through which women and children's health may be affected and demonstrates the importance of taking a comprehensive approach toward armed conflict. Moreover, aerial spraying has been virtually unanticipated in terms of timing and location (Camacho and Mejía 2017). Fourth, Colombia – like most of Latin America – is a context with stark social inequalities and high rates of violence, which makes it a particularly relevant context to study which groups of the population are more sensitive to negative health outcomes of conflict.

While past work has observed a link between anti-coca fumigation and miscarriages in Colombia (Camacho and Mejía 2017) our study is the first to investigate live birth outcomes such as birthweight in relation to fumigation. Past literature from Colombia has shown a link between ceasefires and reductions in stillbirths and perinatal mortality (Buitrago and Moreno-Serra 2021) and between landmine explosions and lower birthweight (Camacho 2008). The present study offers alternative measurements of armed conflict, focusing on events of organized violence and casualties in those events, since landmine explosions only account for a small fraction of the violence to which Colombian women are exposed (Restrepo, Spagat, and Vargas 2006). Whereas previous studies (Buitrago and Moreno-Serra 2021; Camacho 2008) are restricted to births in health care facilities recorded in medical files, our individual-level survey data also contain non-institutional births, which most often occur in rural areas where conflict has been most concentrated in Colombia. Finally, while most previous work on health outcomes of conflict is focused on the universal effects, we instead look at how some women and their children may be more vulnerable to conflict than others. More specifically, we look at heterogeneous effects related to the mothers' age, residence, and educational level.

Adverse birth outcomes such as low birthweight represent significant public health challenges and we need a better understanding of the root causes and contextual factors in order to inform policies to improve the situation. Our study also contributes to existing knowledge about long-term consequences of armed conflict for the intergenerational linkages between maternal and child health. The findings from this article may be useful in addressing maternal and child health outcomes in settings plagued by conflict and production of narcotics.

Understanding Birthweight

Birthweight is a strong predictor of infant and child mortality and is widely regarded as a key early life indicator of later-life health and SES outcomes (Barker 1995; Ben-Shlomo and Kuh 2002; Almond and Currie 2011). Both low birthweight (<2500 g) and high birthweight/fetal macrosomia (≥4500 g) are associated with poorer health throughout the lifecourse; however, studies suggest that within these thresholds higher birthweight is positively associated with later-life health and SES outcomes (Adair et al. 2013).

In addition to genetic factors, birthweight is determined by maternal health and behavior, SES, as well as the social and physical environmental context to which a fetus is exposed (Kramer 1987). For example, lower SES, living in impoverished neighborhood conditions, or lack of access to adequate antenatal care have all been shown to have adverse effects on perinatal health (Krieger et al. 2003). Thus, birthweight is a unique indicator simultaneously measuring maternal and offspring health.

In Utero Exposure to Armed Conflict and Pregnancy Outcomes

The fetal origins hypothesis is often used to describe how intrauterine exposure to deleterious circumstances may lead to detrimental health outcomes throughout a child's lifecourse (Barker 1995; Ben-Shlomo and Kuh 2002). In the broader literature, four main pathways have been proposed as mediators through which armed conflict may link to adverse pregnancy outcomes such as lower birthweight. We display these connections in Figure 1.

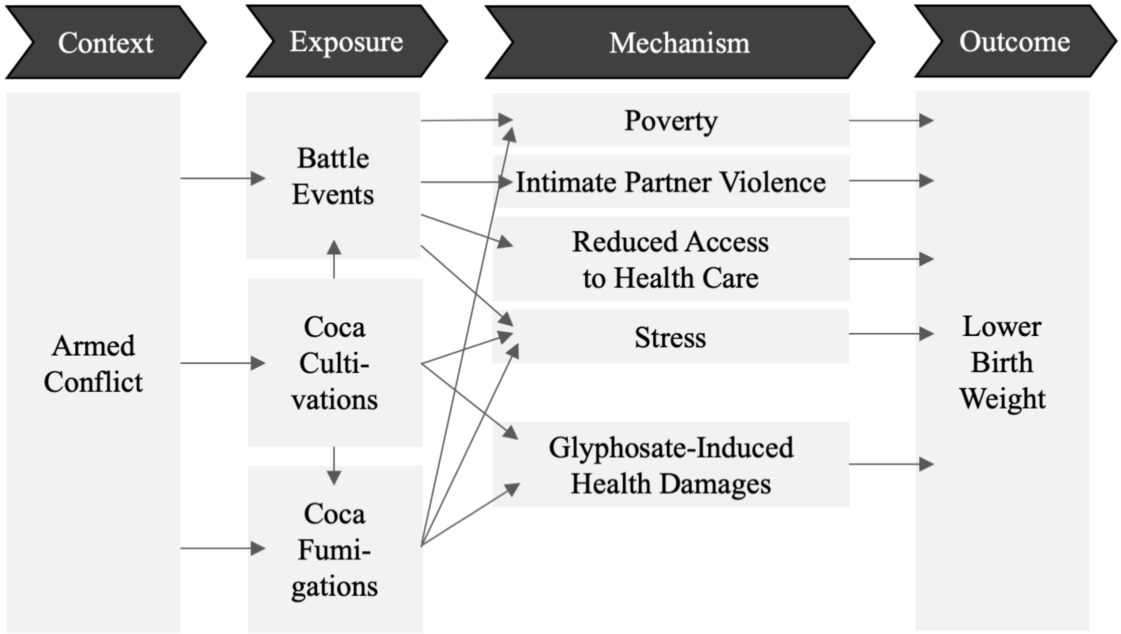

Figure 1. Links between armed conflict and birthweight.

First, conflict is known to cause and perpetuate poverty and food insecurity (Ibáñez and Vélez 2008). This in turn may lead to nutritional deficiencies that are detrimental to the fetus, especially during the last trimester when the fetus grows the most (Bozzoli and Quintana-Domeque 2014).

Second, conflict has been related to an increase in intimate partner violence (IPV) (Ekhator-Mobayode et al. 2022; La Mattina 2017; Østby 2016b; Østby, Leiby, and Nordås 2019; Svallfors 2021a) that in turn is known to associate with adverse pregnancy outcomes (Coker, Sanderson, and Dong 2004; Hoang et al. 2016; Lipsky et al. 2003, 2004; Moraes, Amorim, and Reichenheim 2006; Valladares et al. 2002).

Third, conflict often reduces health care access, including use of prenatal care and institutional child delivery (Østby et al. 2018; Ramos Jaraba et al. 2020; Ziegler et al. 2020).

Fourth, mother's stress has been linked to excess production of the placental-derived corticotropin releasing hormone that accelerates the maturation of the fetus' organs and increases the risk of low birthweight, especially if exposure happens during first trimester (Mulder et al. 2002; Nakamura, Sheps, and Clara Arck 2008). Such stress-responses may come from losing partners, other family, and community leaders (Black, Devereux, and Salvanes 2016; Catalano and Hartig 2001; Class et al. 2011; Laszlo et al. 2013), as well as persecution and threats of violence (Lauderdale 2006). These events have been tragically common in Colombia (Franco et al. 2006) and many other conflict-ridden countries. War-related trauma may have intergenerational impacts through epigenetic transmission resulting in harmful birth outcomes (Seng et al. 2011).

We also propose a fifth pathway linking armed conflict to birthweight; anecdotal evidence from Colombia reports an increase in adverse birth outcomes among women who live near coca cultivation areas. This is thought to be due to the chemicals found in pesticides to keep coca plants alive as well as anti-coca fumigation that have been distributed by aircraft as a part of the government's eradication program Plan Colombia since 2000 (Chaparro González et al. 2015). Glyphosate is one of the active ingredients used in both weeds and coca eradication compounds (Benner, Mena, and Schneider 2016). The teratogenicity (ability to cause birth defects) of glyphosate-based herbicides remains controversial (de Araujo, Delgado, and Paumgartten 2016; Paganelli et al. 2010; Parvez et al. 2018; Pu et al. 2020; Ruiz-Toledo et al. 2014; Ruuskanen et al. 2020). Nevertheless, an increase in medical consultations due to miscarriages, respiratory illnesses, and dermatological illnesses was documented in relation to the fumigation carried out in Plan Colombia (Camacho and Mejía 2017). Higher glyphosate levels in pregnant women have also been associated with shortened gestational lengths (Parvez et al. 2018).

We expect some of these mechanisms to be mutually reinforcing. For example, poverty and food insecurity will likely cause additional stress (Piperata et al. 2020), and further reductions in access to healthcare if women cannot pay for transport to clinics or healthcare fees (Svallfors 2021b). IPV is both likely to cause stress (Ellsberg et al. 2008) and to increase if women's intimate partners exert violence as a response to poverty-induced stress (Svallfors 2021a). Women suffering from stress may adopt coping mechanisms such as tobacco and alcohol consumption, and become less prone to participate in healthy activities such as physical exercise (García-Moreno et al., 2013), which could increase the risk of adverse birth outcomes.

Due to the complexity of the mechanisms and the lack of appropriate data to capture the first four mechanisms, we do not make any claims about which of these mechanisms may or may not be operative. Instead we explore how the relationship between conflict and birthweight varies across subgroups of the population (related to mother's age, residence, and educational level) to investigate maternal and child health vulnerabilities, and how timing during the three trimesters matters for this relationship. The trimester-disaggregated approach allows us to explore which phase of the pregnancy is more vulnerable to hazardous exposures due to conflict, which may inform antenatal health care interventions as to when pregnant women living in war zones are most in need of support. In contrast to the first mechanisms, we directly study exposure to anti-coca fumigation as a proxy for glyphosate-induced health damages.

Crime and Birthweight

A growing literature has documented consequences for birthweight when pregnant women live in an area with crime. The relationship holds in US contexts such as Chicago (Mayne et al. 2013; Matoba et al, 2019; Morenoff 2003) New Orleans (Felker-Kantor et al. 2017), Raleigh (Messer et al. 2006), and California (Goin et al. 2013), as well as in other countries such as Brazil (Dos Santos et al. 2021; Foureaux Koppensteiner and Manacorda 2016), Chile (Zapata et al. 1992), Mexico (Brown 2018), and Scotland (Clemens and Dibben 2017).

Fear and stress are the main mechanisms linking crime and low birthweight in this literature, whereby biological responses to stressors affect the intrauterine environment and development of the fetus. This pathway is similar to how conflict is argued to affect birthweight. The literature provides a discussion of more indirect pathways as well. Community violence has been associated with loss of sleep (Rosalind et al. 2004), which has implications for maternal health. In addition, mental health problems can develop and lead to difficulties achieving dietary needs and in keeping up commitment to prenatal care (Dos Santos et al. 2021). The distrust that develops in contexts with crime can lead to social isolation and its health consequences (Morenoff 2003). Living in a crime ridden area can also affect health behaviors that are relevant to pregnancy outcomes through the use of unhealthy coping mechanisms such as tobacco, alcohol and drugs (Mayne et al. 2013), lower physical activity (Messer et al. 2006) as well as through pessimistic expectations related to having a long life (Morenoff 2003). Brown (2018) argues in the case of Mexico that the increased crime also negatively impacted household economic circumstances, which can also affect pregnant women's nutritional intake.

Socio-Economic Status Differences

Given how low-SES women are usually both most exposed to violence as well as most vulnerable, we anticipate heterogeneous effects of conflict on birth outcomes.

In Colombia, rural areas have been disproportionately affected by conflict (Franco et al. 2006). Coca is grown as a cash crop, representing the most profitable crop for small countryside farms (Jansson 2008). Aerial fumigation has been directed toward areas where coca plantations are grown. Thus, women in rural areas are likely most exposed to both organized violence and anti-coca fumigation, and thereby also stress and glyphosate-induced health damages.

Colombian women in rural areas are also more likely to be poor, have lower levels of education, and have less access to all kinds of state resources including health care (Svallfors 2021b). However, they are less likely to be victimized to intimate partner violence, potentially because of the lack of anonymity and presence of more traditional structures of social control in rural areas (Friedemann-Sanchez and Lovatón 2012; Kishor and Johnson 2004; Svallfors 2021a).

Women with lower levels of education are more vulnerable to both armed conflict (Svallfors 2021b) and IPV (Friedemann-Sanchez and Lovatón 2012; Svallfors 2021a). We also expect them to have less access to financial and health-promoting resources including nutrition and health care services, and to be more agriculture-dependent, which may place them at higher risk of exposure to anti-coca fumigation.

Past literature has discussed adolescent pregnancy, which is very common in Colombia, as a consequence of conflict and inequality (Alzate 2014). In 2010, 20 percent of girls in Colombia became mothers before the age of 18, and 15 percent before age 16. In rural areas, almost one-third of girls below 18 have had at least one child, compared to around one-sixth of girls in urban areas. Adolescent women in rural areas are more likely to have lower levels of education, be in a cohabiting relationship, and have their first sexual relationship earlier. They are also less likely to use a condom at first sex or any type of contraception when married. Even if 75 percent of adolescent women live in urban areas (Martes-Camargo 2015), those living in the countryside are likely at substantially higher risk of adverse maternal and child outcomes due to both social and biological factors (such as poverty, IPV, and immaturity of the reproductive system) (Friedemann-Sanchez and Lovatón 2012; Roth et al. 1998; Svallfors 2021a).

Conflict and Coca in Colombia

Colombia's armed conflict started in the 1960s and involves the government, paramilitary groups, organized crime networks, and left-wing guerrilla groups. It was initiated as a response to elitist and clientelist bipartisan politics, unequal land ownership, socioeconomic marginalization, and a governmental vacuum in remote areas of the country. In the 1970s, illicit armed groups started to produce and traffic narcotics as a way to finance military activities. Coca is used to produce cocaine and is by far the most lucrative crop for small farmers in Colombia (Jansson 2008).

The Colombian and United States governments launched Plan Colombia in 2000, a military aid agreement to combat the illicit cultivation of coca. Part of this program was aerial spraying from US military airplanes. The Colombian and United States governments have insisted that the aerial spraying of glyphosate is harmless (U.S. Embassy in Colombia n.d.), which has resulted in a territorial dispute with Ecuador, whose government reports residual effects on human health and environmental outcomes (Peñaherrera Colina et al. 2007). The Colombian government led by President Manuel Santos ceased the use of glyphosate in coca eradication as of May, 2015 to prevent negative effects on public health. However, the subsequent government led by President Ivan Duque announced in 2018 the eradication program would be reinstated, using drones to reduce the amount of glyphosate used (Idrovo and Rodríguez-Villamizar 2018).

The cocaine production has further fuelled fighting over strategic areas of interest, such as trafficking corridors and areas where coca can be grown (Jansson 2008). As a result, Colombia has long had the highest mortality levels in the Western hemisphere because of conflict (Garfield and Llanten Morales 2004). More than half a million murders were committed in Colombia 1975–2004, representing a mean of one homicide every half an hour and 10–15 percent of the total mortality rate (Franco et al. 2006). Violence has also taken the form of forced disappearances, forced displacement, use of antipersonnel mines, and kidnappings (Franco et al. 2006). The protracted violence in Colombia produces significant challenges to development. Although Colombia is an upper middle-income country, it has one of the most unequal income distributions in the world (World Bank 2019). In 2002, approximately half of the country's population lived in conditions of poverty and one fifth in extreme poverty. In 2015, these numbers had diminished to 28 and 8 percent, respectively (DANE 2016). Despite important progressions in maternal and child health as well as poverty reduction in the 2000s, regional inequalities remain a major challenge.

The distribution of casualties due to organized violence and anti-coca fumigation in Colombia's departments is displayed in Figure 2.

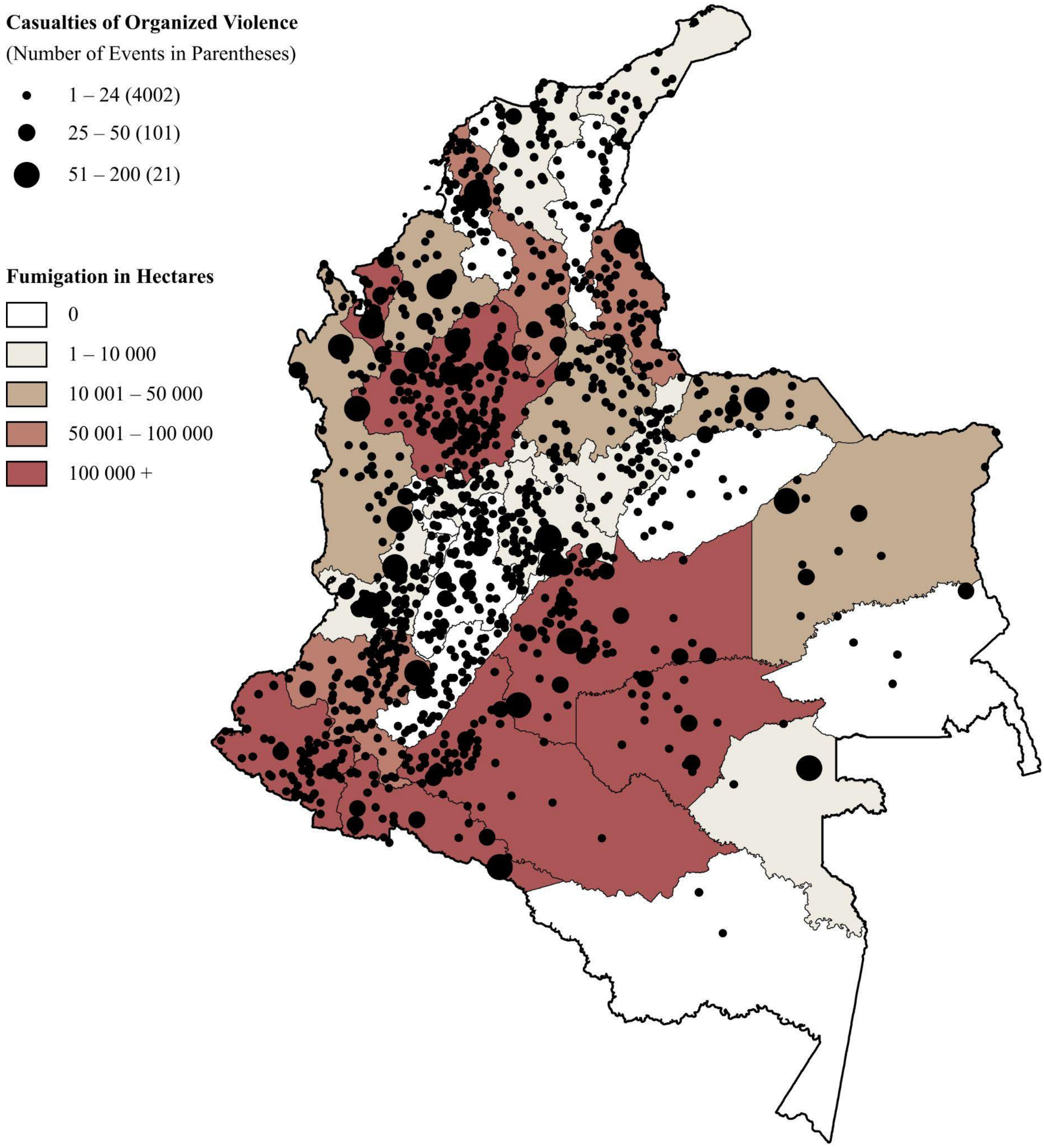

Figure 2. Distribution of casualties and anti-coca fumigation in Colombia's departments

Note: Each dot is an event of organized violence and a bigger size indicates more casualties in that event. Darker colors indicate higher levels of fumigation measured in hectares.

Hypotheses

Based on the discussion above, we test the following hypotheses:

- Hypothesis 1: The more exposed a mother is to organized violence, the lower the birthweight of her child.

- Hypothesis 2: The more exposed a mother is to anti-coca fumigation, the lower the birthweight of her child.
- Hypothesis 3: The negative effect of conflict on birthweight is stronger for teenage mothers.
- Hypothesis 4: The negative effect of conflict on birthweight is stronger for mothers residing in rural areas.
- Hypothesis 5: The negative effect of conflict on birthweight is stronger for mothers with lower levels of education.

Health-protective behaviors such as increased antenatal care could reduce the probability of harmful birth outcomes such as low birthweight (Torche and Villarreal 2014)[1]. But this is not what we anticipate in Colombia since health care services seem to suffer from conflict-related destruction and decay (Svallfors 2021b).

In Colombia, exposure to glyphosate during pregnancy has been associated with higher risk of preterm birth (Parvez et al. 2018) and miscarriage (Camacho and Mejía 2017). Any relationship that we might observe between fumigation and birthweight is net of gestational length and survival. This positive selection into live birth and removing the gestational length effect of fumigations means we will likely not find a very strong correlation.

Research Design

Data and Sample

Five sets of data are combined to evaluate the relationship between armed conflict and birthweight.

The Demographic and Health Surveys (DHS) contain information about women's health, their pregnancies, and the timing of births and health of those children (DHS 2005, 2011, 2017). We pool three rounds of data from the Colombian DHS 2004/05, 2009/10 and 2015/16 to enable long-term analyses.

In our sample the unit of analysis is woman-pregnancy, restricted to births in the five years preceding the interview due to the lack of birthweight information related to other births. Only surviving children and mothers are included, likely leading to an underestimation of the

[1] This finding could, however, be an artifact of not observing pregnancies during the surge of drug-related violence in Mexico, but only afterwards (Brown 2018).

impact of war on children's health. Only pregnancies resulting in a singleton birth are included, since multiple births are almost exclusively lower weight. Births with unclear timing and mothers with unclear ages constituted a negligible share and were removed from the sample. We limit our sample to births during the years 2000–2016 due to data availability, and to mothers with at least two live births during observation (the last five years) due to the maternal fixed effects approach presented in the following section. The analytical sample excludes pregnancies to women who changed residence during pregnancy to correctly assign exposure. These inclusion criteria result in a sample of 4,291 births by 2,048 mothers. For an exclusion flowchart, see the Appendix (Figure A).

The Uppsala Conflict Data Program Georeferenced Event Dataset (UCDP-GED) captures organized violence events in which at least one person was killed, based on news reports and other secondary sources, with information about the location and timing of those events. UCDP-GED is relatively conservative in measuring the magnitude of violence, but advantageous for sub-national analyses (Croicu and Sundberg 2018; Eck 2012; Restrepo et al. 2006; Sundberg and Melander 2013).

The dataset Eradication of Illicit Plants was collected by the Colombian Anti-Narcotics Police (DIRAN), a special unit inside the Colombian National Police in charge of most of the design and implementation of Plan Colombia.

El Sistema Integrado de Monitoreo de Cultivos Ilícitos (the Integrated Illicit Crops Monitoring System; SIMCI) offers information from the year 2000 about the location and quantity (in hectares) of coca plantations. The information is collected from satellite pictures of the entire Colombian territory, measured December 31 annually.

Population density at the municipality level is collected from the Colombian governmental agency *Departamento Nacional de Planeación*'s database TerriData.

We link these datasets by the administrative subdivision where the respondent resided at interview and the events of violence and fumigation occurred. This is done matching monthly fumigation and violence data at the respondent's location to each pregnancy during both the full pregnancy and each trimester. We use two alternative geographic levels – smaller municipalities and larger departments – to enable comparisons of how location matters for the relationship between conflict and birthweight. This approach allows us to investigate how exposure to deleterious exposures related to conflict (violence and fumigation) during pregnancy as well as each trimester correlates with birth outcomes (birthweight).

Since the cultivation data is only available annually and not monthly, we cannot distinguish between trimesters when measuring exposure to local coca cultivation. For this reason, we treat the coca cultivation indicator as a control variable, rather than an exposure variable.

Variables

The focal independent variables capture exposure to organized violence, coca cultivation and anti-coca fumigation in the respondent's home municipality and region. We use Akaike's Information Criterion (AIC) to examine the relevance of the multiple violence and fumigation indicators. Exposures are measured at two geographical levels (municipality and department) with different functional forms (continuous, categorical[2] and binary[3] specifications) during the three respective trimesters (assigned according to the gestational length of the pregnancy). The indicators that contributed most to model fit were at the department level. We use continuous measures of the number of *casualties* in events of organized violence and the number of *coca hectares* present, and categorical measures of zero, low or high anti-coca *fumigation level*. A list of all indicators we tested is available in the Appendix. Regression models with other indicators are available upon request.

We expect the independent variables to be interlinked. Concentration of coca cultivation indicates both the presence of both armed groups and organized crime networks as well as the exposure to pesticides used to keep plants alive. The satellite images of coca cultivation are analyzed by computer programs and experts to distinguish coca plants from other crops when planning for aerial spraying of glyphosate. In our sample, 29 percent of pregnancies were exposed to both organized violence and anti-coca fumigation; 45 percent to both coca cultivation and fumigation; and 29 percent to all three. In other words, although there is overlap between the types of exposure, there are also many pregnancies that were not exposed to two or all three hazards of conflict[4].

Since the coca cultivation data is collected at the end of each year, we use the average of the current and previous years to estimate the yearly coca cultivation intensity (Camacho and Mejía 2017). Women's exposure is calculated during the full pregnancy the year they were

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[2] The categorical violence variables were divided into three levels: zero violence, and two levels of violence split 50/50 into a low and high distribution of casualties.

[3] The binary violence variables measured whether there were any events of organized violence.

[4] When we look at each trimester separately, around 14 percent of the sample were exposed to both organized violence and anti-coca fumigation.

pregnant. Women whose pregnancies spanned two calendar years are given a value corresponding to the average between the two years they were pregnant.

Our dependent variable *birthweight* is measured continuously in grams. 21 percent of the pregnancies had birthweight reported from a written health card, and 79 percent from mother's recall (not shown). A histogram with the birthweight distribution in our sample and the full population is available in the Appendix (Figure B), as well as a discussion about birthweight heaping (Boeke et al. 2012).

Controls include *birth order* of the child, the *mother's age at birth* because pregnancies at very low or high ages would be more at risk of adverse outcomes, and *gestational length* to isolate the risk of LBW from preterm delivery . Birthweight and gestational age are intimately linked and have shown to independently impact offspring outcomes (Juárez et al. 2016; Wilcox and Skjaerven 1992); the causal relationship between birthweight and gestational age remains unclear as intrauterine growth has been shown to impact gestational duration (Kramer 1987; Zeitlin et al. 2000). We distinguish between pregnancies that spanned 5–6, 7, 8, 9 or 10 months. Gestation was self-reported in monthly format and the vast majority of pregnancies spanned 9 months.

To explore heterogeneous effects in the relationship between exposure to conflict and birthweight, we stratify the sample by three separate variables. First, we explore whether it was a *teen pregnancy*, defined as the mother being 19 years old or younger at the time of birth.

Second, mother's *type of place of residence*, in which urban is defined as respondent "living in a nucleus of 1,500 or more inhabitants" (Montgomery, 2003, 491). We use three categories: rural, urban with low population density (<50 inhabitants per km2), and urban with high population density (50+ inhabitants per km2). In alternative analyses presented in the Appendix (Table J), we use the simple rural/urban distinction as well as distinguish between low- and high-population density areas in which the latter category is defined as having 100 or more inhabitants per km2. The variable used in the main paper improved model fit more. The population density information is fixed for 2010 due to the lack of data prior to this year.

Third, *mother's educational level* is time-varying and constructed from the items capturing the highest level of education achieved at time of interview, whether the respondent was in education at interview, respondent's age, and the typical age at graduation in Colombia. The time-varying educational variable comes with some limitations, as it is based on an assumption of a quite rigid educational system with no study breaks, repeating of school years, or earlier/postponed entries into the school system. The variable approximates whether women had finished primary, secondary or tertiary school at the birth of each child.

We do not control for child's birth year to avoid an age-period-birth cohort (APC) collinearity bias since mother's birth year (captured in the fixed effects) and age at birth are equal to child's birth year, which in turn determines assignment to treatment (for a further discussion on APC issues in fixed effects models, see Holford 2006; Kravdal 2019; Wilson et al. 2021). Mother's age at birth adds more to model fit and is an important indicator of SES. Child's birth year did not contribute to the model net of the mother's age at birth.

Descriptive statistics of the sample of pregnancies are displayed in Table 1.

Table 1 Descriptive statistics of the sample population

Variable	Value	Frequency	Percent
Fumigation level during:			
First trimester	*Zero*	3,389	78.98
	Low	478	11.14
	High	424	9.88
Second trimester	*Zero*	3,293	76.74
	Low	542	12.63
	High	456	10.63
Third trimester (b)	*Zero*	3,310	77.88
	Low	512	12.05
	High	428	10.07
	No third trimester	41	0.96
Full pregnancy	*Zero*	2,762	64.37
	Low	831	19.37
	High	698	16.27
Mother's age at birth	*12–19*	1,281	29.85
	20–24	1,601	37.31
	25–29	818	19.06
	30–34	394	9.18
	35–39	161	3.75
	40–49	36	0.84
Gestational length	5–6 months	41	0.96
	7 months	97	2.26
	8 months	532	12.40
	9 months	3,619	84.34
	10 months	2	0.05
Teen pregnancy	*No*	3,010	70.15
	Yes	1,281	29.85
Type of place of residence	*Rural*	1,434	33.42
	Urban low density	886	20.65
	Urban high density	1,921	44.77
	Urban density missing	50	1.17
Mother's educational level	*Primary or lower*	1,787	41.65
	Secondary	2,137	49.80
	Tertiary	367	8.55
TOTAL		**4,291**	**100.00**

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Casualties during:					
First trimester	4,291	8.78	21.04	0	305
Second trimester	4,291	8.71	21.08	0	305
Third trimester (b)	4,250	7.61	18.46	0	305
Full pregnancy	4,291	25.02	51.83	0	581
Coca hectares	4,291	2382.28	4957.85	0	62159.69
Birth weight	4,291	3217.95	603.19	500	7000
Birth order	4,291	1.57	.58	1	4

(b) The sample size for conflict exposure is somewhat lower during third trimester because pregnancies ending in live birth after five or six months did not have a third trimester.

Models

We conduct linear regressions to estimate how exposure to local violence and coca plantations relate to weight at birth.

Mother-fixed effects are used to rule out unobserved heterogeneity based on factors that do not vary across women's pregnancies. Our results should therefore not be driven by unobserved, time-invariant compositional differences between mothers that correlate with birth outcomes. Those characteristics include genetics, ethnicity, location, and age at first birth. The fixed effects do not control for endogeneity emerging from time-varying unobserved variation that is not captured by period, birth order, or birth cohort of mother and child. Still, much of this time-varying unobserved variation may be attributable to the mechanisms of the exposure (conflict) and not necessarily confounders.

Five stepwise model specifications were estimated. Model 1 adjusted for birth order and the gestational length of the pregnancy only, analyzing the impact of exposure to violence and anti-coca fumigation during the full pregnancy. Model 2 added mother-fixed effects and age at childbirth. Model 3 broke down the violence and fumigation exposure variables into three exposure windows, corresponding to each trimester. In Models 4–6 we explored heterogeneous effects according to, respectively, mother's type of place of residence, whether the pregnancy was to an adolescent mother, and mother's level of education. We split the sample across these three variables, rather than add interaction effects, because an interaction based on time-constant and time-varying covariates may not yield an accurate within-unit estimate in fixed effects models (Giesselmann and Schmidt-Catran, 2020). We use predicted probabilities to assess the social significance of findings from Models 4–6. Finally, Model 7 estimates the effects of intrauterine exposures for children born to the most vulnerable mothers we identified: adolescent girls with low education in urban areas exposed to organized violence. We present predicted probabilities for this specific group.

Results

Estimates of the relationship between intrauterine exposure to organized violence and anti-coca fumigation on birthweight are presented in Table 2. Models 1.1–2.2 explores this relationship throughout the full pregnancy, and Models 3.1–4.2 disaggregated by trimester.

In the most basic Model 1.1, without maternal fixed effects or age at childbirth, exposure to violence during pregnancy relates positively to birthweight, but the finding is not statistically significant. After introducing fixed effects and age at childbirth in Model 2.1, there is a statistically significant negative association between exposure to violence during pregnancy and birthweight, by -0.75 g per additional battle casualty.

Exposure to low levels of fumigation was positively and significantly associated with birthweight by 55 g in Model 1.2, but these findings do not hold once we introduce fixed effects. Instead, the relationship is negative and statistically insignificant. Focusing on point estimates, we find no substantial difference between low and high fumigation levels, which implies that any level of fumigation is potentially harmful.

The change between the models in the effect direction means that maternal or local effects on birthweight were correlated with conflict casualties and fumigation. Since these models control for gestational length of the pregnancy, this indicates that a mother's exposure to organized violence is indeed detrimental to the intrauterine growth of her children, in support of Hypotheses 1.

The maternal fixed effects' error term accounts for 50 to 60 percent of the variation in birthweight according to Rho (not shown). It suggests that the fixed effects are an important addition to the model.

Table 2 Regression models of the associations between birth weight and exposure to organized violence and anti-coca fumigation during pregnancy

	Full pregnancy (n=4,291)	
Model 1.1		
Casualties	0.24	(0.20)
Model 1.2		
Fumigation level (ref.=no fumigation)		
Low	**54.73***	(23.83)
High	32.93	(31.53)
Model 2.1		
Casualties	**-0.75****	(0.28)
Model 2.2		
Fumigation level (ref.=no fumigation)		
Low	-33.81	(33.35)
High	-45.66	(45.19)

	Trimester 1 (n=4,291)		Trimester 2 (n=4,291)		Trimester 3 (n=4,250)	
Model 3.1						
Casualties	0.56	(0.45)	0.37	(0.54)	0.72	(0.51)
Model 3.2						
Fumigation level (ref.=no fumigation)						
Low	7.43	(27.83)	9.28	(25.76)	15.05	(30.75)
High	-30.71	(32.78)	15.69	(31.87)	-6.22	(28.96)
Model 4.1						
Casualties	**-1.41***	(0.68)	**-1.76*****	(0.53)	-0.14	(0.68)
Model 4.2						
Fumigation level (ref.=no fumigation)						
Low	-31.56	(33.07)	-40.09	(31.36)	-52.72	(34.68)
High	-47.12	(39.74)	1.79	(37.16)	**-74.07***	(37.28)

***p < 0.001, ** p < 0.01, *p < 0.05, ref.=reference. Standard errors clustered by mother in parentheses. All models adjust for birth order and gestational length. Models 2.1, 2.2, 4.1 and 4.2 include mother fixed effects and mother's age at childbirth. Models 1.2, 2.2, 3.2 and 4.2 control for coca cultivation during the year(s) of pregnancy.

Next, we break down the relationship further by looking at exposure during the three trimesters separately. Again, the association between violence and birthweight is first positive and insignificant in the basic Model 3.1, but negative and significant when adding fixed effects and age at childbirth in Model 4.1. We find that the prior result was driven by exposure to violence during the first and second trimesters, by -1.41 and -1.76 g respectively per additional casualty.

In Model 3.2, there are no significant relationships, but these results do not hold when we add fixed effects and mother's age at birth in Model 4.2. According to the latter, point estimates are more consistently negative for birth weight, with similar magnitude for low and high exposure, excluding the second trimester. The only estimate to be considered reasonably statistically significant was exposure to high levels of fumigation during the third trimester, which was associated with a -74 g reduction compared to no exposure. This finding supports Hypothesis 2.

In other words, the coefficients in Models 2.1 and 2.2 were diminished because the effects were averaged out over all three trimesters, which obscured the insignificant relationship in the third trimester with casualties and the significant relationship in the third trimester with fumigation.

Table 3 Predicted birth weight in grams by exposure to organized violence and anti-coca fumigation

Model 4.1	**Trimester 2 (n=4,291)**	
Casualties		
0	3233 g	(3224-3242 g)
150	2969 g	(2823-3115 g)
300	2706 g	(2405-3007 g)
Model 4.2	**Trimester 3 (n=4,250)**	
Fumigation level (ref. = no fumigation)		
No	3243 g	(3232-3255 g)
Low	3136 g	(2945-3327 g)
High	3029 g	(2635-3423 g)

***$p < 0.001$, ** $p < 0.01$, *$p < 0.05$, ref.=reference. Confidence intervals in parenthesis. The predictive margins are derived from Models 4.1 and 4.2 in Table 2. Adjusted for mother fixed effects, birth order, gestational length, and mother's age at childbirth. Model 4.2 controls for coca cultivation during the year(s) of pregnancy. Controls are adjusted at their mean values.

To estimate the social significance of these findings, we use predicted probabilities derived from Models 4.1 and 4.2 presented in Table 3. The predicted margins are based on the mean values in the control variables and for the trimester that displayed the most sensitivity to each respective external shock. These predictions show a negative gradient in weight at birth over exposure to both violence and fumigation with violence showing a markedly steeper gradient. However, confidence intervals indicate that having any conflict violence is more predictive of a lower birth weight than the difference between different thresholds of casualties. For fumigation, all confidence intervals overlap.

Children born to mothers who were not exposed to violence weigh on average 3233 g, i.e., close to the mean weight at birth of 3218 g for the full sample (see Table 1). By comparison, those born to mothers exposed to the highest observed value of organized violence (300 deaths) during the second trimester weigh on average 2706 g. Although extrapolating to 300 casualties may include only a small portion of our sample (as shown in the CIs), it is a level of casualties that is not uncommon in contexts of armed conflict more generally. When it comes to fumigation, the predicted estimates are 3242 g for the unexposed and 3029 g for children born to mothers that were exposed to high levels during the third trimester. The average difference of 527 and 213 g between the exposed and the unexposed of, respectively, violence and fumigation is not large enough to push exposed children beneath the clinical definition of low birthweight (at 2500 g) but may nevertheless place them at a disadvantage in terms of future health and SES outcomes.

Heterogeneous Effects

Next, we test Hypotheses 3–5 to explore whether these relationships vary by subgroups of the population. More specifically, we split the sample according to whether the mother was a teenager, type of place of residence, and mother's highest level of education. These models all apply a fixed effects approach and are displayed in Table 4.

Table 4 Regression models of the associations between birth weight and exposure to violence and anti-coca fumigation during pregnancy, by subgroups of the population

	Subgroup	Trimester 1		Trimester 2		Trimester 3	
Model 5.1	Teen pregnancy						
Casualties	*No*	-1.17	(0.67)	-0.71	(0.69)	1.23	(0.78)
	Yes	-2.97	(2.35)	**-4.21*****	(1.26)	**-3.32***	(1.64)
Model 5.2							
Fumigation level (ref.=no fumigation)							
Low	*No*	-38.88	(39.19)	-66.62	(40.06)	-61.22	(39.97)
High		-18.16	(55.02)	-17.16	(45.71)	-88.22	(49.96)
Low	*Yes*	27.24	(82.05)	53.20	(71.05)	41.53	(78.12)
High		-66.89	(82.83)	66.83	(86.04)	-69.36	(70.90)
Model 6.1	Residence						
Casualties	*Rural*	0.49	(1.41)	-1.01	(0.80)	1.37	(1.07)
	Urban low density	**-3.95****	(1.38)	-2.32	(1.63)	**-2.66***	(1.31)
	Urban high density	-1.57	(0.84)	**-2.17****	(0.72)	-0.50	(1.08)
Model 6.2							
Fumigation level (ref.=no fumigation)							
Low	*Rural*	-77.77	(57.37)	11.14	(57.57)	**-121.99***	(56.24)
High		-75.98	(73.71)	74.10	(61.45)	-78.47	(64.55)
Low	*Urban low density*	-88.75	(81.10)	-74.64	(67.14)	-82.70	(84.19)
High		26.00	(76.07)	-99.52	(73.45)	-88.46	(71.67)
Low	*Urban high density*	30.72	(46.00)	-67.49	(44.87)	8.89	(53.76)
High		-100.47	(63.49)	8.10	(60.41)	-86.76	(59.18)
Model 7.1	Education						
Casualties	*Primary or less*	**-2.59***	(1.16)	**-2.79*****	(0.72)	-0.47	(0.95)
	Secondary	-0.77	(1.01)	-1.54	(0.92)	0.63	(1.18)
	Tertiary	-0.05	(1.64)	1.44	(2.01)	-3.62	(3.46)
Model 7.2							
Fumigation level (ref.=no fumigation)							
Low	*Primary or less*	-47.64	(61.17)	-33.18	(59.84)	**-122.17***	(58.65)
High		-64.54	(68.80)	17.05	(68.29)	-99.41	(57.38)
Low	*Secondary*	-8.03	(53.15)	-47.28	(46.65)	-13.50	(56.79)
High		3.24	(68.88)	-1.65	(58.17)	-80.81	(65.35)
Low	*Tertiary*	-30.19	(103.15)	-98.77	(108.59)	**-196.08***	(79.35)
High		-133.92	(135.55)	-38.45	(114.14)	-15.69	(137.97)

***p < 0.001, ** p < 0.01, *p < 0.05, ref.=reference. Standard errors clustered by mother in parentheses. All models adjust for mother fixed effects, birth order and gestational length. Models 5.2, 6.2 and 7.2 control for coca cultivation during the year(s) of pregnancy. All models except 5.1 and 5.2 control for mother's age at childbirth. In Models 6.1 and 6.2, high population density is defined as a municipality with more than 50 inhabitants per km2.

Exposure to violence during second and third trimesters links to lower birthweight for teenage mothers, by around -3 to -4 g per additional casualty (model 5.1), which is more than four times the effect we saw for the whole sample. There is also a health penalty of exposure to organized violence for urban mothers regardless of the population density in the municipality of residence, by around -2 to -4 g per additional casualty (model 6.1). In low-density urban areas, the effects during first and third trimesters are significant. In high-density areas, it is the second trimester that appears to matter, although there is no substantive difference between the point estimates for the first and second trimesters. For children born to mothers with primary or lower levels of education, exposure to violence during the first and second trimesters is associated with around a -2.7 g reduction in birthweight per casualty (model 7.1).

Exposure to low levels of fumigation is significantly negative for birthweight in rural areas (-122 g, Model 6.2) and among mothers with primary or tertiary education (-122 or -196 g, Model 7.2). All significant effects of fumigation can be found during the third trimester. Exposure to high levels of fumigations is not significantly related to birthweight for any sociodemographic groups. We find the greatest precision of estimates for low fumigation levels and the third trimester, even if point estimates are often similar for high fumigation levels.

Due to the fixed effects and split sample approach, our teen pregnancy variable captures women who had *only* adolescent pregnancies during observation, not those who had at least one. Since adolescent pregnancy is so common in Colombia, as in many other low- and middle-income contexts plagued by armed conflict, we believe this analysis has merit despite the selective sample. In the Appendix we discuss an alternative approach to investigating how teenage pregnancy matters for the effect of conflict on birthweight (see Table I). The strong health penalty of violence in the second trimester holds for women who have only one teenage pregnancy.

Looking at the overall picture emerging from Table 4, not all point estimates operate in the expected direction in these stratified models. For example, we find substantial positive coefficients related to casualties for the third trimester for non-teenage pregnancies and for those occurring in rural areas, as well as for tertiary educated women in the second trimester. These counterintuitive findings are not statistically significant, which is likely due to smaller samples and loss of power.

Table 5 shows predicted probabilities derived from the corresponding models in Table 4, zooming in on the trimester that was most affected. Regardless of SES, the children that we observe are not terribly affected by fumigation, as all groups range between 3106–3376 g on average at birth.

Table 5 Predicted birth weight in grams by exposure to violence and fumigation across subgroups of the population

Teen pregnancy		**No**	**Yes**
Model 5.1			
Casualties (second trimester)			
0		3243 g (3252-3255 g)	3211 g (3189-3234 g)
150		3136 g (2945-3327 g)	2580 g (2231-2928 g)
300		3029 g (2635-3423 g)	1948 g (1228-2668 g)
Model 5.2			
Fumigation level (third trimester)			
No		3270 g (3251-3288 g)	3189 g (3159-3220 g)
Low		3220 g (3153-3286 g)	3240 g (3103-3377 g)
High		3184 g (3078-3289 g)	3168 g (3038-3299 g)
Type of place of residence	**Rural**	**Urban low density**	**Urban high density**
Model 6.1			
Casualties (first trimester)			
0	3224 g (3198-3249 g)	3277 g (3256-3299 g)	3215 g (3199-3230 g)
150	3297 g (2908-3687 g)	2685 g (2300-3069 g)	2979 g (2746-3213 g)
300	3371 g (2566-4175 g)	2092 g (1302-2882 g)	2744 g (2263-3225 g)
Model 6.2			
Fumigation level (third trimester)			
No	3249 g (3215-3282 g)	3292 g (3255-3328 g)	3225 g (3203-3246 g)
Low	3160 g (3067-3252 g)	3217 g (3080-3354 g)	3256 g (3165-3347 g)
High	3234 g (3065-3403 g)	3182 g (3052-3312 g)	3181 g (3029-3333 g)
Mother's level of education	**Primary**	**Secondary**	**Tertiary**
Model 7.1			
Casualties (second trimester)			
0	3232 g (3217-3247 g)	3245 g (3231-3258 g)	3202 g (3181-3224 g)
150	2813 g (2618-3008 g)	3014 g (2759-3270 g)	3418 g (2849-3987 g)
300	2394 g (1988-2799 g)	2784 g (2259-3309 g)	3634 g (2474-4793 g)
Model 7.2			
Fumigation level (third trimester)			
No	3233 g (3209-3258 g)	3263 g (3240-3286 g)	3254 g (3192-3316 g)
Low	3127 g (3029-3225 g)	3247 g (3153-3341 g)	3106 g (2953-3259 g)
High	3186 g (3078-3295 g)	3168 g (3035-3302 g)	3376 g (2987-3766 g)

***$p < 0.001$, ** $p < 0.01$, *$p < 0.05$, ref.=reference. Confidence intervals in parentheses. The predictive margins are derived from corresponding Models presented in Table 4. Adjusted for mother fixed effects, birth order, and gestational length. All models except 5.1 and 5.2 control for mother's age at childbirth. Models 5.2, 6.2 and 7.2 control for coca cultivation during the year(s) of pregnancy. In Models 6.1 and 6.2, high population density is defined as a municipality with more than 50 inhabitants per km2. Controls are adjusted at their mean values.

The children who fare worst among all groups under analysis are those from teenage mothers exposed to high levels of organized violence during the second trimester, in accordance with Hypothesis 3 (but only with respect to violence, not fumigation). Whereas unexposed mothers do not differ notably in terms of age at birth, children born to highly violence-exposed teenage mothers weigh on average 1263 g less than the unexposed.

Similarly, there is no spatial segregation in weight at birth among the unexposed, who are all average-weight, regardless of type of residence. But children born to urban mothers residing in either low- or high-population density areas exposed to high levels of organized violence during the first trimester weigh on average 1187 or 471 less, respectively, which is surprising since rural mothers were expected to fare worse according to Hypothesis 4. Given that stable geographical factors are netted out by fixed effects, these differences only reflect time-varying variation in rural and urban areas.

The same pattern can be found for educational differences; the unexposed children weigh close to the average weight at birth regardless of mother's educational level, but exposed children from mothers with little to no education weigh more than 800 g less at 2394 g. Also among those with secondary education, there is a gradient in birthweight over conflict and the highly exposed weigh almost 500 g less. We thus find support of Hypothesis 5. It seems, then, that women with lower SES are more vulnerable to the mechanisms linking conflict to low birth weight.

To investigate further how various vulnerabilities may intersect, we look at marginal effects for the group that seem to be most at risk from exposure to violence (Table 6): adolescent mothers with low education in urban areas. Here, we group pregnancies to mothers in all urban areas regardless of population density. Also in this unique group, mothers who are not exposed to organized violence give birth to average-sized children. But children born to the most exposed mothers in this demographic weigh on average 1623 g, which is well under the low birthweight threshold and constitutes a substantial health penalty.

Table 6 Predicted birth weight in grams by exposure to violence among adolescent mothers with low education in urban areas (regardless of population density in municipality)

Model 7	**Trimester 2 (n=650)**	
Casualties		
0	3221 g	(3182-3261 g)
150	2422 g	(1869-2975 g)
300	1623 g	(477-2769 g)

***p < 0.001, ** p < 0.01, *p < 0.05, ref.=reference. Confidence intervals in parentheses. Adjusted for mother fixed effects, birth order, and gestational length. Controls are adjusted at their mean values.

Limitations

Information on birthweight was limited by mother's knowledge and some children not having been weighed after birth. While there was no selection bias according to department, residence or age at birth, mothers with primary education or lower were substantially more likely not to report birthweight. This may have been due to mother's illiteracy and/or giving birth outside of medical facilities. We attempted to avoid this potential selection bias by stratifying the sample according to education as well as by excluding women with only primary education or lower (see Table F in the Appendix). Removing women with lower education from the sample weakened the relationship as would be expected if the detrimental effects of conflict on birthweight are driven by women with lower SES, as displayed in Tables 5 and 6. The health penalty we observe related to this vulnerable group may be underestimating the full effect if we were able to avoid the loss of those who did not report a birth weight, particularly if this is due to differences in literacy or medical intervention into childbirth.

Our models did not account for any meteorological drift by which fumigation could spill over into neighboring regions and from rural to urban areas (Benner, Mena, and Schneider 2016), nor spatial diffusion of conflict by which battle violence in one area could spill over to neighboring regions (Gleditsch and Weidmann 2012). Measuring exposure in larger departments rather than smaller municipalities likely remedies this problem to a certain, but unmeasurable, extent. Our analysis also did not investigate ecological crises such as droughts and food production shortages, even if these are likely to affect nutritional intake and intrauterine growth (Bozzoli and Quintana-Domeque 2014).

Our data do not contain detailed information about women's migration histories, which poses a challenge to exposure identification. The only available information is the number of years women have lived in the place of residence at interview, from which it is possible to infer the year of relocation[5]. Even if we excluded women who reported a move during pregnancy from the sample, respondents may not disclose shorter moves and returns. It is also not known whether women moved within the same administrative unit or not. Past research shows that aerial eradication spraying does not relate to selective migration (Camacho and Mejía 2017). Conflict is, however, a known driver of migration including forced displacement albeit not uniformly (Verwimp et al. 2020; Williams et al. 2021).

We did not explore how the relationship between armed conflict and birthweight differed depending on the gender of the child. Boys are expected to be more sensitive to adverse intrauterine exposure than girls (Dagnelie et al. 2018; Quintana-Domeque and Ródenas-Serrano 2017; Valente 2015). But same-sex sibling models over-sample families with three

[5] There is no information in the Colombian DHS about previous place of residence that may enable analyses of how rural-urban migration influences birth outcomes (cf. Østby 2016a) nor about the distance to a healthcare facility (cf. Karra, Fink, and Canning 2017). We cannot assess the issue of displacement because data on this was only available in the 2010 survey round and thus not used here (cf. Friedemann-Sanchez and Lovaton 2012).

children or families who have same-sex siblings, which hinders generalizability to the whole population and may introduce unknown sources of selectivity bias.

Women may lose access to health care and adopt health-protective behaviors due to conflict. However, we could not use an indicator of antenatal care visits due to a lack of variation when combining the fixed effects, pregnancy characteristics and birthweight in stratified models by antenatal care. We could also not investigate the relevance of giving birth in or outside a healthcare facility, as this information was not available in the Colombian DHS.

Family income or wealth were not available as time-varying indicators, and therefore not included as controls but instead picked up by the mother-fixed effects to the extent that these are stable over time. Father's characteristics are not included, which may be important if there are systematic differences by geographical location or due to homogamy according to SES. To the extent that all observed pregnancies are to the same father, these are also adjusted with the maternal fixed effects. Additionally, paternal characteristics tend to be less relevant than maternal (Mattsson and Rylander 2013; Shah 2010).

Discussion

We found that pregnant women's exposure to organized violence and aerial anti-coca fumigation of glyphosate in the context of armed conflict was linked to lower weight at birth, net of gestational length. This suggests that multiple harmful factors that Colombian women face during pregnancy lead to a reduction in fetal growth. The results corroborate Camacho's (2008) findings for birthweight reductions in relation to landmine explosions in Colombia, by also looking at non-institutional births and a more comprehensive definition of organized violence. In relation to other pregnancy outcomes, our conclusions are also in line with Camacho and Mejía's (2017) report of an increased risk of pregnancy complications ending in miscarriage due to fumigation. While an increase in miscarriages due to fumigation represent a culling effect, our results are indicative of a scarring effect on live-born children through lower birthweight that may impair their future health and SES outcomes. This supported our Hypothesis 1.

Even if the results for conflict were more consistent, fumigation is not necessarily a negligible factor given the large amount of evidence that points towards negative future outcomes for children born lower-weight. Thus, we find partial support for Hypothesis 2. It is also possible that fumigation has other detrimental effects to health than reductions in birthweight. For example, our results are net of gestational length, and it is possible that fumigation increases the risk of preterm birth. We already know that higher levels of glyphosate in pregnant women have been associated with shorter gestational length (Parvez et al. 2018) and that fumigation in Colombia correlates with an increase in the risk of miscarriage (Camacho and Mejía 2017). The latter finding suggests that our sample is likely positively selected and thus may be more robust to the adverse health effects of fumigation. We were not able to investigate gestational length as an outcome due to the lack of detailed information on gestational length in the data. Potential selection effects into live birth means that the findings reported here should be regarded as floor effects.

We found that the relationship between birthweight and violence was driven by exposure during the first and second trimesters, and between birthweight and fumigation during the third trimester. Past literature suggests that the first trimester is most sensitive to mother's stress (Mulder et al. 2002) and the third trimester is most sensitive to harmful effects on fetal growth, such as nutritional deficiencies (Bozzoli and Quintana-Domeque 2014). Even if we cannot make any conclusive interpretations on which mechanism is operative to drive the relationships due to a lack of data, it is clear that timing matters. This finding underscores the need for future research to disaggregate pregnancy outcomes from hazardous exposures by trimester.

Our findings also point towards teenage mothers as a particularly vulnerable group in terms of hazardous exposures during pregnancy, in line with Hypothesis 3. Since adolescent fertility is relatively common in Colombia, our findings emphasize the need to support young women's family planning and maternal health needs. This is especially important in Latin America, where both teenage pregnancies and organized violence are common. Past literature has discussed adolescent pregnancy as a consequence of conflict and inequality (Alzate 2014). Our study adds to knowledge by empirically demonstrating that maternal and child health is negatively affected by exposure to conflict among teenage mothers.

It is clear that space matters for health outcomes. We expected in Hypothesis 4 that rural women would be more vulnerable to the effects of armed conflict than women living in the countryside. This seems to be true regarding fumigation exposure, but not organized violence. The only information about spatial segregation available in the DHS is the type of place of residence: urban vs. rural. But the urban poor in peripheral parts of cities often face bigger health risks than rural and city center dwellers, and in Latin America residents in smaller cities are disadvantaged in comparison to residents of large cities in terms of public services (Montgomery et al. 2003). We distinguished between urban areas with low or high population density to further unpack these differences. Our results suggest that those living in cities are at more risk from violence, regardless of the population density in the municipality. This unexpected finding may reflect urban poverty and that smaller urban areas or peripheral parts of larger cities may be as deprived of public services as rural residences, or are more poor, stressed, or at risk of interpersonal violence. But it is not possible to tell from the data what the mechanism behind that differential risk is.

We find support forHypothesis 5; mothers with lower education are more sensitive to violence compared to those with higher levels of education. This could be reflective of additional stress, income differentials, intimate partner violence, nutritional deficiencies, and less access to health care. However, we could not investigate these mechanisms more closely with the available data.

Finally, we show powerful additive effects of vulnerability to armed conflict on birthweight. The worst-off group in our sample (children born to adolescent mothers with low education in urban areas) are substantially lower weight when exposed to organized violence, compared to their unexposed peers. Our finding underscores the need for an intersectional approach to research and development initiatives, since multiple social structures shape health conditions with epigenetic repercussions across the lifecourse.

In conclusion, our findings show that armed conflict is detrimental to maternal and child wellbeing, which has negative consequences for development (Gates et al. 2012). Our study has clear policy implications. The Colombian government should – yet again – cease aerial anti-coca fumigation due to the potentially detrimental health effects on pregnant women and their children, and take all necessary steps to implement the Havana Peace Accords and secure peace negotiations with remaining non-state armed actors. This endeavor requires shifting focus from military to human security, from retributive to restorative justice. In terms of secondary prevention, efforts should focus on tailoring comprehensive and intersectional maternal, reproductive and child health interventions to women and children living in the most conflict-affected areas.

References

Adair, Linda S, Caroline HD Fall, Clive Osmond, Aryeh D Stein, Reynaldo Martorell, Manuel Ramirez-Zea, Harshpal Singh Sachdev, et al. (2013). Associations of Linear Growth and Relative Weight Gain during Early Life with Adult Health and Human Capital in Countries of Low and Middle Income: Findings from Five Birth Cohort Studies. *The Lancet* 382 (9891): 525–34. https://doi.org/10.1016/S0140-6736(13)60103-8.

Almond, Douglas, and Janet Currie. (2011). Killing Me Softly: The Fetal Origins Hypothesis. *Journal of Economic Perspectives* 25(3):153–72. doi: 10.1257/jep.25.3.153.

Alzate, Mónica M. (2014). Adolescent Pregnancy in Colombia: The Price of Inequality and Political Conflict. In *International Handbook of Adolescent Pregnancy*, edited by Andrew L. Cherry and Mary E. Dillon, 241–55. Boston, MA: Springer US. https://doi.org/10.1007/978-1-4899-8026-7_13.

de Araujo, Jessica S. A., Isabella F. Delgado, and Francisco J. R. Paumgartten. (2016). Glyphosate and Adverse Pregnancy Outcomes, a Systematic Review of Observational Studies. *BMC Public Health* 16(1):472. doi: 10.1186/s12889-016-3153-3.

Avila, Ramiro, Elizabeth Bravo, Jaime Breilh, Arturo Campaña, Cesar Paz-y-Mino, Luis Peñaherrera, and José Valencia. (2007). *El Sistema de Aspersiones Aéreas Del Plan Colombia y Sus Impactos Sobre El Ecosistema y La Salud En La Frontera Ecuatoriana*. Quito: Comisión Científica Ecuatoriana.

Barker, David J. (1995). Fetal Origins of Coronary Heart Disease. *BMJ* 311 (6998): 171–74. https://doi.org/10.1136/bmj.311.6998.171.

Ben-Shlomo, Yoav, and Diana Kuh. (2002). A Life Course Approach to Chronic Disease Epidemiology: Conceptual Models, Empirical Challenges and Interdisciplinary Perspectives. *International Journal of Epidemiology* 31 (2): 285–93. https://doi.org/10.1093/ije/31.2.285.

Benner, Peter, Hermann Mena, and René Schneider. (2016). Modeling Glyphosate Aerial Spray Drift at the Ecuador–Colombia Border. *Applied Mathematical Modelling* 40(1):373–87. doi: 10.1016/j.apm.2015.04.057.

Black, Sandra E., Paul J. Devereux, and Kjell G. Salvanes. (2016). Does Grief Transfer across Generations? Bereavements during Pregnancy and Child Outcomes. *American Economic Journal: Applied Economics* 8(1):193–223. doi: 10.1257/app.20140262.

Boeke, Caroline E., Constanza Marín, Henry Oliveros, Mercedes Mora-Plazas, Samantha Agudelo-Cañas, and Eduardo Villamor. (2012). Validity of Maternal Birthweight Recall Among Colombian Children. *Maternal and Child Health Journal* 16 (4): 753–59. https://doi.org/10.1007/s10995-011-0803-z.

Bozzoli, Carlos, and Climent Quintana-Domeque. (2014). The Weight of the Crisis: Evidence From Newborns in Argentina. *Review of Economics and Statistics* 96(3):550–62. doi: 10.1162/REST_a_00398.

Brown, Ryan. (2018). The Mexican Drug War and Early-Life Health: The Impact of Violent Crime on Birth Outcomes. *Demography* 55(1):319–40.

Buitrago, Giancarlo, and Rodrigo Moreno-Serra. (2021). Conflict Violence Reduction and Pregnancy Outcomes: A Regression Discontinuity Design in Colombia. *PLOS Medicine* 18(7):e1003684. doi: 10.1371/journal.pmed.1003684.

Camacho, Adriana. (2008). Stress and Birth Weight: Evidence from Terrorist Attacks. *The American Economic Review* 98(2):511–15.

Camacho, Adriana, and Daniel Mejía. (2017). The Health Consequences of Aerial Spraying Illicit Crops: The Case of Colombia. *Journal of Health Economics* 54:147–60. doi: 10.1016/j.jhealeco.2017.04.005.

Catalano, Ralph, and Terry Hartig. (2001). Communal Bereavement and the Incidence of Very Low Birthweight in Sweden. *Journal of Health and Social Behavior* 42(4):333–41. doi: 10.2307/3090182.

Chaparro González, Nina, Annika Dalén, Diana Esther Guzmán, and Margarita Martínez Osorio. (2015). *El ejercicio de la interrupción voluntaria del embarazo en el marco del conflicto armado*. Bogotá D.C: Dejusticia – Centro de estudios de derecho, justicia y sociedad.

Class, Quetzal A., Paul Lichtenstein, Niklas Långström, and Brian M. D’Onofrio. (2011). Timing of Prenatal Maternal Exposure to Severe Life Events and Adverse Pregnancy Outcomes: A Population Study of 2.6 Million Pregnancies. *Psychosomatic Medicine* 73(3):234–41. doi: 10.1097/PSY.0b013e31820a62ce.

Clemens, Tom, and Chris Dibben. (2017). Living in Stressful Neighbourhoods during Pregnancy: An Observational Study of Crime Rates and Birth Outcomes. *European Journal of Public Health* 27(2):197–202. doi: 10.1093/eurpub/ckw131.

Coker, Ann L., Maureen Sanderson, and Beili Dong. (2004). Partner Violence during Pregnancy and Risk of Adverse Pregnancy Outcomes. *Paediatric & Perinatal Epidemiology* 18(4):260–69. doi: 10.1111/j.1365-3016.2004.00569.x.

Croicu, Mihai, and Ralph Sundberg. (2018). *UCDP Georeferenced Event Dataset Codebook Version 18.1*. Uppsala University: Department of Peace and Conflict Research.

Currie, Janet, and Tom Vogl. (2013). Early-Life Health and Adult Circumstance in Developing Countries. *Annual Review of Economics* 5:1–36. doi: 10.1146/annurev-economics-081412-103704.

Dagnelie, Olivier, Giacomo Davide De Luca, and Jean-François Maystadt. (2018). ‘Violence, Selection and Infant Mortality in Congo’. *Journal of Health Economics* 59:153–77. doi: 10.1016/j.jhealeco.2018.02.004.

DANE. (2016). *Pobreza Multidimensional En Colombia Año 2016*. Bogotá: Departamento Administrativo Nacional de Estadística.

DHS. (2005). *Colombia Salud Sexual y Reproductiva*. Bogotá: Profamilia.

DHS. (2011). *Colombia Encuesta Nacional de Demografía y Salud 2010*. Bogotá: Profamilia.

DHS. (2017). *Colombia Encuesta Nacional de Demografía y Salud 2015*. Bogotá: Profamilia.

Eck, Kristine. (2012). In Data We Trust? A Comparison of UCDP GED and ACLED Conflict Events Datasets. *Cooperation and Conflict* 47(1):124–41. doi: 10.1177/0010836711434463.

Ekhator-Mobayode, Uche Eseosa, Lucia C. Hanmer, Eliana Rubiano-Matulevich, and Diana Jimena Arango. (2022). The Effect of Armed Conflict on Intimate Partner Violence: Evidence from the Boko Haram Insurgency in Nigeria. *World Development* 153 (May):105780. doi: 10.1016/j.worlddev.2021.105780.

Ellsberg, Mary, Henrica A. F. M. Jansen, Lori Heise, Charlotte H. Watts, and Claudia García-Moreno. (2008). Intimate Partner Violence and Women's Physical and Mental Health in the WHO Multi-Country Study on Women's Health and Domestic Violence: An Observational Study. *The Lancet* 371:1165–72. doi: 10.1016/S0140-6736(08)60522-X.

Felker-Kantor, Erica, Maeve Wallace, and Katherine Theall. (2017). Living in Violence: Neighborhood Domestic Violence and Small for Gestational Age Births. *Health & Place* 46:130–36. doi: 10.1016/j.healthplace.2017.05.011.

Foureaux Koppensteiner, Martin, and Marco Manacorda. (2016). Violence and Birth Outcomes: Evidence from Homicides in Brazil. *Journal of Development Economics* 119:16–33. doi: 10.1016/j.jdeveco.2015.11.003.

Franco, Saúl, Clara Mercedes Suarez, Claudia Beatriz Naranjo, Liliana Carolina Báez, and Patricia Rozo. (2006). The Effects of the Armed Conflict on the Life and Health in Colombia. *Ciência & Saúde Coletiva* 11(2):349–61.

Friedemann-Sanchez, Greta, and Rodrigo Lovaton. (2012). Intimate Partner Violence in Colombia: Who Is at Risk? *Social Forces* 91(2): 663–88. https://doi.org/10.1093/sf/sos131.

Gates, Scott, Håvard Hegre, Håvard Mokleiv Nygård, and Håvard Strand. (2012). Development Consequences of Armed Conflict. *World Development* 40(9): 1713–22. Doi: 10.1016/j.worlddev.2012.04.031.

García-Moreno, Claudia, Christina Pallitto, Karen Devries, Heidi Stöckl, Charlotte Watts, and Naeemah Abrahams. (2013). *Global and Regional Estimates of Violence against Women: Prevalence and Health Effects of Intimate Partner Violence and Non-Partner Sexual Violence*. Geneva: World Health Organization.

Giesselmann, Marco, and Alexander W. Schmidt-Catran. (2020). Interactions in Fixed Effects Regression Models. *Sociological Methods & Research*. doi: 10.1177/0049124120914934.

Gleditsch, Kristian Skrede, and Nils B. Weidmann. (2012). Richardson in the Information Age: Geographic Information Systems and Spatial Data in International Studies. *Annual Review of Political Science* 15 (1): 461–81. https://doi.org/10.1146/annurev-polisci-031710-112604.

Goin, Dana E., Anu M. Gomez, Kriszta Farkas, Scott C. Zimmerman, Ellicott C. Matthay, and Jennifer Ahern. (2019). Exposure to Community Homicide During Pregnancy and Adverse Birth Outcomes: A Within-Community Matched Design. *Epidemiology* 30(5):713–22. doi: 10.1097/EDE.0000000000001044.

Hoang, Thanh Nguyen, Toan Ngo Van, Tine Gammeltoft, Dan W. Meyrowitsch, Hanh Nguyen Thi Thuy, and Vibeke Rasch. (2016). Association between Intimate Partner Violence during Pregnancy and Adverse Pregnancy Outcomes in Vietnam: A Prospective Cohort Study. *PLoS ONE* 11(9):1–14. doi: 10.1371/journal.pone.0162844.

Holford, Theodore R. 2006. Approaches to Fitting Age-Period-Cohort Models with Unequal Intervals. *Statistics in Medicine* 25(6):977–93. doi: 10.1002/sim.2253.

Ibáñez, Ana María, and Carlos Eduardo Vélez. (2008). Civil Conflict and Forced Migration: The Micro Determinants and Welfare Losses of Displacement in Colombia. *World Development* 36 (4): 659–76. Doi: 10.1016/j.worlddev.2007.04.013.

Idrovo, Alvaro Javier, and Laura A. Rodríguez-Villamizar. (2018). Moving Back in Policy Banning Glyphosate Use in Colombia. *The Lancet* 392(10154):1194. doi: 10.1016/S0140-6736(18)31883-X.

Jansson, Oscar. (2008). *The Cursed Leaf: An Anthropology of the Political Economy of Cocaine Production in Southern Colombia*. PhD thesis, Department of Cultural Anthropology and Ethnology, Uppsala University.

Juárez, Sol, Anna Goodman, Bianca De Stavola, and Ilona Koupil. (2016). Birth Characteristics and All-Cause Mortality: A Sibling Analysis Using the Uppsala Birth Cohort Multigenerational Study. *Journal of Developmental Origins of Health and Disease* 7(4):374–83. doi: 10.1017/S2040174416000179.

Karra, Mahesh, Günther Fink, and David Canning. (2017). Facility Distance and Child Mortality: A Multi-Country Study of Health Facility Access, Service Utilization, and Child Health Outcomes. *International Journal of Epidemiology* 46(3): 817–26. https://doi.org/10.1093/ije/dyw062.

Kishor, Sunita, and Kiersten Johnson. (2004). *Profiling Domestic Violence: A Multi-Country Study.* Calverton, Maryland: ORC Macro.

Kramer, Michael S. (1987). Determinants of Low Birth Weight: Methodological Assessment and Meta-Analysis. *Bulletin of the World Health Organization* 65 (5): 663–737.

Kramer, Michael S. 1987. Intrauterine Growth and Gestational Duration Determinants. *Pediatrics* 80(4):502–11. doi: 10.1542/peds.80.4.502.

Kravdal, Øystein. 2019. Taking Birth Year into Account When Analysing Effects of Maternal Age on Child Health and Other Outcomes: The Value of a Multilevel-Multiprocess Model Compared to a Sibling Model. *Demographic Research* 40:1249–90.

Krieger, Nancy, Jarvis T. Chen, Pamela D. Waterman, Mah-Jabeen Soobader, S. V. Subramanian, and Rosa Carson. (2003). Choosing Area Based Socioeconomic Measures to Monitor Social Inequalities in Low birthweight and Childhood Lead Poisoning: The Public Health Disparities Geocoding Project (US). *Journal of Epidemiology & Community Health* 57 (3): 186–99. https://doi.org/10.1136/jech.57.3.186.

La Mattina, Giulia. (2017). Civil Conflict, Domestic Violence and Intra-Household Bargaining in Post-Genocide Rwanda. *Journal of Development Economics* 124:168–98. doi: 10.1016/j.jdeveco.2016.08.001.

Laszlo, Kd, T. Svensson, J. Li, C. Obel, M. Vestergaard, J. Olsen, and S. Cnattingius. (2013). Maternal Bereavement during Pregnancy and the Risk of Stillbirth: A Nationwide Cohort Study in Sweden. *American Journal of Epidemiology* 177(3):219–27. doi: 10.1093/aje/kws383.

Lauderdale, Diane S. (2006). Birth Outcomes for Arabic-Named Women in California before and after September 11. *Demography* 43(1):185–201.

Lipsky, Sherry, Victoria L. Holt, Thomas R. Easterling, and Casthy W. Critchlow. (2004). Police-Reported Intimate Partner Violence During Pregnancy and the Risk of Antenatal Hospitalization. *Maternal & Child Health Journal* 8(2):55–63. doi: 10.1023/B:MACI.0000025727.68281.aa.

Lipsky, Sherry, Victoria L. Holt, Thomas R. Easterling, and Cathy W. Critchlow. (2003). Impact of Police-Reported Intimate Partner Violence during Pregnancy on Birth Outcomes. *Obstetrics & Gynecology* 102(3):557–64. doi: 10.1016/S0029-7844(03)00573-8.

Matoba, Nana, Margarita Reina, Nikhil Prachand, Matthew M. Davis, and James W. Collins. (2019). Neighborhood Gun Violence and Birth Outcomes in Chicago. *Maternal and Child Health Journal* 23(9):1251–59. doi: 10.1007/s10995-019-02765-w.

Mattsson, Kristina, and Lars Rylander. (2013). Influence of Maternal and Paternal Birthweight on Offspring Birthweight – a Population-Based Intergenerational Study. *Paediatric and Perinatal Epidemiology* 27(2):138–44. doi: 10.1111/ppe.12015.

Martes-Camargo, Paula Mercedes. (2015). Análisis de La Fecundidad Adolescente En Colombia, 2010. *Papeles de Población* 21 (85): 141–76.

Mayne, Stephanie L., Lindsay R. Pool, William A. Grobman, and Kiarri N. Kershaw. (2018). Associations of Neighbourhood Crime with Adverse Pregnancy Outcomes among Women in Chicago: Analysis of Electronic Health Records from 2009 to 2013. *Journal of Epidemiology and Community Health* 72(3):230–36. doi: 10.1136/jech-2017-209801.

Messer, Lynne C., Jay S. Kaufman, Nancy Dole, Amy Herring, and Barbara A. Laraia. (2006). Violent Crime Exposure Classification and Adverse Birth Outcomes: A Geographically-Defined Cohort Study. *International Journal of Health Geographics* 5(1):22. doi: 10.1186/1476-072X-5-22.

Montgomery, Mark R., Richard Stren, Barney Cohen, and Holly E. Reed, eds. (2003). *Cities Transformed: Demographic Change and Its Implications in the Developing World*. Washington, DC: The National Academies Press. doi: 10.17226/10693.

Moraes, C. L., A. R. Amorim, and M. E. Reichenheim. (2006). Gestational Weight Gain Differentials in the Presence of Intimate Partner Violence. *International Journal of Gynecology & Obstetrics* 95(3):254–60. doi: 10.1016/j.ijgo.2006.08.015.

Morenoff, Jeffrey D. (2003). Neighborhood Mechanisms and the Spatial Dynamics of Birth Weight. *American Journal of Sociology* 108(5):976–1017. doi: 10.1086/374405.

Mulder, Eduard JH, PG Robles De Medina, Anja C. Huizink, Bea RH Van den Bergh, Jan K. Buitelaar, and Gerard HA Visser. (2002). Prenatal Maternal Stress: Effects on Pregnancy and the (Unborn) Child. *Early Human Development* 70(1):3–14.

Nakamura, Katrina, Sam Sheps, and Petra Clara Arck. (2008). Stress and Reproductive Failure: Past Notions, Present Insights and Future Directions. *Journal of Assisted Reproduction and Genetics* 25(2–3):47–62. doi: 10.1007/s10815-008-9206-5.

Oskorouchi, Hamid Reza. (2019). Learning to Fight: Afghan Child Health and In-utero Exposure to Conflict. *Population and Development Review* 45: 275–300. doi: 10.1111/padr.12229.

Østby, Gudrun. (2016a). Rural–Urban Migration, Inequality and Urban Social Disorder: Evidence from African and Asian Cities. *Conflict Management and Peace Science* 33(5): 491–515. https://doi.org/10.1177/0738894215581315.

Østby, Gudrun. (2016b). *Violence Begets Violence: Armed Conflict and Domestic Sexual Violence in Sub-Saharan Africa*. HiCN Working Paper 233.

Østby, Gudrun, Michele Leiby, and Ragnhild Nordås. (2019). The Legacy of Wartime Violence on Intimate-Partner Abuse: Microlevel Evidence from Peru, 1980–2009. *International Studies Quarterly* 63(1):1–14. doi: 10.1093/isq/sqy043.

Østby, Gudrun, Henrik Urdal, Andreas Forø Tollefsen, Andreas Kotsadam, Ragnhild Belbo, and Christin Ormhaug. (2018). *Demography* 55(4):1295–1316. doi: 10.1007/s13524-018-0685-4

Paganelli, Alejandra, Victoria Gnazzo, Helena Acosta, Silvia L. López, and Andrés E. Carrasco. (2010). Glyphosate-Based Herbicides Produce Teratogenic Effects on Vertebrates by Impairing Retinoic Acid Signaling. *Chemical Research in Toxicology* 23(10):1586–95. doi: 10.1021/tx1001749.

Parvez, S., R. R. Gerona, C. Proctor, M. Friesen, J. L. Ashby, J. L. Reiter, Z. Lui, and P. D. Winchester. (2018). Glyphosate Exposure in Pregnancy and Shortened Gestational

Length: A Prospective Indiana Birth Cohort Study. *Environmental Health* 17(1):23. doi: 10.1186/s12940-018-0367-0.

Piperata, Barbara A., Mariano Salazar, Kammi K. Schmeer, and Andrés Herrera Rodríguez. (2020). Tranquility Is a Child with a Full Belly: Pathways Linking Food Insecurity and Maternal Mental Distress in Nicaragua. *Ecology of Food and Nutrition* 59(1):79–103. doi: 10.1080/03670244.2019.1671835.

Pu, Yaoyu, Jun Yang, Lijia Chang, Youge Qu, Siming Wang, Zhongwei Xiong, Jiancheng Zhang, Yunfei Tan, Xingming Wang, Yuko Fujita, Tamaki Ishima, Debin Wang, Sung Hee Hwang, Bruce D. Hammock, and Kenji Hashimoto. (2020). Maternal Glyphosate Exposure Causes Autism-like Behaviors in Offspring through Increased Expression of Soluble Epoxide Hydrolase. *PNAS* 117(21):11753–59. doi: 10.1073/pnas.1922287117.

Quintana-Domeque, Climent, and Pedro Ródenas-Serrano. (2017). The Hidden Costs of Terrorism: The Effects on Health at Birth. *Journal of Health Economics* 56:47–60. doi: 10.1016/j.jhealeco.2017.08.006.

Ramos Jaraba, Sara Milena, Natalia Quiceno Toro, María Ochoa Sierra, Laura Ruiz Sánchez, Marlly Andrea García Jiménez, Mary Y. Salazar-Barrientos, Edison Bedoya Bedoya, Gladis Adriana Vélez Álvarez, Ana Langer, Jewel Gausman, and Isabel C. Garcés-Palacio. (2020). Health in Conflict and Post-Conflict Settings: Reproductive, Maternal and Child Health in Colombia. *Conflict and Health* 14(1):33. doi: 10.1186/s13031-020-00273-1.

Restrepo, Jorge A., Michael Spagat, and Juan F. Vargas. (2006). The Severity of the Colombian Conflict: Cross-Country Datasets Versus New Micro-Data. *Journal of Peace Research* 43(1):99–115. doi: 10.1177/0022343306059924.

Roth, Jeffrey, Jo Hendrickson, Max Schilling, and Daniel W. Stowell. (1998). The Risk of Teen Mothers Having Low Birth Weight Babies: Implications of Recent Medical Research for School Health Personnel. *Journal of School Health* 68 (7): 271–75. https://doi.org/10.1111/j.1746-1561.1998.tb00581.x.

Ruiz-Toledo, Jovani, Ricardo Castro, Norma Rivero-Pérez, Ricardo Bello-Mendoza, and Daniel Sánchez. (2014). Occurrence of Glyphosate in Water Bodies Derived from Intensive Agriculture in a Tropical Region of Southern Mexico. *Bulletin of Environmental Contamination and Toxicology* 93(3):289–93. doi: 10.1007/s00128-014-1328-0.

Ruuskanen, Suvi, Miia J. Rainio, Maiju Uusitalo, Kari Saikkonen, and Marjo Helander. (2020). Effects of Parental Exposure to Glyphosate-Based Herbicides on Embryonic Development and Oxidative Status: A Long-Term Experiment in a Bird Model. *Scientific Reports* 10(1):6349. doi: 10.1038/s41598-020-63365-1.

dos Santos, Angélica Carreira, Alexandra Brentani, and Günther Fink. (2021). Associations between Neighborhood Violence during Pregnancy and Birth Outcomes: Evidence from São Paulo's Western Region Birth Cohort. *BMC Public Health* 21(1):865. doi: 10.1186/s12889-021-10900-y.

Seng, Julia S., Lisa Kane Low, Mickey Sperlich, David L. Ronis, and Israel Liberzon. (2011). Posttraumatic Stress Disorder, Child Abuse History, Birth Weight, and Gestational Age: A Prospective Cohort Study. *BJOG : An International Journal of Obstetrics and Gynaecology* 118(11):1329–39. doi: 10.1111/j.1471-0528.2011.03071.x.

Shah, Prakesh S. (2010). Paternal Factors and Low Birthweight, Preterm, and Small for Gestational Age Births: A Systematic Review. *American Journal of Obstetrics and Gynecology* 202(2):103–23. doi: 10.1016/j.ajog.2009.08.026.

Sundberg, Ralph, and Erik Melander. (2013). Introducing the UCDP Georeferenced Event Dataset. *Journal of Peace Research* 50(4):523–32.

Svallfors, Signe. (2021a). Hidden Casualties: The Links between Intimate Partner Violence and Armed Conflict in Colombia. *Politics & Gender*, online first. doi: 10.1017/S1743923X2100043X.

Svallfors, Signe. (2021b). Reproductive Justice in the Colombian Armed Conflict. In *Bodies and Battlefields: Sexual and reproductive health and rights in the Colombian armed conflict*. PhD dissertation. Department of Sociology, Stockholm University.

Torche, Florencia, and Andrés Villarreal. (2014). Prenatal Exposure to Violence and Birth Weight in Mexico: Selectivity, Exposure, and Behavioral Responses. *American Sociological Review* 79(5):966.

U.S. Embassy in Colombia. (n.d.) Eradication & Environmental. *U.S. Embassy in Colombia*. Retrieved 29 December 2020 (https://co.usembassy.gov/embassy/bogota/sections-offices/eradication-environmental/).

Valente, Christine. (2015). Civil Conflict, Gender-Specific Fetal Loss, and Selection: A New Test of the Trivers–Willard Hypothesis. *Journal of Health Economics* 39:31–50. doi: 10.1016/j.jhealeco.2014.10.005.

Valladares, Eliette, Mary Ellsberg, Rodolfo Peña, Ulf Högberg, and Lars Åke Persson. (2002). Physical Partner Abuse during Pregnancy: A Risk Factor for Low Birth Weight in Nicaragua. *Obstetrics & Gynecology* 100(4):700–705. doi: 10.1016/S0029-7844(02)02093-8.

Verwimp, Philip, Davide Osti and Gudrun Østby. (2020). Forced Displacement, Migration, and Fertility in Burundi. *Population and Development Review* 46: 287-319. doi: 10.1111/padr.12316.

Wilcox, Allen J., and Rolv Skjaerven. (1992). "Birth Weight and Perinatal Mortality: The Effect of Gestational Age." *American Journal of Public Health* 82(3):378–82.

Williams, Nathalie, Michelle L. O'Brien, and Xiaozheng Yao. (2021). How Armed Conflict Influences Migration. *Population and Development Review* 47(3): 781–811. doi: 10.1111/padr.12408.

Wilson, Ben, Maarten J. Bijlsma, Siddartha Aradhya, and Alice Goisis. (2021). Problems in the Family: Controlling for Age, Period or Cohort in Sibling Comparison Designs.

Stockholm Research Reports in Demography 2021:04. doi: 10.17045/sthlmuni.14055407.v1.

World Bank. (2019). Gini Index (World Bank Estimate) - Colombia. Retrieved 20 September 2021 (https://data.worldbank.org/indicator/SI.POV.GINI?locations=CO&most_recent_value_desc=true).

Zapata, B. C., A. Rebolledo, E. Atalah, B. Newman, and M. C. King. (1992). The Influence of Social and Political Violence on the Risk of Pregnancy Complications. *American Journal of Public Health* 82(5):685–90. doi: 10.2105/ajph.82.5.685.

Zeitlin, Jennifer, Pierre-Yves Ancel, Marie-Joseph Saurel-Cubizolles, and Emile Papiernik. (2000). The Relationship between Intrauterine Growth Restriction and Preterm Delivery: An Empirical Approach Using Data from a European Case-Control Study. *BJOG: An International Journal of Obstetrics & Gynaecology* 107(6):750–58. doi: 10.1111/j.1471-0528.2000.tb13336.x.

Ziegler, Bianca R., Moses Kansanga, Yuji Sano, Joseph Kangmennaang, Daniel Kpienbaareh, and Isaac Luginaah. (2020). Antenatal Care Utilization in the Fragile and Conflict-Affected Context of the Democratic Republic of the Congo. *Social Science & Medicine* 262:113253. doi: 10.1016/j.socscimed.2020.113253.

Online Appendix

Figure A describes a flowchart of the sample selection and final population.

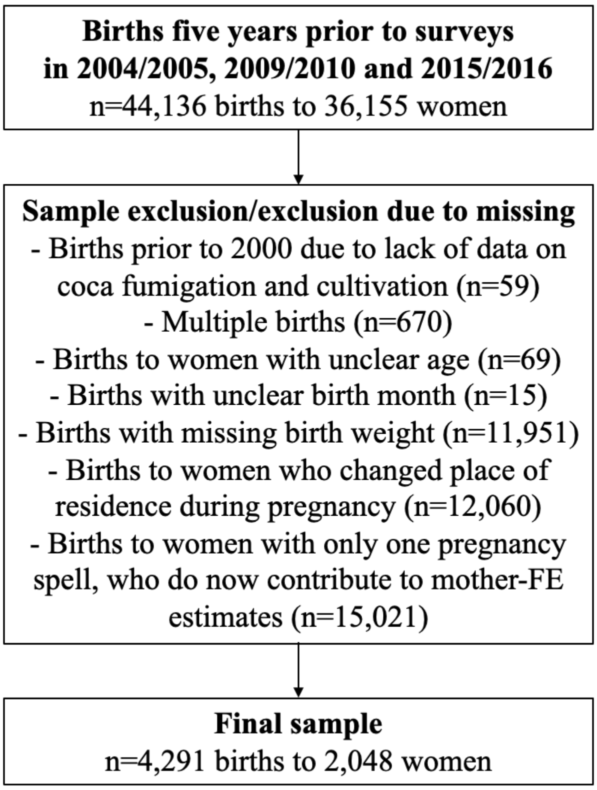

Figure A. Selection flow and final population

Table A displays the list of 64 exposure indicators explored in the focal variable selection according to type of exposure, geographical level, time it covers, and functional form.

Table A List of exposure variables

Exposure	Geographic level	Timing	Functional form
Conflict events	Department	Trimester 1	Continuous
Conflict events	Department	Trimester 2	Continuous
Conflict events	Department	Trimester 3	Continuous
Conflict events	Department	Full pregnancy	Continuous
Conflict deaths	Department	Trimester 1	Continuous
Conflict deaths	Department	Trimester 2	Continuous
Conflict deaths	Department	Trimester 3	Continuous
Conflict deaths	Department	Full pregnancy	Continuous
Conflict events	Municipality	Trimester 1	Continuous
Conflict events	Municipality	Trimester 2	Continuous
Conflict events	Municipality	Trimester 3	Continuous
Conflict events	Municipality	Full pregnancy	Continuous
Conflict deaths	Municipality	Trimester 1	Continuous
Conflict deaths	Municipality	Trimester 2	Continuous
Conflict deaths	Municipality	Trimester 3	Continuous
Conflict deaths	Municipality	Full pregnancy	Continuous
Conflict events	Department	Trimester 1	Dichotomous
Conflict events	Department	Trimester 2	Dichotomous
Conflict events	Department	Trimester 3	Dichotomous
Conflict events	Department	Full pregnancy	Dichotomous
Conflict events	Municipality	Trimester 1	Dichotomous
Conflict events	Municipality	Trimester 2	Dichotomous
Conflict events	Municipality	Trimester 3	Dichotomous
Conflict events	Municipality	Full pregnancy	Dichotomous
Conflict deaths	Department	Trimester 1	Categorical
Conflict deaths	Department	Trimester 2	Categorical
Conflict deaths	Department	Trimester 3	Categorical
Conflict deaths	Department	Full pregnancy	Categorical
Conflict deaths	Municipality	Trimester 1	Categorical
Conflict deaths	Municipality	Trimester 2	Categorical
Conflict deaths	Municipality	Trimester 3	Categorical
Conflict deaths	Municipality	Full pregnancy	Categorical
Coca cultivations	Department	Year(s) of pregnancy	Continuous
Coca cultivations	Department	Year(s) of pregnancy	Dichotomous
Coca cultivations	Department	Year(s) of pregnancy	Categorical
Coca cultivations	Municipality	Year(s) of pregnancy	Continuous
Coca cultivations	Municipality	Year(s) of pregnancy	Dichotomous
Coca cultivations	Municipality	Year(s) of pregnancy	Categorical
Anti-coca fumigations	Department	Trimester 1	Continuous
Anti-coca fumigations	Department	Trimester 2	Continuous
Anti-coca fumigations	Department	Trimester 3	Continuous
Anti-coca fumigations	Department	Full pregnancy	Continuous
Anti-coca fumigations	Municipality	Trimester 1	Continuous
Anti-coca fumigations	Municipality	Trimester 2	Continuous
Anti-coca fumigations	Municipality	Trimester 3	Continuous
Anti-coca fumigations	Municipality	Full pregnancy	Continuous
Anti-coca fumigations	Department	Trimester 1	Dichotomous
Anti-coca fumigations	Department	Trimester 2	Dichotomous
Anti-coca fumigations	Department	Trimester 3	Dichotomous
Anti-coca fumigations	Department	Full pregnancy	Dichotomous
Anti-coca fumigations	Municipality	Trimester 1	Dichotomous
Anti-coca fumigations	Municipality	Trimester 2	Dichotomous
Anti-coca fumigations	Municipality	Trimester 3	Dichotomous
Anti-coca fumigations	Municipality	Full pregnancy	Dichotomous
Anti-coca fumigations	Department	Trimester 1	Categorical
Anti-coca fumigations	Department	Trimester 2	Categorical
Anti-coca fumigations	Department	Trimester 3	Categorical
Anti-coca fumigations	Department	Full pregnancy	Categorical
Anti-coca fumigations	Municipality	Trimester 1	Categorical
Anti-coca fumigations	Municipality	Trimester 2	Categorical
Anti-coca fumigations	Municipality	Trimester 3	Categorical
Anti-coca fumigations	Municipality	Full pregnancy	Categorical
TOTAL NUMBER OF INDICATORS			**64**

Figure B displays the distribution of birthweight in our sample and the full population. As mentioned, 79 percent of recorded birthweights are based on mother's recall and 21 from a written card. There is a tendency of birthweight heaping, i.e., rounding birthweight to even 100-numbers. A closer analysis shows that heaping occurs for 82 percent of recorded birthweights overall, and 85 percent if the birthweight is recorded from mother's recall. We regressed birthweight heaping on our focal violence and fumigation as well as our three SES variables, net of birth order and gestational length of the pregnancy. Without mother-fixed effects, there is a correlation between heaping and the exposures as well as SES factors except teenage pregnancy. Adding fixed effects (with or without mother's age at birth), there is only a heaping tendency for women with lower levels of education (women with tertiary education are 16% less likely to report an even number by comparison). These analyses are available upon request.

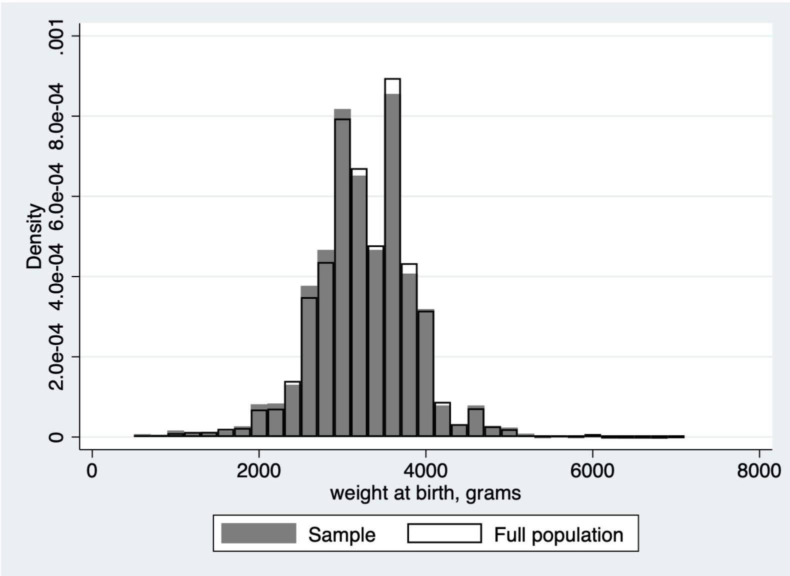

Figure B. Histogram of the birthweight distribution in our sample (grey bars) and the full population (bars with black border)

Table B displays descriptive statistics including pregnancies to women who only had one pregnancy during observation. Here, the sample is slightly older.

Table B Descriptive statistics of the sample population, including births to women who had only one pregnancy during observation

Variable	Value	Frequency	Percent
Fumigation level during:			
First trimester	*Zero*	14,832	76.80
	Low	2,296	11.89
	High	2,184	11.31
Second trimester	*Zero*	14,731	76.28
	Low	2,321	12.02
	High	2,260	11.70
Third trimester (b)	*Zero*	14,777	76.52
	Low	2,303	11.93
	High	2,087	10.81
	No third trimester	145	0.75
Full pregnancy	*Zero*	12,331	63.85
	Low	3,577	18.52
	High	3,404	17.63
Mother's age at birth	*12–19*	5,299	27.44
	20–24	6,088	31.52
	25–29	4,015	20.79
	30–34	2,380	12.32
	35–39	1,201	6.22
	40–49	329	1.70
Gestational length	5–6 months	145	0.75
	7 months	440	2.28
	8 months	2,571	13.31
	9 months	16,134	83.54
	10 months	22	0.11
Teen pregnancy	*No*	14,013	72.56
	Yes	5,299	27.44
Type of place of residence	*Rural*	5,518	28.57
	Urban low density	3,846	19.92
	Urban high density	9,696	50.21
	Urban density missing	252	1.30
Mother's educational level	*Primary or lower*	7,294	37.77
	Secondary	9,289	48.10
	Tertiary	2,729	14.13
TOTAL		**19,312**	**100.00**

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Casualties during:					
First trimester	19,312	8.21	19.68	0	305
Second trimester	19,312	7.99	20.11	0	305
Third trimester (b)	19,167	7.34	18.97	0	305
Full pregnancy	19,312	23.48	50.36	0	581
Coca hectares	19,312	2530.67	5117.20	0	62159.69
Birth weight	19,312	3218.83	603.48	500	7000
Birth order	19,312	1.16	.40	1	4

(b) The sample size for conflict exposure is somewhat lower during third trimester because pregnancies ending in live birth after five or six months did not have a third trimester.

Table C includes women with only one pregnancy to the models without fixed effects, corresponding to Models 1.1 and 1.2 in Table 2. Here, the positive relationship between violence and birthweight is significant and similar in size, but the earlier significant positive relationship for low levels of fumigation is not present.

Table C Regression models of the associations between birth weight and exposure to violence and anti-coca fumigation during full pregnancy, including women who only had one pregnancy during observation

	Full pregnancy (n=19,312)	
Model C.1		
Casualties	**0.23****	(0.08)
Model C.2		
Fumigation level (ref.=no fumigation)		
Low	19.55	(11.02)
High	-22.85	(15.11)

***p < 0.001, ** p < 0.01, *p < 0.05, ref.=reference. Standard errors clustered by mother in parentheses. All models adjust for mother fixed effects, birth order, gestational length, and mother's age at childbirth. Models C.2 controls for coca cultivation during the year(s) of pregnancy.

Table D includes indicators for violence and fumigation in the same model, for each trimester or the full pregnancy respectively. While the coefficients for violence are stable, the results for fumigation are no longer significant. This is likely because organized violence, anti-coca fumigation and cultivation are highly correlated. It again emphasizes the relative importance of violence over fumigation.

Table D Regression models of the associations between birth weight and exposure to violence and anti-coca fumigation during pregnancy; both conflict and fumigations in the same model

Model D	**Full pregnancy (n=4,291)**		**Trimester 1 (n=4,291)**		**Trimester 2 (n=4,291)**		**Trimester 3 (n=4,250)**	
Casualties	**-1.40***	(0.67)	**-1.74****	(0.53)	-0.12	(0.68)	**-0.75****	(0.28)
Fumigation level (ref.=no fumigation)								
Low	-72.59	(77.16)	34.62	(71.00)	-57.09	(70.75)	-27.56	(53.56)
High	102.49	(86.73)	105.01	(76.22)	80.52	(65.04)	99.59	(90.79)

***p < 0.001, ** p < 0.01, *p < 0.05, ref.=reference. Standard errors clustered at the mother level in parentheses. Adjusted for mother fixed effects, birth order, gestational length, coca cultivation during the year(s) of pregnancy, and mother's age at childbirth.

Table E excludes the coca cultivation variable from models of anti-coca fumigation. The main findings are largely robust to this re-specification. According to Camacho and Mejía (2018), controlling for coca cultivation in models of aerial spraying enables excluding the health effect of chemicals used in cocaine production. This variable contributes to model fit in about half of the models (AIC test results are available upon request). Hence, proximity to coca plantations does not seem like an important control. Overall, presence of coca cultivation in the department (measured continuously in number of hectares) associates to a statistically significant reduction in birthweight, but there are no clear patterns by SES (not shown).

Table E Regression models of the associations between birth weight and exposure to anti-coca fumigation during pregnancy; excluding the control for coca cultivation

Model E	**Full pregnancy (n=4,291)**		**Trimester 1 (n=4,291)**		**Trimester 2 (n=4,291)**		**Trimester 3 (n=4,250)**	
Fumigation level (ref.=no fumigation)								
Low	-34.37	(33.36)	-33.99	(32.81)	-40.94	(31.37)	-53.02	(34.68)
High	-48.59	(45.06)	-51.75	(39.26)	1.29	(37.18)	**-74.26***	(37.29)

***p < 0.001, ** p < 0.01, *p < 0.05, ref.=reference. Standard errors clustered by mother in parentheses. Adjusted for mother fixed effects, birth order and mother's age at childbirth.

Table F excludes women with only primary education who are most likely to misreport birthweight. The results of violence are insignificant, and the coefficients for fumigation are significant only at low levels during the second trimester and both levels during full pregnancy. This point towards how the detrimental effects of conflict on birthweight are driven by women with lower socioeconomic status, as displayed in Tables 5 and 6.

Table F Regression models of the associations between birth weight and exposure to violence and anti-coca fumigation during pregnancy; excluding women with only primary education who are most likely to misreport birth weight

	Full pregnancy (n=2,504)		**Trimester 1 (n=2,504)**		**Trimester 2 (n=2,504)**		**Trimester 3 (n=2,477)**	
Model F.1								
Casualties	-0.36	(0.42)	-0.73	(0.83)	-0.87	(0.79)	0.10	(1.07)
Model F.2								
Fumigation level (ref.=no fumigation)								
Low	-7.70	(41.37)	-13.18	(45.67)	-54.78	(41.74)	-27.35	(49.65)
High	-27.58	(59.13)	-5.45	(59.61)	-4.88	(51.06)	-58.10	(57.50)

***p < 0.001, ** p < 0.01, *p < 0.05, ref.=reference. Standard errors clustered at the mother level in parentheses. Adjusted for mother fixed effects, birth order, gestational length, and mother's age at childbirth. Model F.2 controls for coca cultivation during the year(s) of pregnancy.

Table G does not include a control variable for gestational length. Here, the relationships between violence and birthweight are negative and statistically significant during the first and second trimesters and the full pregnancy. The results are insignificant for fumigation. These models do not distinguish between gestational growth from preterm birth, hence we prefer the models presented in Table 2.

Table G Regression models of the associations between birth weight and exposure to violence and anti-coca fumigation during pregnancy; excluding gestational length of pregnancy

	Full pregnancy (n=4,291)		Trimester 1 (n=4,291)		Trimester 2 (n=4,291)		Trimester 3 (n=4,250)	
Model G.1								
Casualties	**-0.69***	(0.33)	**-1.74***	(0.85)	**-1.71****	(0.60)	0.35	(0.70)
Model G.2								
Fumigation level (ref.=no fumigation)								
Low	-22.35	(37.16)	-19.95	(35.43)	-55.65	(35.41)	-16.31	(36.48)
High	10.12	(49.87)	-17.37	(44.09)	22.88	(41.92)	-42.36	(38.88)

***p < 0.001, ** p < 0.01, *p < 0.05, ref.=reference. Standard errors clustered by mother in parentheses. All models adjust for birth order, mother fixed effects, and mother's age at childbirth. Model G.2 controls for coca cultivation during the year(s) of pregnancy.

Table H overcomes the limitations of the variable used in Tables 4 to 6 by distinguishing not by whether each pregnancy was to an adolescent mother or not, but instead between children born to women who had no teen pregnancies, one teen pregnancy out of at least two, and two or more teen pregnancies. This approach allows us to study women who had only one teen pregnancy, without running the risk of implementing a cross-level interaction that could bias the estimates in a fixed effects model (Giesselmann and Schmidt-Catran, 2020).

In Model H.1, the relationship between casualties and birthweight persists for adolescent births to women who only have one adolescent birth, and intensifies for women with two adolescent births. There are no significant relationships between birthweight and fumigation.

Table H Regression models of the associations between birth weight and exposure to conflict and anti-coca fumigation during pregnancy, by an alternative measure for teen pregnancy

	Subgroup	Trimester 1		Trimester 2		Trimester 3	
Model H.1							
Casualties	*No teen pregnancy*	-1.15	(0.68)	-0.62	(0.72)	1.43	(0.79)
	One teen pregnancy	-0.76	(1.56)	**-2.76***	(1.18)	-1.27	(1.53)
	Two or more teen pregnancies	-2.88	(2.36)	**-4.26****	(1.26)	-3.15	(1.65)
Model H.2							
Fumigation level (ref.=no fumigation)							
Low	*No teen pregnancy*	-41.36	(39.92)	-71.21	(40.69)	-51.52	(40.45)
High		-20.20	(55.74)	-17.38	(46.56)	-89.83	(50.96)
Low	*One teen pregnancy*	-78.95	(78.53)	-43.86	(72.11)	-147.61	(88.43)
High		-105.40	(84.63)	-2.36	(90.22)	-61.98	(86.18)
Low	*Two or more teen pregnancies*	47.04	(77.83)	52.20	(66.76)	56.47	(74.35)
High		-46.21	(79.08)	71.60	(84.94)	-52.27	(68.34)

***p < 0.001, ** p < 0.01, *p < 0.05, ref.=reference. Standard errors clustered by mother in parentheses. All models adjust for mother fixed effects, birth order and gestational length. Model H.2 controls for coca cultivation during the year(s) of pregnancy.

Table I displays alternative measures of urban residence. In Models I.1 and I.2, pregnancies to urban mothers regardless of population density in the municipality are grouped together. Here, there is a negative effect for trimesters one and two at around 2 gram per casualty in urban areas. However, these models only separate between whether the mother lived in a nucleus of more or less than 1,500 inhabitants, which does not reveal much about the context. Hence, we prefer to add the distinction of population density in the municipality.

In Models I.3 and I.4, we replace the threshold of high population density in an urban area to 100 inhabitants per km2 instead of 50. Here, in comparison to Table 4, the relationship between birthweight and violence in urban areas is significant for the second instead of the third trimester in low-density municipalities. The significant effect of violence during the second trimester in high-density areas disappears. With regards to exposure to fumigations, the findings remain insignificant. Since the measure with a threshold of 50 inhabitants contributed more to model fit, we prefer that indicator instead of the one presented here.

Table I Regression models of the associations between birth weight and exposure to violence and anti-coca fumigation during pregnancy, by alternative specifications of type of place of residence

	Subgroup	**Trimester 1**		**Trimester 2**		**Trimester 3**	
Model I.1	Residence						
Casualties	*Urban*	**-2.45*****	(0.70)	**-2.18****	(0.67)	-1.29	(0.85)
Model I.2							
Fumigation level (ref.=no fumigation)							
Low	*Urban*	-10.12	(41.11)	-66.31	(37.50)	-17.41	(44.51)
High		-33.42	(48.04)	-36.42	(46.51)	-85.26	(45.78)
Model I.3	Residence						
Casualties	*Urban low density*	**-3.29*****	(0.99)	**-2.64****	(0.95)	-1.63	(1.10)
	Urban high density	-1.27	(0.99)	-1.69	(0.89)	-0.99	(1.33)
Model I.4							
Fumigation level (ref.=no fumigation)							
Low	*Urban low density*	-27.48	(68.15)	-62.91	(57.17)	-48.20	(67.66)
High		43.27	(71.35)	-126.66	(65.59)	-72.12	(64.92)
Low	*Urban high density*	14.00	(50.68)	-68.92	(49.62)	13.09	(59.94)
High		-105.85	(65.19)	85.31	(65.10)	-95.05	(64.17)

***p < 0.001, ** p < 0.01, *p < 0.05, ref.=reference. Standard errors clustered by mother in parentheses. All models adjust for mother fixed effects, birth order, gestational length, and mother's age at childbirth. Models I.2 and I.4 control for coca cultivation during the year(s) of pregnancy. In Models I.3 and I.4, high population density is defined as a municipality with more than 100 inhabitants per km2.

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