

## War is not healthy. Political violence and infant health outcomes in Colombia

### La guerra no es saludable. Violencia política y sus efectos en la salud infantil en Colombia

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Received 27<sup>th</sup> January 2016 / Sent for Modification 16<sup>th</sup> August 2017 / Accepted 18<sup>th</sup> January 2018

#### ABSTRACT

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**Objectives** To establish and quantify the effect of the internal armed conflict in Colombia on infant health, particularly birth weight.

**Methods** This document explores time differences in relation to the impact of the internal armed conflict in Colombia, measured by municipal homicide rates, on infant health, quantified as infant mortality and birth weight. Based on individual data from the 1995 and 2000 Colombian National Demographic and Health Surveys, along with annual municipal data on violence and economic performance, results obtained from two biological siblings are compared using a maternal fixed logistic regression, as one was born in a violent era and the other during a peaceful moment.

**Results** Political violence negatively affected infant health outcomes during the peak of violence experienced by Colombia in the 1990s, with worse outcomes for male infants than for females. Controlling fixed maternal effects shows a three times greater probability of being born with low birth in infants born during increased violence, compared to their siblings born in more peaceful times.

**Conclusions** These results make visible all the effects of intense and long-lasting armed conflicts, as is the case of Colombia, since not only direct actors involved in conflict are affected, but also infants who show worse health outcomes. These results allows targeting policies for reducing the effects on populations in conflict or during the reconstruction period; in this case, the provision of maternal care during the gestational period and special care for newborns in areas under high violence levels should be a priority.

**Key Words:** Infant mortality; low birth weight; warfare; Colombia (*source: MeSH, NLM*).

#### RESUMEN

**Objetivos** Establecer y cuantificar el efecto del conflicto armado interno en Colombia en la salud infantil, particularmente en el peso al nacer.

**Métodos** Este documento explora las diferencias en el tiempo de la intensidad del conflicto armado interno en Colombia, medido por las tasas de homicidios municipales, sobre la salud infantil, cuantificado como mortalidad infantil y peso al nacer. Mediante el uso de datos individuales de las encuestas nacionales de demografía y salud de Colombia de 1995 y 2000, combinados con datos anuales de nivel municipal sobre violencia y desempeño económico, se confrontan los resultados entre dos hermanos biológicos, uno nacido en una era violenta y otro en un momento pacífico utilizando una regresión logística de control materno.

**Resultados** La violencia política afecta negativamente la salud infantil, lo que se pudo cuantificar durante el pico de violencia que experimentó Colombia en los años 90, con peores resultados para los bebés varones que en sus contrapartes. El control de los efectos fijos maternos muestra una probabilidad significativa tres veces mayor de nacer con bajo peso al nacer para los bebés nacidos durante el aumento de la violencia, en comparación con sus hermanos nacidos en épocas más pacíficas.

**Conclusiones** Estos resultados hacen visibles la totalidad de los efectos de conflictos armados intensos y duraderos, como es el caso colombiano, en donde no sólo los acto-

res directos involucrados en el mismo se ven afectados, sino que también los recién nacidos muestran peores resultados de salud. Los resultados de este estudio permiten focalizar políticas en la reducción de los efectos en poblaciones en conflicto o durante el período de reconstrucción, en este caso se sugiere la provisión de cuidado materno durante el período gestacional y cuidado especial para recién nacidos en áreas de altos niveles de violencia como una prioridad.

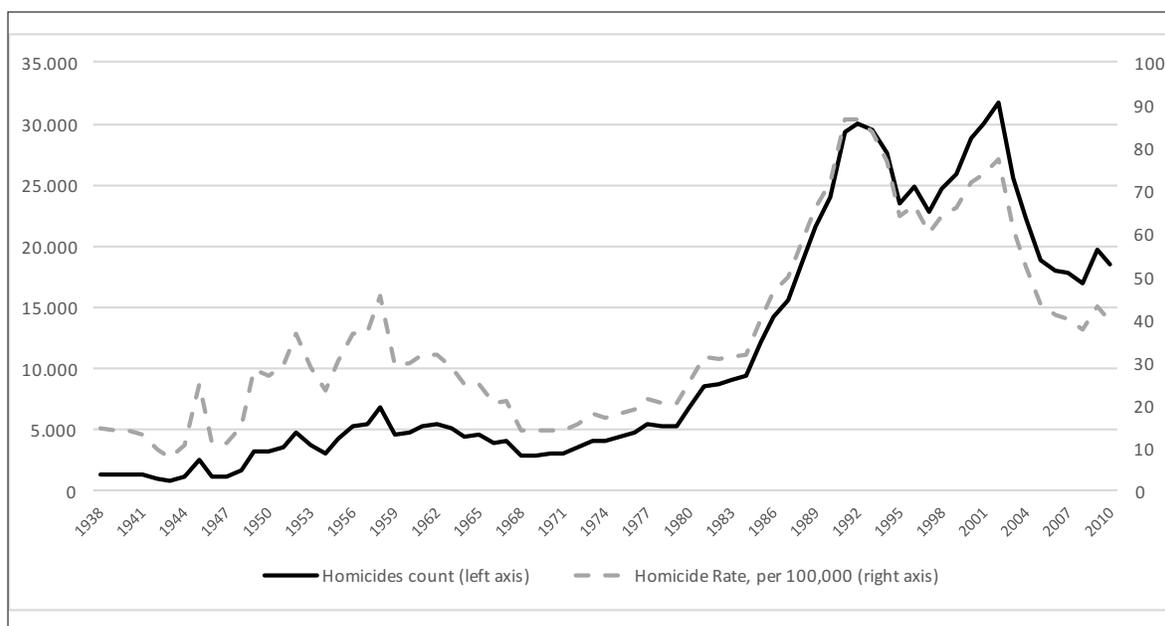
**Palabras Clave:** Salud del niño; mortalidad infantil; peso al nacer; guerra y conflictos armados; Colombia (*fuentes:* DeCS, BIREME).

Violence is a global public health issue, mainly because it depletes young adults by large numbers (1-3). However, other subtle and indirect consequences of violence that reflect on human capital formation, particularly in infant health outcomes, are not fully identified in long lasting conflicts. This article intends to quantify the effects of political violence on infant health, as they are not directly involved in armed conflicts.

During the past three decades, Colombia has been the most violent country of the Americas. The current civilian conflict has persisted for almost sixty years and has involved several armed actors, generating many human losses. This conflict has recently entered into a new phase after the signing of the Peace Agreements between the Government and the oldest guerrilla group in Colombia in November 2016. The direct consequences of the conflict have been widely studied in Colombia, such as human lives lost in combat and the negative effects on economic performance (4-8). But an important issue, usually ignored, is the effect of violence on infant health which, in turn, is a potent measure of human capital formation and development.

This document combines data from two Colombian Demographic and Health Surveys conducted in 1995 and 2000, and municipality indicators on violence, economic performance and governmental health investments. This information allows estimating the effect of violence on both infant mortality and health outcomes for Colombian babies born during the violence peak between 1990 and 2000. This study presents novel estimates by using both cross-sectional and maternal fixed effects estimations, which consist in contrasting health outcomes of children born to the same mother and at the same municipality, but at different periods, being one considerably more violent than the other. Results suggest that as violence increases the likelihood of an infant dying, affecting particularly males. Moreover, birth weight is three times higher and significant during violent times. Birth weight is one of the most studied measures regarding infant health, as it directly relates to infant mortality and to all other developmental health outcomes of infants, including malnutrition, stunted growth and cognitive development (9-12).

Figure 1. Homicide rates and counts for Colombia, 1938-2009



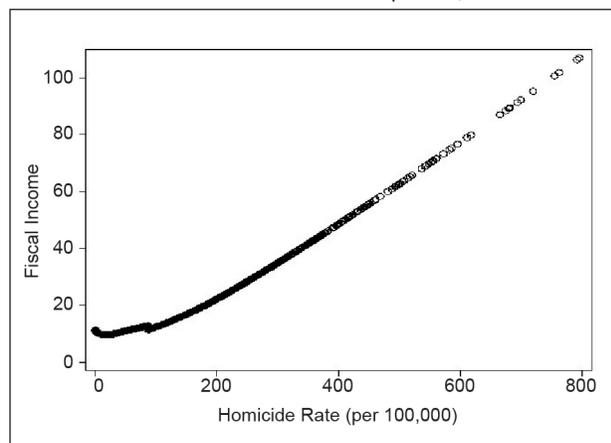
Source: Own elaboration based on the annual reports provided in the Colombian Official Statistics Yearbook-DANE

These findings advocate the need for reinforcing pre-natal control in women and their children who reside in areas exposed to violence, including access to health inputs (i.e. vaccination) and where health facilities are either destroyed, crowded or accessibility has been reduced due to the conflict.

### Violence and human health: Colombian context

Colombia had a steadily growing economy during the twentieth century despite three major civil conflicts. The first, known as the Thousand Days' War (1899-1902), was the result of confrontations between loyalists of the two main political parties: liberals and conservatives. Then came a seven-year period known as La Violencia (The Violence) (1946-53), which was marked by confrontations between liberal and conservative guerrillas, mainly in rural areas. Finally, the current internal conflict began in the mid-1960s after the birth of socialist guerrillas in rural areas; this is known as Internal Armed Conflict (1965-2016), and in 2017, with the implementation of the Peace Agreements, it entered into a new phase. This conflict reached its violence peak, measured by homicide rates, during the 1990s, as shown in Figure 1. In contrast to similar processes elsewhere in Latin America, the Colombian case escalated both in intensity and in number of actors involved, including the expansion of illicit, but very profitable, activities such as drug trafficking, a factor that has intensified the conflict.

**Figure 2.** Relationship between fiscal income per capita and homicide rates in Colombian municipalities, 1990-2000



Moreover, the expansionist movements of the main illegal armed groups in Colombia pose a counter-intuitive development of the conflict. High homicide rates co-exist in places whose regional economies have the most accelerated growth, instead of the poorest municipalities (Figure 2). This behavior fits the Greed Theory (13,14,15) and is true in isolated Colombian regions

with sudden income increases related to the exploitation of minerals, bananas, coca leaf plantations and cocaine processing (6). This weak relationship between poverty and violence outbreaks allows for a cleaner research design for the question at hand.

### Indirect effects of the conflict on human health

Several studies have linked the effects of violence on health outcomes of children directly involved in the conflict. First, refugee children or internally displaced children living in camps suffer from higher infection and mortality rates due to the rapid spread of communicable diseases, such as the cases of Uganda, and Zepa and Sarajevo in Bosnia and Herzegovina (3). Second, children outside these camps also experience negative outcomes on psychiatric well-being during and after their involvement in conflict (16-18) and there is a need to measure such impact in order to properly diagnose them (19). Other literature links civil conflict and lower standardized heights by age (z-scores) in children and adolescents exposed to conflict in several contexts: Akresh et al. (20) reported shorter young children by age in the Ethiopia-Eritrean conflict; Bundervoet et al. (21) found that children born within the Burundi conflict are shorter; and Alderman et al. (22) found shorter adolescents in Zimbabwe. All of these cases may be the result of poorer nutritional attainments, as exposed in the cross-country exercise using the Uppsala Conflict Data Program-UCDP (23).

Only (24) and (25) studied indirect effects of conflict on infants, both using the Colombian context, but none using rich individual survey records. Both studies used vital registration data, which are highly underreported in Colombia; in the case of infant mortality, data are underreported by 30% and births by 50% for the 1990s (26). This study expects to fill this gap in the literature by using individual records to uncover the effect on birth weight directly linked with better physical health, not only during the first months of life, but also in later years (27, 28, 29, 30). Finally, the statistical methodology proposed here has not been used in previous research, which accounts for maternal fix effects and allows exploring similar situations where Demographic and Health Surveys are available and can be combined with violence and other covariates.

## METHODOLOGY

### Data

Data combine several variables collected at the municipality level with individual information captured by two Demographic and Health Surveys (DHS) carried out in

1995 and 2000, which provide information on births during the peak decade of conflict (Figure 1). The DHS is a freely distributed survey run by Macro-International and Profamilia in Colombia that targets women aged 15 to 49 and their children no older than five years old (31,32). Survey data is preferred over vital statistics in Colombia for both quantity and quality, as vital statistics are highly underestimated (26).

The municipality level variables include: (i) population estimations by age and sex, calculated by the author based on two Colombian censuses (1985 and 1993) carried out by the National Statistical Office (DANE); (ii) total number of homicides available by sex and large age groups collected by DANE; and (iii) public investments on health and health-related sectors and fiscal income provided for each municipality, taken from the fiscal year balance report of each municipality, collected by the Office of the Comptroller General of Colombia (Contraloría General de la República). These latter variables are expressed in constant Colombian pesos for the year 1998.

This study included all women who had single births between 1990 and 2000, with reliable information on date of birth, and who had at the least one infant death per year. DHS includes relevant variables on infant health such as: (i) socioeconomic conditions of the household, urban/rural environment, access to public services, availability of toilet facilities, possession of appliances—all summarized in a wealth index—, age of household head, number of household members, partners' age, occupational status and education levels of both the mother and her partner; (ii) women's fertility conditions; (iii) body mass index (BMI); (iv) demographic characteristics such as women's age, relationship to the household head, civil status, whether the husband lives with her, migration status, reason for migration, children's age, sex and survivorship; (v) health care practices and health status for the last four born babies including birth order, who attended the delivery, infants' weight and size at the moment of the survey, babies' social security coverage, number of months of exclusive breastfeeding, vaccinations (for BCG, DPT, polio, measles and hepatitis B), week of first prenatal checkup, and diarrhea episodes during the two weeks before the survey took place and how it was treated; (vi) prenatal health care for the latest pregnancy and attended by whom, alcohol and tobacco consumption, whether the mother received medical attention due to complications or not, and if she was physically attacked while pregnant.

### Research strategy

Given the characteristics of the Colombian conflict, contrary to what is believed, conflict is not caused by extreme

poverty, but is related to children's health. Figure 2 shows the smoothed trend of the per capita fiscal incomes, a proxy for income of the Colombian municipalities and their homicide rates. This fact reinforces other authors' findings that violence appears in municipalities where sudden economic positive shocks appear (7,5,33,34) and reduces the probability that both facts under study are caused by the same determinant.

Two estimation strategies capture the effect of violence on infant health outcomes. The first approach is a logistic regression, where the dependent variable is whether an infant died or not, directly capturing the effect of violence on infant mortality following the model:

$$[1] \quad Health_{imt} = \theta v_{mt} + \alpha z_{mt} + \beta x_{imt} + \varepsilon_{imt}$$

Where Health is the health outcome under study for infant  $i$  who was born at time  $t$  in municipality  $m$ . For instance, Health equals 1 if an infant dies and 0 otherwise, or in the case of low birth weight Health will equal 1 if the baby was born with low birth weight (less than 2 500 grams) and 0 otherwise.

The main purpose of this document is to estimate  $\theta$ , which is the parameter that measures the effect of violence ( $v$ ) at municipal level ( $m$ ), measured by homicide rates. The control variables were described above and are represented in Equation (1) as  $z_m$  and  $x_i$ . The former variables include controls collected at municipal level (i.e. public investments in health and health related sectors) and the latter ( $x_i$ ) includes controls collected at individual level (i.e. DHS variables). The error term ( $\varepsilon_{imt}$ ) captures the unobservable determinants and measurement errors.

Violence is measured as total homicide rates, male homicide rates and young males' homicide rates (ages 15 to 45). Homicides keep the highest quality both in numbers as in cause of death and are considered in the literature as one of the best proxies for violence (i.e. 35).

Unobserved heterogeneity could arise from either reactions of households to the knowledge of health endowments in the baby or to violence in the region. To reduce those issues, a logistic regression with multiple random effects was run, where the error term ( $\varepsilon_{imt}$ ) represents a combination of permanent and transitory processes, such that:

$$[2] \quad \varepsilon_{imt} = v_{imt} + u_{imt}$$

Where the first term represents the time-invariant unobserved heterogeneity (i.e. genetic predisposition), and the second term represents the time-varying stochastic error or error due to factors inherent to the process other

than measured or unobserved covariates. Both components are assumed to be normally distributed, independent, and uncorrelated with independent variables.

Another way to reduce such effects is to control family variation, which can be captured as a maternal fixed effect. DHS information on women's birth history was considered and compared with health outcome for different babies born to the same mother in the same place, but one of them was born in during a more intense moment of the conflict, while the other was born during a less violent time. To reduce push migration of the mother induced by health or violence-related issues, all estimations were made on non-migrant mothers. Thus, heterogeneity was reduced by assuming similar genetic composition of the babies and then considering the effects of the conflict on a baby's health, using this within-family estimation.

## RESULTS

Results correspond to babies born to respondents up to five years of age before the survey, who lived in 61 Colombian municipalities. The average weight at birth from 1990 to 2000 was 3 204.3 grams for Colombian babies, of which 6.59% were born with low weight, and an average size of 49.81 centimeters. Only 3.48% of the babies died before their first year of life, at 2.47 months on average. During pregnancy, women attended to 5.5 prenatal appointments on average and spent 10.6 months breastfeeding. The average overall homicide rate was 81.67 per 100 000 inhabitants; the homicide rate in males almost doubles that number with an average of 156.05, while the homicide rate in young males (ages 15-45) was 269.63 per 100 000. All calculations presented here use overall homicide rates, but the estimators lead to practically the same coefficients, regardless of the homicide rate used.

Infant mortality regressions are estimated for both sexes and each sex separately, as male babies have higher mortality rates than females (36). To avoid misspecification in extreme observations, violence (homicide rates over 800) and birth weight (below 1 000 grams or over 4 000 grams) were dropped. Table 1 shows the results of a logistic random effects regression of homicide rates on infant deaths. The coefficients suggest the expected positive effect of homicide rates on the probability of an infant's death, although it is not statistically significant for both sexes and females only. The effect of violence on infant death lagged one year and was negative but statistically insignificant. It was included to control auto-regressive patterns in the series; lags of higher order do not hold such effect.

The statistically significant results in males suggest that the effect of violence is being absorbed by the weakest of the sexes. Nature tends to favor survival by giving birth to sexing mammals, humans among them (37). A coefficient of 0.0048 represents an increase of 0.48% in male infant mortality per increase of 1 per 100 000 in the total homicide rate in Colombia. Considering that the average homicide rate during the decade in the municipalities studied was 81.67 per 100 000 inhabitants, and that the average infant mortality rate in Colombia was around 34 per 1 000 live births, a marginal increment in the homicide rate would lead to almost 2 more infant deaths per 1 000 live births. Other specification models excluded some of the independent variables but still yielded the same parameter for violence, which provides strong evidence of parameter consistency in the model.

**Table 1.** Effect of homicide rates (per 1 000) on infant mortality, 1990-1999. Logistic random effects regression.  
Dependent Variable: Dead infant =1

	Both Sexes	Males	Females
Homicide rate	0.001 (-0.002)	0.004 (0.002)*	-0.004 (0.003)
Lag homicide rate	-0.001 (0.002)	-0.003 (0.003)	0.002 (0.002)
Municipality controls	Y	Y	Y
Household controls	Y	Y	Y
Rural residency	Y	Y	Y
Mother's demographic characteristics	Y	Y	Y
Prenatal care	N	N	N
Delivery care	N	N	N
Number of cases identified	5,786	2 902	2 864

Robust standard errors in parenthesis.\*\*\*Significant at 1%, \*\*significant at 5%; \*significant at 10%. Source: Own elaboration

The proposed maternal fixed effects exercise drastically reduces the number of observations, but allows for enough cases; descriptive statistics are presented in Table 2. Since the exercise requires mothers with at least two births, those who had at least one birth in a violent era and one in a less violent time were selected. For instance, the study included a mother with three children, of which two were born in pacific times and one in a more violent era.

Table 2 shows that all characteristics are, on average, similar with no statistically difference in means for babies born in either pacific or violent times, including weight at birth, except for levels of violence and fiscal income. Both of them are much higher for violent times, coinciding with the literature on the Colombian conflict, since violence erupts in zones with sudden economic positive shocks. It is worth noting that mothers, on average, tend to behave similarly with all of their children unless extraordinary events happen, such as an outbreak of violence.

**Table 2.** Descriptive statistics of mothers who gave birth between 1990 and 2000 during violent+ and non-violent periods

Variable	Observations		Mean		Standard deviation	
	Violent time	Non-violent time	Violent time	Non-violent time	Violent time	Non-violent time
<b>Infants characteristics</b>						
Weight at birth (gm)	296	252	3307.92	3318.58	658.99	702.91
Height at birth (cm)	119	107	49.69	49.88	4.12	3.44
Children's age at death (months)	19	17	2.67	3.01	2.79	3.34
<b>Household characteristics</b>						
Age of household head	19	21	31.81	32.55	7	7.06
Number of household members	467	457	6.41	6.28	2.65	2.67
Partner's age	419	413	32.54	32.56	7.15	7.05
Wealth Index	378	373	-0.3	-0.3	1.16	1.17
<b>Women's Characteristics</b>						
Educational attainment of women	467	457	6.16	6.03	3.9	3.88
Age	467	457	28	28.25	5.92	5.94
Children ever born	467	457	3.64	3.67	2.16	2.23
Number of births in the past five years	467	457	2.51	2.48	0.71	0.67
Age at first birth	467	457	20.15	20.29	4.05	4.13
Weight (kg)	453	442	58.29	57.86	10.83	10.23
Height (cm)	453	444	153.64	153.65	6	6.03
BMI	453	442	2467.18	2449.63	421.52	399.24
<b>Health care practices</b>						
Number or prenatal appointments*	415	291	5.08	4.32	3.94	3.41
Prenatal appointments attended by a doctor	292	415	0.72	0.76	0.45	0.43
Delivery attended by a doctor	467	457	0.69	0.65	0.46	0.48
Baby has health card	448	440	0.9	0.88	0.3	0.32
Baby has ever been vaccinated	192	217	0.91	0.91	0.28	0.29
Has received BCG vaccination	447	439	0.89	0.87	0.32	0.33
Has received Polio vaccination	435	447	0.9	0.89	0.3	0.31
Has received DPT vaccination	447	438	0.86	0.89	0.35	0.31
Has received measles vaccination	442	432	0.57	0.61	0.49	0.49
Has received hepatitis vaccination	208	237	0.57	0.52	0.5	0.5
Has received DTP vaccination*	208	237	0.24	0.41	0.43	0.49
Months breastfeeding	445	437	10.05	11.18	7.51	7.89
<b>Municipalities characteristics</b>						
Fiscal income per capita (hund. of mill. of pesos 1998)	467	457	6.48	5.87	8.47	8.65
Public investments on health sector (hund. of mill. of pesos 1998)	467	457	2.41	2.44	2.99	3.04
Homicide rate*	467	457	70.52	23.83	60.98	10.36
Male homicide rate*	467	457	133.86	44.33	119.7	19.91
Young males homicide rate (ages 15-45)*	467	457	231.3	75.7	215.91	36.19

\*The difference in means is statistically significant based on a t-test; +Violent times are defined as those with overall homicide rates above the median; Source: Own elaboration

**Table 3.** Effect of homicide rates (per 1 000) on low birth weight, 1990-2000. Maternal fixed logistic regression. Dependent variable: infant born with LBW=1

	Violent times	Non-violent times
Homicide rate	1.105 (0.295)***	0.029 (0.032)
Lag homicide rate	-0.706 (2.014)	0.002 (0.010)
Municipality controls	Y	Y
Household controls	Y	Y
Rural residency	Y	Y
Mother's demographic characteristics	Y	Y
Prenatal care	Y	Y
Delivery care	N	N
Number of cases identified	99	95

Robust Standard Errors in parenthesis; \*\*\*Significant at 1%

Violent times have been defined as periods with homicide rates above the median overall homicide rate for the 61 municipalities. The estimations show the probability of being born with low birth weight, as there are not enough observations for infant deaths. Table 3 shows the results for both sexes as the number of cases, again, do not allow estimations for each sex.

The results are significant and large in magnitude. Marginal increments in violence increase the probability of being born with low weight in children born in violent times by 10.5%. The parameters are much larger for this regression than for the random effects logit model, and imply a difference in the probability of a baby being born with low birth weight three times higher and significant in children born in violent times, as opposed to insignificant effects for babies born in pacific times. This latter result is truly remarkable for the Colombian case, where birth weight is the main determinant of children's health (38). These results reinforce the idea that violence is harmful to infant health, and affects the positive effects of government investments to provide health services, as well as time and money investments that households do to increase their health.

## DISCUSSION

The results of the logistic regression on a time series with random effects per mother and controlled by autoregressive patterns in homicide rates suggest a higher probability of dying in babies born during violent periods, affecting mainly infant males. Maternal fixed effects, in women who never migrated and had at least one child during a peaceful time and another during a more violent time in the same municipality, showed a probability three times higher of being born with low birth weight during an outbreak of violence, contrasted to their siblings born in a more peaceful time.

The implications of these findings on policies go beyond the fact that violence is not healthy for infants. After controlling maternal specific conditions, municipality conditions, household characteristics and health practices, current violence has a negative effect on infant health outcomes. Therefore, violence has an indirect effect on human capital formation through health. It is important for governments to emphasize on health delivery services, in particular to mothers and infants living in areas under high violence levels. Those services should target the weakest babies, that is, those born preterm or below 2 500 grams, while more aggressive vaccination and nutritional campaigns should cover both women in reproductive years and their young children •

**Conflict of interest:** None.

**Funding:** Financial support provided by the Universidad Nacional de Colombia through the Internal Call DIB#8003054, Project HERMES#5287.

**Acknowledgements:** I would like to thank the Universidad Nacional de Colombia –Internal Call-DIB#8003054, for providing financial support for conducting this research and to Iván Díaz who provided research assistance. I also thank Ronald Lee, Edward Miguel and the participants at the Annual Colombian Statistics Conference 2010 and the Demography of Conflict Symposium 2011 at Stanford University for their helpful inputs. Finally, I thank Sandra Rodríguez who made this research possible by providing data. This work was finished while Urdinola was a Santo Domingo Visiting Scholar at Harvard University.

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