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Effects of Conflict on Child Health: Evidence from the 1990–1994 Northern Mali Conflict

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Abstract

This study evaluates the impact of the 1990–1994 conflict in northern Mali on child health at different timings of exposure (in utero and after birth). Two anthropometric variables (height-for-age and weight-for-height Z-scores) are used as indicators of child health. The empirical strategy relies on the difference-in-difference approach based on birth cohort, GIS residence information, and conflict intensity. The intensity of conflict exposure is measured by the number of deaths resulting from a conflict that broke out within a 10-km radius of each community. The estimation results show that the more severe the exposure to children and their mothers, the greater is the negative impact on the height, but not on the weight, of children. Additionally, the timing of conflict exposure plays a critical role in the outcome of a child's health: exposure to conflict in utero, rather than after birth, negatively affects health. Placebo test as well as tests of selective migration, fertility, and mortality are conducted and confirmed the robustness of the main results. The differential effects of the timing of exposure in utero suggest that the heightened maternal stress is the main mechanism.

Keywords: Child health; Conflict; Early-life shock; Mali

JEL classification: I15, J13, O15

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1. Introduction

In Sub-Saharan Africa (SSA), 75% of countries have experienced civil conflicts since World War II (Gleditsch et al. 2002). Although the occurrence of large armed conflicts has declined in the past 30 years, the number of small conflicts as well as the risk of violent conflicts have been increasing (World Bank 2011). Armed conflict deteriorates both physical capital and human capital, which hinders a nation’s future development. Studies of armed conflict have found that early-life health plays a critical role in socioeconomic outcomes because children exposed to armed conflict in utero are likely to be less educated (see Ouili 2017 for Cote d’Ivoire; Weldeegzie 2017 for Ethiopia), less healthy in adulthood (see Akresh et al. 2012b for Nigeria; Akbulut-Yuksel 2017 for Germany; Singhal 2019 for Vietnam) and in early childhood (see Akresh et al. 2012a for Eritrea; Akresh et al. 2014 for Ethiopia and Eritrea; Bundervoet et al. 2009 for Burundi; Guantai and Kijima 2020 for Kenya; Minoiu and Shemyakina 2014 for Cote d’Ivoire; Shemyakina 2018 for Zimbabwe; Tranchant et al. 2014 for India), and less likely to survive in utero and during the first year of life (see Dagnelie et al. 2018 for Democratic Republic of Congo; Wagner et al. 2018 for Africa). Although studies examining the effect of armed conflict in SSA have recently been growing, there are some methodological challenges to identifying those actually exposed to conflict. Therefore, rigorous empirical evidence on the impact of conflict exposure in SSA on human capital is still lacking.

This study examines the effects of the 1990–1994 conflict in northern Mali on child health using the Malian Demographic and Health Surveys of 1995–1996 and 2001 (MDHS95/96 and MDHS2001 hereafter)[1] by the difference-in-difference approach based on birth cohort, GIS residence information, and conflict intensity. Since its independence in 1960, northern Mali has witnessed several conflicts in which the armed forces of nomadic tribes, namely the Tuareg, have attempted to form an autonomous state. Mali is considered to be a critical case given its serious child health conditions, where the infant

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[1] There are DHS surveys conducted in Mali before the conflict. However, these surveys did not collect GIS information of residence. Since our identification relies on the distance between conflict location and the place of residence, we cannot use the pre-conflict round data in our main analysis. We also try to compare the pre-conflict dataset using another method in Section 5.1.

mortality rate is one of the worst in the world (World Development Indicators 2014). In addition, the northern area affected by the conflict is poorer and the child health conditions are worse than those across the rest of the country (Cellule de Planification et de Statistique et al. 2014). It remains unclear whether the poorer health conditions among children in the northern region can be solely attributed to their low socioeconomic conditions or whether in-utero conflict exposure (or the culling effect) also plays a role. In this study, we use more accurate location information based on GPS data to identify the areas most affected by the conflict. This approach allows us to adopt a more reliable identification strategy than those used in previous studies.

A rapidly growing strand of the literature shows a negative association between conflict and child health by examining the impact of violent shocks exposed in utero on birthweight (Camacho 2008; Guantai and Kijima 2020; Mansour and Rees 2012), following research testing the fetal origin hypothesis (Glynn et al. 2001; Almond and Mazumder 2011).[2] In SSA, however, using birthweight as a measure of a child's health tends to be problematic since delivering at home is common, and thus birthweight is less likely to be measured. The dataset generally comprises birthweight information only for children of urban residents and wealthier households, which results in selection bias and self-reported bias. Since anthropometric measures such as weight and height can be easily scaled by survey teams using measured height and weight, it is less likely to suffer from such bias. For these reasons, this study uses the height-for-age Z-score (HAZ) and weight-for-height Z-score (WHZ) to measure child health conditions.[3] Since HAZ captures the accumulated nutrition conditions and WHZ reflects the short-term nutrition conditions, a few studies using anthropometric measures use only HAZ (Bundervoet et al. 2009; Akresh et al. 2012a, 2014; Minoiu and Shemyakina 2014). We also use WHZ because the data used in this study were collected immediately after the conflict.

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[2] The effects of armed conflict on child health outside SSA have been examined by Brown (2018) for Mexico, Kecmanovic (2013) for Croatia, Leon (2012) for South Korea, Shemyakina (2011) for Tajikistan, and Singh and Shemyakina (2016) for India.

[3] HAZ and WHZ are standardized, measured by incorporating children's growth separately according to sex and age group (World Health Organization and Unicef 2009). Shemyakina (2018) is an exception in which both WHZ and HAZ are examined.

Previous research has mainly used the number of months exposed and distance to conflict areas. However, these measurements may not precisely capture intensity. For example, even if children were attacked at the same time, one child may have experienced a conflict in only one place, whereas another child may have experienced several conflicts in multiple places. Moreover, the severity of conflict exposure should differ by the scale of the conflict or number of casualties, even if the conflict took place in the same place or for the same duration. To overcome this limitation, we utilize intensity measure of exposure, namely the number of deaths, which aggregates casualties occurred at the same time.

It was observed in the Malian Conflict that in areas with fierce battles, regular markets were closed and access to health facilities was disrupted (Tuncalp et al. 2015), and the security was compromised such as robbery and private punishment (Poulton and Youssouf 1998). There must have been other ways that conflict affects civilians (Kadir et al. 2019). It is, therefore, challenging to specify the scale of the conflict that affects non-combatant population. This study examines the possible two mechanisms how child health is affected by the conflict: (1) physical damage caused by worsening access to resources such as health care and food; and (2) maternal stress caused by psychological stress during the pregnancy which affects the development of the fetus.

The first mechanism, the physical damage, can be caused by insufficient nutritious food and health care services. It has been reported that the problem of pregnant women in need of prenatal care not being able to receive health care service due to changes in living conditions caused by armed conflicts (Chukwuma and Ekhator-Mobayode 2019). Disruption of the health care service may lead to increase in maternal mortality (Kotsadam and Østby 2019). The opportunities to take prenatal care can be lost by a decline in health care providers (David et al. 2017; Kabakian-Khasholian et al. 2013) and loss of accessibility (Bosmans et al. 2008; Chi et al. 2015). It has shown that the effect of negative shocks through physical damage is caused by the exposure during late pregnancy (Almond et al. 2011; Stein and Lumey 2000).

The second mechanism, the maternal stress, is explained by the hypothesis that maternal psychological distress during early pregnancy is linked to fetal and childhood development (Ferreira 1965; Henrichs et al. 2010; Rahman et al. 2007). The maternal psychological distress might make an increase in her cortisol level and then dysregulation of the hypothalamic-pituitary-adrenal axis (Diego et al. 2006). This hormonal change can lead to dysregulation of the same mechanism of the fetus and may subsequently affect childhood growth (Entringer et al. 2010; Harris and Seckl 2011). It has been demonstrated that these effects are more likely to be expressed when exposed to negative shocks during early pregnancy (Eskenazi et al. 2007; Guantai and Kijima 2020; Torche 2011).

This paper finds that the conflict negatively affected the height of children who were exposed in utero but not after birth. Although these findings may be due to selective migration, selective fertility, and higher mortality, we do not find such possibilities. Based on a placebo test to examine the identification assumption holds and robustness checks by using different conflict exposure variables, we confirm that the main empirical results are robust. By investigating differential effects by the timing of exposure in utero, we find that the negative effect on HAZ is caused by the exposure during the first trimester of the pregnancy. Furthermore, there is no evidence that the conflict has changed access to maternal health services. Therefore, it can be concluded that the maternal stress affected the child health.

When conflicts continue for years, children can be exposed not only in utero but also after birth. However, no study has thus far examined the relative importance of in-utero and after-birth exposure to conflicts on child health.[4] This study therefore investigates whether the timing of exposure matters to child health outcomes and if so which yields more severe effects on child health. We find that the negative impact of conflict on health outcomes can be mainly attributed to in-utero exposure, whereas after-birth exposure does not significantly affect child health.

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[4] An exception is Akresh et al. (2014), who found that in-utero exposure does not worsen children's health in Ethiopia, while after-birth exposure negatively affects children in Ethiopia and Eretria.

2. Background on Northern Mali Conflicts and Conflict Data

The most recent conflict in northern Mali broke out in January 2012, during which approximately 300,000 people were forced to evacuate their residences to move to safer places (United Nations High Commissioner for Refugees 2013). This was not the first time that the people of northern Mali had been embroiled in a conflict. Previous conflicts also broke out during 1962–1964, 1990–1995, and 2007–2009, the causes of which are deep rooted. In this study, we examine the effects of the second northern Mali conflict (also known as the Tuareg Rebellion) on child health outcomes. We focus on the second Tuareg rebellion because the number of casualties during this conflict was estimated to be the highest (UCDP Datasets 2014). Child health data on the first and fourth conflicts are unavailable and the main conflict areas during the third rebellion were located in Niger, not Mali.

In northern Mali, the main ethnic groups comprise the pastoral Tuareg and Moors (Arabs) as well as the sedentary Songhay (Benjaminsen 2008). The Tuareg depend on animals grazing in broad areas covering Mali, Algeria, and Niger for their livelihood. However, the establishment of the Malian border at the time of independence restricted their nomadic ways (Smith 2009; Kisangani 2012). Moreover, the first president, Modibo Keita, considered nomadism to be an obstacle to the country's modernization and the new Malian administration discriminated against the Tuareg in northern Mali, deeming them unproductive and futile (Benjaminsen 2008). The anti-nomad policy resulted in the marginalization of nomads, which was one of the reasons underlying the first Tuareg Rebellion (Lecocq 2004).[5] The objective of the rebellion was to establish an autonomous state by separating from the southern part of Mali, where the major ethnic group Bambara holds political and economic power (Benini 1993; Krings 1995; Lecocq 2004).

The loss of cattle due to serious drought in the late 1980s caused several young Tuaregs to emigrate to Algeria and Libya, where many joined the Tuareg military

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[5] The Tuareg owned slaves and thus were further marginalized after the latter's liberalization. After independence, traditional pastoral leaders who dominated land management in wetlands along the Niger River lost power under the modernization policy, which resulted in land use conflicts between pastoralists and farmers (pasture vs. rice fields), and the encroachment of large areas by the latter led to the marginalization of pastoralists (Benjaminsen and Ba 2009).

(Benjaminsen 2008). There was anger among the Tuareg because government officials stole international relief aid for those affected by drought. Further, more than 300 Tuaregs were killed in Niger and more than 100 were executed by the Malian army in 1990 (Krings 1995). Given the escalating frustration among Tuaregs toward the government, in June 1990, a small group of Tuareg youth attacked a prison in Menaka (300 km from Gao city), which was followed by the Tuareg's establishment of armed forces, the Popular Movement for the Liberation of Azawad. This came to be known as the second Tuareg rebellion (Keita 1998; Benjaminsen 2008).

The rebellions took the form of mobile commandos targeting paramilitary forces (Sidib 2012). In retaliation, the Malian army attacked not only the Tuareg but also the Moors because it was unable to distinguish between the two groups. Many Tuareg people fled to Mauritania (Benini 1993). At the end of 1990, direct talks were held between the Mali government and rebel leaders, resulting in the Tamanrasset Peace Treaty in January 1991, which promised that 47% of the national budget would be allocated to the north (Benjaminsen 2008). However, soon after the Treaty was signed, the government was toppled and the rebel group was separated into opponents (moderate and extreme groups) and proponents of the accord (Kisangani 2012). There was conflict among the rebel groups, reflecting the power dynamics in Tuareg society (Lecocq and Klute 2013).[6] The army was beyond the control of the transition government, which increased violence against civilians and compelled people to flee to safer places.

In 1991, most of the violence occurred in Goundam (west of Timbuktu), which became a buffer zone between the government and rebels (Benini 1993).[7] By the end of 1991, the rebels attacked the villages around Lake Faguibine, located to the northwest of

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[6] Tuareg rebels were split into four factions after the signing of the Tamanrasset Peace Treaty: the Arab-Islamic Front of Azawad, the Revolutionary Liberation Army of Azawad, the Popular Liberation Front of Azawad, and the Popular Movement of Azawad (MPA). The first three groups were established by dissidents to the Tamanrasset Peace Treaty, which was agreed upon between MPLA and the Malian government. The Arab-Islamic Front of Azawad was formed by the Hassani Arab minority group in northeast Mali. MPA was initially based among Tuareg refugees and exiles in Algeria and Libya. The Tuareg were also divided by the royal family line (Boas 2014).

[7] In May 1991, numerous civilian Tuareg and Moors were massacred in Lere by the Malian army (Randall 2005).

Goundam, which were then abandoned. As a result, many nomads lost access to food, which worsened the violence and led to the stealing of cattle and grains from other families (Benini 1993). In September 1991, the International Committee of the Red Cross were stationed in Goundam to protect civilians, which made it possible for weekly markets to once again be held and for medical staff to return to their outposts. Although food distribution by the Red Cross was unreliable because of poor logistics and the dispersed locations of people in need, it helped reduce ethnic tension by decreasing the occurrences of food theft. Indeed, the high mortality rates were mainly ascribed to violence and measles, not famine (Benini 1993).

Attacks by both the government army and the rebels continued sporadically, even after a national pact was signed in April 1992 (Lecocq and Klute 2013).[8] After more than 100 innocent civilians (Songhai) were killed by one of the Tuareg rebel groups, a self-defense group was formed by the Songhai population, the Patriotic Movement Ghanda Koy, which resulted in a conflict against the Tuareg rebels in 1994 in major northern Mali cities such as Bourem, Gao, and Ansongo (Lecocq and Klute 2013). In June and July 1994, 500 people were killed and more than 160,000 refugees fled to Algeria and Burkina Faso (Kisangani 2012).

MPA, a moderate rebel group, defeated the other, more extreme opposition rebel groups and forced them to sign a peace accord in December 1994 (Kisangani 2012). From October 1994, the government took control of the army, and peace processes were initiated by civil society (e.g., international NGOs and the Church of Norway) (Benjaminsen 2008). In 1996, a peace ceremony was held in Timbuktu and the second Tuareg rebellion was declared over (Poulton and ag Youssouf 1998).

During this conflict, it is estimated that 250,000 people were temporally displaced and became refugees outside the country (Benini 1993). Those displaced had to leave their livestock and farmland behind, which were their main income sources. Food shortages and unsanitary living conditions in refugee camps affected pregnant women

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[8] MPA, with support from the Malian army, fought against the Popular Liberation Front of Azawad and ARL.

and infants. Those in conflict areas had less access to healthcare facilities and medical attention.[9] The socioeconomic disruption severely affected not only the rebel groups and the army but also civilians in northern Mali. We thus postulate that children exposed to conflict in utero and after birth have worse health outcomes.

3. Data and Descriptive Statistics

3.1. Data

3.1.1. Conflict database

The conflict data used in this study are taken from the Uppsala Conflict Data Program (UCDP). The UCDP database comprises information on the 103,665 global conflicts since 1989. The data provide detailed information on each conflict such as belligerents, period of conflict (start and end dates), number of deaths, and location reference using GPS coordinates. This allows us to construct accurate measures of the conflicts in terms of their location, timing, and severity.

[Figure 1 about here]

In the UCDP dataset, 67 conflicts are recorded in Mali for 1990–1994. With the exception of eight cases, all conflicts occurred in northern Mali (also called Azawad territory), particularly Gao and Timbuktu (Figure 1).[10] In these six years, the number of deaths reached 1,324 and more than half of them were recorded in 1994; 78% of the deaths were civilians.

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[9] Tuncalp et al. (2015) analyzed data on healthcare facilities collected during the 2012 northern Mali conflict and found that facilities in conflict areas lacked several services such as prenatal care, skilled care during childbirth, and postnatal care because of the medical supply chain, and even qualified healthcare workers.

[10] Table A1 in the Appendix provides detailed information on these conflicts.

3.1.2. Child health data

The data are taken from MDHS95/96 and MDHS2001. The MDHS is a nationally representative household survey that contains household characteristics including geo-referenced locations as well as detailed health measures on mothers and children aged under five years.[11] The MDHS comprises information on women aged 15–49 years, their pregnancies in the past five years, and children aged 0–5 years, which means that the data include children born between 1992 and 2001.

3.1.3. Construction of the conflict exposure variables

For each child in the sample, we create three variables indicating the intensity of conflict exposure in utero, after birth, and both in utero and after birth (total) as follows: $Deaths_i^{in-utero}$, which denotes the number of deaths from the conflicts within a 10-km radius of the community when he/she was an unborn child; $Deaths_i^{after\ birth}$, which indicates the number of deaths when he/she turned one year old; and $Deaths_i^{total}$, which is the sum of deaths when he/she was an unborn child and one year old. We also construct exposure variables based on different distances other than 10 km and perform a regression analysis as a robustness check, as presented in Section 5.

3.2. Descriptive Statistics

Households are categorized into two groups depending on conflict exposure: “Near to conflict areas” households are located within a 10-km radius of a conflict area, while “Not near to conflict areas” households are outside this radius. We call these groups “conflict areas” and “non-conflict areas,” respectively. Since the northern region has stagnated economically compared with the rest of Mali, and most of the children exposed to conflict were in the northern region, the common trend assumption may not hold if we compare

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[11] The MDHS is based on multiple stratified sampling (Coulibaly et al. 1996; Cellule de Planification et de Statistique du Ministère de la Santé et al. 2002). It uses sample weights to obtain nationally representative results. Thus, all the analyses presented in this paper are obtained using these weights. Primary sampling unit (PSU) is village. The information about the name and location of each PSU are not publicly available.

conflict areas with non-conflict areas in the southern region. Thus, we restrict the sample to households in the northern region.[12]

Table 1 shows the descriptive statistics of the variables. Column (1) presents the estimated mean of the variables for the full sample and Columns (2) and (3) show those for conflict and non-conflict areas, respectively. To compare conflict with non-conflict areas, the table also displays the differences in each variable in Column (4). These differences are tested using a t-test and the results are shown by asterisks.

[Table 1 about here]

Panel A of Table 1 shows the child and household characteristics. The children in the sample are less likely to be the first-born (birth order is 4.5) and twin siblings are rare (2%). The average age of the children's mothers is about 27 years. Mothers are mostly uneducated (i.e., not even attending primary school) and married (98%). One-fifth of the sampled children reside in urban areas. The difference between the mean characteristics in conflict and non-conflict areas (Column (4)) indicates that on average mothers in conflict areas tend to be more educated and healthy, live in urban areas, and be richer than those in non-conflict areas. These differences are likely to be mainly derived from the locations of conflict areas since most conflicts broke out in towns. When comparing the means of the household characteristics in urban samples in conflict and non-conflict areas, all these differences disappear (see Table A3 in the Appendix).

Panel B in Table 1 shows the main outcome variables (HAZ and WHZ) for the conflict and non-conflict areas as well as age cohorts for those exposed in utero and those not.[13] There are differences in HAZ between conflict and non-conflict areas, while in any given area there are no significant differences between exposed and non-exposed cohorts.

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[12] In this study, households in the Mopti, Timbuktu, Kidal, and Gao regions are considered to be in the northern region (Poulton and ag Youssouf 1998). Table A2 in the Appendix shows the descriptive statistics of the national sample. Households in the northern region tend to have a lower educational background and wealth status than those in the southern region.

[13] In Table 1, the age cohort "exposed in utero" includes those born before October 1995 and the cohort "not exposed in utero" are those born after October 1995.

For WHZ, children exposed to a conflict have worse health outcomes than those not exposed, both in conflict and in non-conflict areas. Panel C shows the total number of deaths when exposed in utero and/or after birth. In conflict areas, the average number of deaths from conflicts within a 10-km radius when he/she was in utero and after he/she was born is 23 and 34, respectively.

4. Estimation Model and Results

4.1. Main analysis

Our identification strategy relies on the difference-in-difference approach using the variations in the timing of birth and location. We analyze the effects of conflict exposure on child health outcomes using ordinary least squares as follows:

$$(1)\ \ y_{ijt} = \alpha + \beta E_{ijt} + \gamma X_{ijt} + \delta_1 d_j + \delta_2 d_t + \delta_3 (d_j \times d_t) + \varepsilon_{ijt},$$

where the subscripts $i, j,$ and t indicate child, location, and birth cohort (year-month), respectively. y_{ijt} is a child's health outcomes (HAZ and WHZ). X_{ijt} is a vector for the characteristics of a child (birth order, female dummy, multiple birth, and mother's age at birth) and his/her mother (years of education, HAZ or WHZ, marital status) and a household's characteristics (ethnicity and wealth index).[14] E_{ijt} is a set of the conflict exposure variables defined in the previous section ($Deaths_i^{in-utero}$, $Deaths_i^{after\ birth}$, and $Deaths_i^{total}$). $d_j\ and\ d_t$ are the location and birth cohort (year-month) fixed effects, respectively. $\beta, \gamma,$ and δ are the parameters to be estimated. ε_i is an error term.

Children with in-utero or after-birth conflict exposure are likely to have worse health conditions ($\beta < 0$). In the first two specifications, we separately estimate the impact of conflict exposure in utero and after birth since these impacts could vary. In the third specification, we control for both $Deaths_i^{in-utero}$ and $Deaths_i^{after\ birth}$ at the same time, while in the fourth specification, we use $Deaths_i^{total}$.

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[14] The MDHS data contain a wealth index calculated using a principal component analysis on basic household assets such as type of toilet, water sources, electrification, and materials for the floor and roof of a homestead (Rutstein and Johnson 2004; Gwatkin et al. 2007).

To correctly identify the impact of conflict exposure, Equation (1) relies on two assumptions. The first one is a common trend assumption. Before the conflict broke out, children exposed to a conflict should have grown at the same trend as those not exposed. The second assumption is that once X and other fixed effects are controlled for, the conflict exposure variable does not correlate with the error term in Equation (1). However, this assumption can be violated if some households selectively migrated to mitigate the negative effects of the conflict (selective migration) or if some mothers purposively delayed pregnancy during the conflict to avoid its effects (selective fertility). We acknowledge that our model relies on these assumptions. In Section 5, we show the robustness of the results by testing whether there are differences when we use subsamples of non-movers and mothers who conceived during the conflict in conflict areas and those who did not.

Tables 2 provides the estimated results for HAZ and WHZ. Panel A shows that in-utero exposure to conflict decreases HAZ by 0.574 standard deviation (SD)[15]. This impact is slightly larger than the previous studies: the results of Côte d'Ivoire, the Ethiopian-Eritrean war, and the Burundian war are 0.41, 0.42, and 0.53 SD, respectively (Minoiu and Shemyakina 2014; Akresh et al. 2012a; Bundervoet et al. 2009). Since the mean HAZ of the sample children is -1.341 (Table 1), the estimated impact of the conflict (0.574 SD) suggests that children affected by the conflict are likely to be stunted[16].

Moreover, a one-unit increase in the total number of deaths from the conflict exposed in utero affects HAZ by -0.01, as shown in Columns (5) and (7). Since the average number of deaths exposed in utero is 22.556 (Table 1), the magnitude of the impact of in-utero exposure is 0.226 HAZ (= -0.01 × 22.556) on average. By contrast, the coefficient of after-birth exposure is not statistically significant. We find no evidence that those children

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[15] To interpret the impact of the conflict as centimeters (cm), the average age of children lived in the conflict area is 23.39 months (Table 1). The values of one SD of HAZ for boy and girl at 23 months old are 3.00 and 3.17 cm, respectively (World Health Organization: WHO 2006). That is, children who have been exposed to the conflict is about 1.72 cm (= 0.574 SD × about 3.0 cm) smaller than children who have not, on average. As a reference for other ages, the value of one SD of HAZ for boys at one, three and five years old are 2.38, 3.71 and 4.63 cm, respectively. Likewise, the one for girls (one, three, five years old) are 2.58, 3.81 and 4.76 cm, respectively (World Health Organization 2006).

[16] A person whose HAZ is below -2.0 is classified as stunting (World Health Organization 2006).

exposed to the conflict after birth are less healthy than those who were not. Therefore, the timing of exposure had varying effects on child health: in-utero exposure leads to a child being unhealthy, although this does not hold for after-birth exposure.

By contrast, as shown in Panel B in Table 2, there is no evidence that in-utero and after-birth exposure to the conflict decreases children's weight (WHZ), although the total number of deaths exposed either in utero or after birth (Column (8)) marginally decreases WHZ. Given that the survey was not conducted immediately after the conflict, this is not surprising since weight reflects short-term nutrition conditions. All these results on WHZ are consistent with those of previous studies.

[Table 2 about here]

4.2. Underlying Mechanism

In the main results, we found that in-utero conflict exposure negatively affects child height. In this section, we investigate the mechanism underlying this effect. Given the lack of an effect of after-birth exposure on child height, there should be a negative effect of in-utero exposure on birth outcomes. As explained in the Introduction, birthweight record is not available for all sample children. Instead, we examine how the timing of conflict exposure during pregnancy affects child health. This is because a negative shock in the first trimester of a pregnancy tends to result in more severe consequences in birth outcomes such as low birthweight compared with in a later period (Camacho 2008; Aizer et al. 2016). We run the same model as in Equation (1) with three exposure variables separately for the first, second, and third trimesters. Columns (3) and (4) of Panel A in Table 3 shows that children exposed to a conflict in utero in their early pregnancy are shorter in their early life. Since this effect is found only in the first trimester of their pregnancy, the negative effect of the in-utero conflict exposure is likely to be caused the maternal stress, not by the physical damage.

[Table 3 about here]

For confirming this finding, we examine whether the utilization of healthcare services among mothers affected by the conflict is lower than those who were not by estimating the same model. To measure the utilization of healthcare services, we use four variables: a dummy variable taking one if the mother received prenatal care (doctor or nurse) during the pregnancy and zero otherwise, the number of times the mother visited the clinic for antenatal care, a dummy variable taking one if the mother delivered at a hospital or in a clinic and zero otherwise (using delivery at home as the reference group), and a dummy variable taking one if the child was delivered with assistance from a doctor, nurse, and auxiliary midwife and zero otherwise. As shown in Panel B (Table 3), there is no evidence that mothers exposed to a conflict are less likely to receive healthcare services. This may be because the utilization of healthcare services is low even among those not exposed to a conflict, as shown in Table A4 in the Appendix.

5. Robustness Checks

5.1. Different Definitions of Conflict Area and Exposure

As mentioned in Section 3.1.3, we constructed a variable of the conflict-affected area based on the distance from the mother's residential community to the location of conflict areas recorded in the UCDP data. Since there is no information the size of the conflict areas, we set a 10-km radius as the benchmark case. Table A5 in the Appendix shows the estimation results when the variable for conflict areas is defined by a 20-km radius of conflict areas. The impacts of in-utero exposure on HAZ remain significant and the coefficients are unchanged.

Since our exposure measure is different from those of other studies, it is difficult to compare the magnitude of the impacts. Using the number of months exposed to a conflict, Akresh et al. (2014) and Shemyakina (2018) found that increasing conflict exposure by one month decreases HAZ from -0.005 to -0.002. We also estimate the model using the total months of exposure as the intensity variable (Table A6 in the Appendix), finding that the impacts per month in the northern Mali case are larger than those in previous studies.

Moreover, we follow a similar identification strategy as the previous studies by using a region-level variable as a measure of conflict exposure. We define all parts of the states of Kidal, Gao, Timbuktu, and Mopti as the conflict region and the entire period of 1990-94 as the conflict period. By using a nationwide sample, we estimate the coefficients of interaction terms between conflict region and conflict period which can be interpreted as broader effects on everyday life among non-combatant citizens including spillover effects from the location with the casualty to the neighboring regions through the disruption of the economy and traffic. The estimation results shown in Table A7 in the Appendix. In Panel A, the surveys conducted during the conflict (MDHS 1995/96) and post-conflict (MDHS 2001) are used as in the main analysis. In Panel B, the pre-conflict survey (MDHS 1987) is also used for comparison.[17] These results are qualitatively similar to our main results.

5.2. Placebo Tests

The main results find that in-utero exposure to a conflict decreases a child's height. This result may be due to the differential pre-treatment characteristics and trends between conflict-affected and non-affected areas. As shown in Table 1, conflict-affected households are richer and more likely to live in urban areas than non-affected households. If those affected households migrated from conflict areas and did not return, the sample composition would be affected and the common trend assumption may not hold, resulting in biased estimates.

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[17] Since this conflict exposure measure does not require GIS information on the residence of sample households unlike the main analysis, the survey prior to the conflict (MDHS 1987) could be used.

To alleviate these concerns, we perform a placebo test following Minoiu and Shemyakina (2014) using two survey rounds conducted after the conflict (i.e., MDHS2001 and MDHS2006 that sampled children born between 1997 and 2006).[18] We assign the placebo treatment as if each conflict event broke out five years later than the actual conflict.[19] Since all the children in these two survey rounds were born after the conflict (i.e., were not exposed to the conflict), the difference-in-difference estimator should not be statistically significant. Table 4 shows the estimation results. None of the coefficients of the placebo exposure measures is statistically significant, which means that the results for HAZ in Table 2 are robust and not driven by the pre-existing differences and trends in child health in conflict and non-conflict areas.

[Table 4 about here]

5.3. Selective Migration

Thus far, we have used the location information of respondents' residences to identify whether a household lived in a conflict area during the conflict, assuming it did not relocate. Some respondents may have moved out of the conflict area to avoid attacks. Those who could not move from the conflict area might have been poorer and less healthy than those who could. This potential selective migration could lead to the overestimation of the conflict's effects.

To mitigate the bias from selective migration, we estimate Equation (1) using only those who did not move after the breakout of the conflict following Shemyakina (2018). The estimation results in Table 5 are similar to those in Table 2, showing that in-utero exposure has a negative impact on a child's height; however, there is no evidence that after-birth exposure decreases height. The coefficient of in-utero exposure is slightly

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[18] One survey round was conducted before the conflict, but it does not contain GIS information.

[19] In addition to five years (60 months), we shifted the date on which each conflict broke out to 48–72 months later than the actual conflict. Table A8 in the Appendix shows the results. Only two of the 70 coefficients are statistically significant.

lower than that in the main results. Thus, we can conclude that the negative effects of the conflict are robust and that selective migration is not a confounding factor of the negative health effect of conflicts.

[Table 5 about here]

5.4. Selective Fertility and Mortality

The negative impact of conflicts on child health could be attributed to the fact that healthier women in the conflict region may have delayed their pregnancies until after the conflict. To test this, we examine whether women pregnant during the conflict living with a 10-km radius systematically differ from those who were not. If those pregnant during the conflict were less healthy and poorer than those who were not, the negative effects found in the main results might not be the pure effect of conflict exposure. We run a model similar to that in Equation (1) but use the number of births in the past five years, years of education, height, and wealth as the dependent variables because a mother's human and physical capital as well as her fertility behavior before a given child are likely to affect her choice of having a child during a conflict. Table 6 shows the estimation results. The coefficients of the conflict exposure variable do not differ from zero. There is thus no evidence that mothers pregnant during the conflict and living in conflict areas are systematically different from others. This result suggests that the estimated impact of exposure to conflict in utero on a child's health is not purely due to selective fertility.

[Table 6 about here]

Furthermore, our results may be biased by selective mortality since the probability of child survival may vary between affected and non-affected households. If the mortality rate is higher in conflict areas, the distribution of survived children in the sample could differ in conflict and non-conflict areas. Since those who died are likely to be weaker, the average health of the survived children in the conflict area should be higher than that in the non-conflict area. If this type of selective mortality is observed, our estimates in the main results should be considered to be the upper bound of the negative effect of the conflict. To test this possibility, we use the sample of all the children conceived in the five years before the survey and investigate whether those affected by the conflict are less likely to survive. We use three commonly used mortality indicators: neonatal mortality (child died before turning one month), infant mortality (child died before turning one year), and under-five mortality (child died before turning five years). We use a similar estimation model to that in Equation (1) but use these mortality indicators as the dependent variables. Table 7 presents the estimation results. The coefficients of the exposure variables do not differ from zero, which shows no evidence that pregnancy cases affected by the conflict are less likely to survive after the birth. Thus, we can conclude that any possible bias due to selective mortality is not severe.

[Table 7 about here]

6. Conclusion

In this study, we estimated the impact of the northern Mali conflict on child health. Our measures of conflict exposure capture actual exposure to the violence more precisely than previous studies that have defined conflict-affected areas at district and province levels. Even when using this conflict exposure measure, we found that children exposed to the conflict had worse health outcomes than those who were not. In addition, the impact was greater when the child was exposed to prolonged and more severe conflicts. The impact determined in this study was much larger than that found in earlier studies, suggesting that conflict in poor countries results in greater consequences. The differential effects of the timing of exposure in utero suggest that the heightened maternal stress is the main mechanism. We do not find evidence that alternative mechanism (physical damage) explains the negative effect on child health. The robustness checks confirmed that the estimated impact was not due to selective migration or selective fertility.

We also found that the negative impact on child health was caused mainly by in-utero conflict exposure as opposed to exposure after birth. Although we found no evidence that in-utero exposure to a conflict decreases the weight of the children (WHZ), the negative effect on height (HAZ) is caused by exposure during the first trimester of the pregnancy. Since a negative shock in early pregnancy tends to result in low birthweight, our results are consistent with those of other studies showing that negative shocks during pregnancy caused by natural disasters and terrorist attacks decrease birthweight.

Our finding that in-utero exposure to conflict negatively affects children's height is thus consistent with the literature. One difference is the effect of exposure to the conflict after birth on height. While previous studies have shown that after-birth conflict exposure significantly decreases children's height, we found no such significant effect. Our findings may thus suggest that the effect of in-utero exposure on child health cannot be easily reversed before children reach five years. Given the complementarity between children's health conditions and education, this result partially explains why in-utero exposure to conflict has a negative long-term effect on human capital as shown by other studies. Our results suggest that dedicated support is required for those exposed to conflict in utero. The extent to which the negative effect of in-utero exposure can be recovered in early childhood and how are important research areas to improve children's health conditions in conflict-prone countries.

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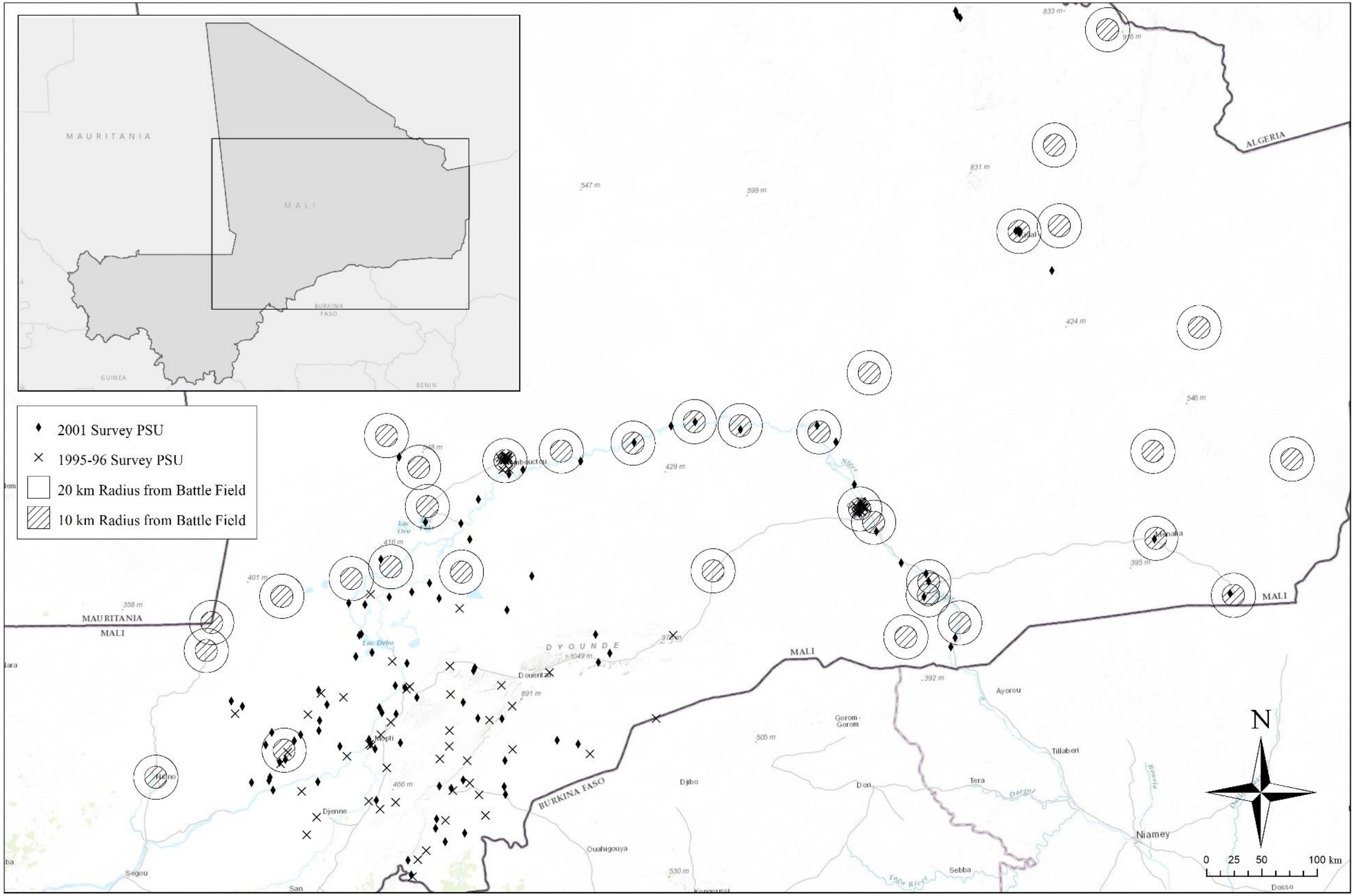
Figure 1: Mali regional map, sampled communities, and conflict areas



Note: Conflict areas and sampled communities (primary sampling unit, PSU) are based on GIS information using ArcGIS software. The source for conflict areas is the UCDP database and that for sampled communities is MDHS95/96 and MDHS2001.

Table 1: Descriptive statistics

Variable	Full Sample (1)	Non - Conflict area (2)	Conflict area (3)	Difference (4)=(3)-(2)
N	2899	2047	852	
Panel A: Child and Household characteristics				
Child characteristics				
Age (months)	22.824	22.757	23.392	0.635
	(0.543)	(0.621)	(0.922)	(1.118)
Birth Order	4.543	4.598	4.078	-0.520***
	(0.073)	(0.081)	(0.106)	(0.133)
Sex; 0=male, 1=female	0.493	0.501	0.427	-0.074**
	(0.012)	(0.013)	(0.024)	(0.027)
Twin; 0=single, 1=multiple	0.022	0.022	0.021	-0.001
	(0.004)	(0.005)	(0.008)	(0.001)
Mother's age at child's birth (months)	334.842	335.572	328.690	-6.881
	(2.996)	(3.353)	(2.770)	(4.347)
Household characteristics				
Mother's highest educational in single years	0.590	0.488	1.453	0.966***
	(0.057)	(0.057)	(0.200)	(0.209)
Mother's Height for Age (HAZ)	-0.442	-0.462	-0.273	0.190**
	(0.035)	(0.039)	(0.042)	(0.057)
Mother's Weight for Height (WHZ)	-0.657	-0.674	-0.518	0.155
	(0.039)	(0.042)	(0.105)	(0.114)
Never married =1, married=0	0.020	0.017	0.042	0.024**
	(0.004)	(0.005)	(0.009)	(0.010)
Wealth Index	-0.253	-0.307	0.210	0.518***
	(0.040)	(0.044)	(0.090)	(0.101)
Type of residence (1=urban, 0=rural)	0.204	0.157	0.605	0.448***
	(0.030)	(0.034)	(0.076)	(0.085)
Panel B: Outcome variables				
Height for Age (HAZ)				
All periods	-1.341	-1.361	-1.179	0.182†
	(0.058)	(0.064)	(0.081)	(0.103)
Born After the war (a)	-1.365	-1.393	-1.123	0.270*
	(0.073)	(0.080)	(0.100)	(0.128)
Born During the war (b)	-1.274	-1.269	-1.319	-0.050
	(0.086)	(0.096)	(0.126)	(0.158)
Diff. in mean HAZ (b)-(a)	0.091	0.124	-0.196+	-0.321
	(0.117)	(0.130)	(0.116)	(0.207)
Weight for Height (WHZ)				
All periods	-0.876	-0.869	-0.935	-0.066
	(0.041)	(0.045)	(0.064)	(0.078)
Born After the war (a)	-0.691	-0.680	-0.790	-0.110
	(0.032)	(0.035)	(0.072)	(0.081)
Born During the war (b)	-1.393	-1.404	-1.301	0.103
	(0.068)	(0.076)	(0.076)	(0.107)
Diff. in mean WHZ (b)-(a)	-0.701***	-0.724***	-0.511***	0.213†
	(0.071)	(0.079)	(0.090)	(0.127)
Panel C: Identification variables				
N				
exposure in-utero	-	-	22.556	-
			(1.615)	
exposure after birth	-	-	33.827	-
			(1.907)	
exposure in-utero and after birth	-	-	37.816	-
			(1.407)	

Note: Cluster (PSU)-level robust standard errors in parentheses. ***, **, *, and † represent significance levels of 0.1%, 1%, 5%, and 10%, respectively.

Table 2: Effects of exposure to conflict on child health

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Height for Age Z-score								
Dummy within 10 km in Utero	-0.574*		-0.576*					
	(0.260)		(0.261)					
Dummy within 10 km after birth		-0.079	-0.101					
		(0.300)	(0.298)					
Dummy within 10 km in Utero or after birth				-0.232				
				(0.249)				
Total Deaths of violence within 10 km in Utero					-0.010*		-0.009*	
					(0.004)		(0.004)	
Total Deaths of violence within 10 km after birth						0.005	0.002	
						(0.005)	(0.005)	
Total Deaths of violence within 10 km in Utero or after birth								-0.006
								(0.004)
N	2899	2899	2899	2899	2899	2899	2899	2899
R-squared	0.341	0.341	0.341	0.341	0.341	0.341	0.341	0.341
Panel B: Weight for Height Z-score								
Dummy within 10 km in Utero	-0.149		-0.142					
	(0.236)		(0.237)					
Dummy within 10 km after birth		0.293	0.287					
		(0.252)	(0.252)					
Dummy within 10 km in Utero or after birth				-0.111				
				(0.250)				
Total Deaths of violence within 10 km in Utero					-0.004		-0.004	
					(0.003)		(0.004)	
Total Deaths of violence within 10 km after birth						-0.000	-0.002	
						(0.003)	(0.004)	
Total Deaths of violence within 10 km in Utero or after birth								-0.006†
								(0.003)
N	2899	2899	2899	2899	2899	2899	2899	2899
R-squared	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.240

Note: All equations include other controls: the characteristics of a child (birth order, female dummy, multiple birth, and mother's age at birth) and his/her mother (years of education, HAZ or WHZ, marital status), a household's characteristics (ethnicity and wealth index), ethnicity dummies, region fixed effects, birth fixed effects, and birth cohort-region fixed effects. Cluster (PSU)-level robust standard errors in parentheses. ***, **, *, and † represent significance levels of 0.1%, 1%, 5%, and 10%, respectively.

Table 3: Underlying mechanism

Panel A: effects on in utero trimesters	HAZ				WHZ			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dummy within 10 km in Utero Trimester 1st	-0.226	-0.223			-0.019	-0.031		
	(0.342)	(0.341)			(0.329)	(0.331)		
Dummy within 10 km in Utero Trimester 2nd	-0.231	-0.231			-0.026	-0.024		
	(0.253)	(0.253)			(0.276)	(0.276)		
Dummy within 10 km in Utero Trimester 3rd	0.219	0.219			-0.439	-0.439		
	(0.413)	(0.413)			(0.320)	(0.320)		
Dummy within 10 km after birth		-0.073				0.291		
		(0.299)				(0.253)		
Total Deaths of violence within 10 km in Utero Trimester 1st			-0.011*	-0.011*			-0.007	-0.007
			(0.005)	(0.005)			(0.004)	(0.004)
Total Deaths of violence within 10 km in Utero Trimester 2nd			-0.010	-0.009			-0.005	-0.005
			(0.006)	(0.006)			(0.006)	(0.006)
Total Deaths of violence within 10 km in Utero Trimester 3rd			-0.007	-0.007			-0.006	-0.006
			(0.009)	(0.009)			(0.007)	(0.007)
Total Deaths of violence within 10 km after birth				0.004				-0.001
				(0.005)				(0.003)
N	2899	2899	2899	2899	2899	2899	2899	2899
R-squared	0.341	0.341	0.341	0.341	0.239	0.240	0.239	0.239

Panel B: access to prenatal care and assistance at delivery	Prenatal Care (Yes=1, No=0)		Delivery at Hospital (Yes=1, No=0)		Number of Antenatal care taken		Delivery with Assistance (Yes=1, No=0)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dummy within 10km in Utero	0.071		-0.074		-0.011		-0.084	
	(0.073)		(0.074)		(0.496)		(0.073)	
Total Deaths of violence within 10km in Utero		0.001		-0.001		-0.002		-0.002
		(0.001)		(0.001)		(0.007)		(0.001)
N	2899	2899	2899	2899	2253	2253	2899	2899
R-squared	0.289	0.289	0.430	0.430	0.344	0.344	0.423	0.423

Note: All the controls used in Table 2 are included as well as covariates, ethnicity dummies, region fixed effects, birth fixed effects, and birth cohort-region fixed effects. Cluster (PSU)-level robust standard errors in parentheses. ***, **, *, and † represent significance levels of 0.1%, 1%, 5%, and 10%, respectively.

Table 4: Robustness check (placebo test)

	Dependent variable: HAZ							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Placebo dummy within 10 km in utero	-0.028		-0.038					
	(0.213)		(0.211)					
Placebo dummy within 10 km after birth		0.168	0.171					
		(0.254)	(0.252)					
Placebo dummy within 10 km in utero or after birth				0.138				
				(0.214)				
Placebo: Total deaths of violence within 10 km in utero					-0.003		-0.003	
					(0.005)		(0.005)	
Placebo: Total deaths of violence within 10 km after birth						0.005	0.005	
						(0.004)	(0.004)	
Placebo: Total deaths of violence within 10 km in utero or after birth								0.002
								(0.003)
N	4904	4904	4904	4904	4904	4904	4904	4904
R-squared	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252

Note: The placebo treatment is assigned to each child so that each conflict occurred 60 months later than the actual conflict. All the controls used in Table 2 are included as well as covariates, ethnicity dummies, region fixed effects, birth fixed effects, and birth cohort-region fixed effects. Cluster (PSU)-level robust standard errors in parentheses. ***, **, *, and † represent significance levels of 0.1%, 1%, 5%, and 10%, respectively.

Table 5: Robustness check (selective migration)

	Dependent variable: HAZ							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dummy within 10 km in utero	-0.612*		-0.617*					
	(0.281)		(0.283)					
Dummy within 10 km after birth		-0.323	-0.338					
		(0.331)	(0.333)					
Dummy within 10 km in utero or after birth				-0.423†				
				(0.252)				
Total deaths of violence within 10 km in utero					-0.008†		-0.008†	
					(0.004)		(0.004)	
Total deaths of violence within 10 km after birth						0.003	0.000	
						(0.005)	(0.005)	
Total deaths of violence within 10 km in utero or after birth								-0.007
								(0.004)
N	2113	2113	2113	2113	2113	2113	2113	2113
R-squared	0.360	0.359	0.360	0.360	0.360	0.359	0.360	0.359

Note: All coefficients are estimated using only the participants who responded that he/she has lived in the residence from before the conflict to the MDHS. Thus, the sample size used in this table decreases from that in the main results (Table 2). All the controls used in Table 2 are included as well as covariates, ethnicity dummies, region fixed effects, birth fixed effects, and birth cohort-region fixed effects. Cluster (PSU)-level robust standard errors in parentheses. ***, **, *, and † represent significance levels of 0.1%, 1%, 5%, and 10%, respectively.

Table 6: Robustness check (selective fertility)

	Number of births in the past five years	Highest education in years	HAZ	Wealth index
	(1)	(2)	(3)	(4)
Mother was pregnant at the outbreak of the violence × Lives within 10 km of the conflict area	0.102	-0.415	0.089	0.188
	(0.072)	(0.289)	(0.123)	(0.170)
Mother was pregnant at the outbreak of the violence	0.076*	0.037	-0.059	0.020
	(0.037)	(0.122)	(0.071)	(0.097)
Mother lives within 10 km of the conflict area	0.112*	0.720*	0.163	0.254†
	(0.056)	(0.308)	(0.111)	(0.145)
N	2353	2353	2353	2353
R-squared	0.014	0.044	0.034	0.150

Note: All coefficients are estimated using the woman-level dataset. Other controls are ethnicity dummies and region fixed effects. Cluster (PSU)-level robust standard errors in parentheses. ***, **, *, and † represent significance levels of 0.1%, 1%, 5%, and 10%, respectively.

Table 7: Robustness check (mortality)

	Neonatal mortality	Infant mortality			Under-five mortality		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Dummy variable specification							
Dummy within 10 km in utero	0.075	0.079			0.062		
	(0.070)	(0.065)			(0.065)		
Dummy within 10 km after birth			0.094			0.045	
			(0.059)			(0.075)	
Dummy within 10 km				0.103†			0.070†
in utero or after birth				(0.054)			(0.043)
N	4215	4215	4215	4215	4215	4215	4215
R-squared	0.071	0.075	0.075	0.076	0.088	0.088	0.088
Panel B: Intensity variable specification							
Total deaths of violence within 10 km in utero	0.000	0.000			0.000		
	(0.001)	(0.001)			(0.001)		
Total deaths of violence within 10 km after birth			0.000			0.001	
			(0.001)			(0.001)	
Total deaths of violence within 10 km				0.001			0.001
in utero or after birth				(0.001)			(0.001)
N	4215	4215	4215	4215	4215	4215	4215
R-squared	0.071	0.075	0.075	0.075	0.088	0.088	0.088

Note: All the controls used in Table 2 are included as well as covariates, ethnicity dummies, region fixed effects, birth fixed effects, and birth cohort-region fixed effects. Cluster (PSU)-level robust standard errors in parentheses. ***, **, *, and † represent significance levels of 0.1%, 1%, 5%, and 10%, respectively.

Table A1: List of conflicts and deaths

Conflict ID	Start date	End date	Deaths
1	1990-06-28	1990-08-28	0
2	1990-08-06	1990-08-06	4
3	1990-07-02	1990-07-02	4
4	1990-07-20	1990-08-10	100
5	1990-08-03	1990-08-03	11
6	1990-08-06	1990-08-06	2
7	1990-08-06	1990-08-06	3
8	1990-06-28	1990-06-28	4
9	1990-07-01	1990-07-31	94
10	1990-06-28	1990-06-28	0
11	1990-09-03	1990-09-04	55
12	1990-08-06	1990-08-06	9
13	1990-07-17	1990-07-21	40
14	1990-07-29	1990-07-29	2
15	1991-06-01	1991-07-31	50
16	1991-03-01	1991-04-30	53
17	1991-05-20	1991-05-20	20
18	1991-03-01	1991-04-30	53
19	1991-12-12	1991-12-12	12
20	1992-01-15	1992-01-31	2
21	1992-06-07	1992-06-15	7
22	1992-06-30	1992-06-30	0
23	1992-05-20	1992-05-20	10
24	1992-02-08	1992-02-18	58
25	1993-12-27	1993-12-27	0
26	1994-07-03	1994-07-03	3
27	1994-11-20	1994-11-20	1
28	1994-05-26	1994-05-27	13
29	1994-06-19	1994-06-29	50
30	1994-06-12	1994-06-12	26
31	1994-12-03	1994-12-03	3
32	1994-11-20	1994-11-20	6
33	1994-11-30	1994-11-30	16
34	1994-06-14	1994-06-14	3
35	1994-06-10	1994-06-12	30
36	1994-06-16	1994-06-19	8
37	1994-07-02	1994-07-17	12
38	1994-11-04	1994-11-04	1
39	1994-07-17	1994-07-17	17
40	1994-05-30	1994-05-30	3
41	1994-07-25	1994-07-25	40
42	1994-10-04	1994-10-04	3
43	1994-10-06	1994-10-06	22
44	1994-10-21	1994-10-22	13
45	1994-06-13	1994-06-13	25
46	1994-04-21	1994-04-21	4
47	1994-10-19	1994-10-20	0
48	1994-07-15	1994-07-28	20
49	1994-12-01	1994-12-01	16
50	1994-06-12	1994-06-12	0
51	1994-05-26	1994-05-27	9
52	1994-07-01	1994-07-01	4
53	1994-11-25	1994-11-25	8
54	1994-05-26	1994-05-27	4
55	1994-07-01	1994-07-01	4
56	1994-07-14	1994-07-14	18
57	1994-12-18	1994-12-18	13
58	1994-06-19	1994-06-19	80
59	1994-11-13	1994-11-13	14
60	1994-04-01	1994-09-21	48
61	1994-10-22	1994-10-23	51
62	1994-10-23	1994-10-25	0
63	1994-06-08	1994-06-08	1
64	1994-07-14	1994-07-14	0
65	1994-06-19	1994-06-19	80
66	1994-06-13	1994-06-14	60
67	1995-01-23	1995-01-23	2

Table A2: Robustness check (descriptive statistics of the national sample)

Variable	Full sample (1)	Southern region (2)	Northern region (3)	Difference (4)=(3)-(2)
N	13732	10833	2899	
Panel A: Child and household characteristics				
Child characteristics				
Birth order	4.483	4.470	4.543	0.729
	(0.038)	(0.043)	(0.073)	(0.084)
Sex; 0=male, 1=female	0.498	0.499	0.493	-0.006
	(0.005)	(0.006)	(0.012)	(0.013)
Twin; 0=single, 1=multiple	0.023	0.024	0.022	-0.002
	(0.002)	(0.002)	(0.004)	(0.005)
Mother’s age at the child’s birth (months)	327.657	326.118	334.842	8.72**
	(1.207)	(1.326)	(2.996)	(3.277)
Household characteristics				
Mother’s highest education in single years	0.811	0.859	0.590	-0.268***
	(0.041)	(0.049)	(0.057)	(0.749)
Mother’s HAZ	-0.351	-0.332	-0.442	0.110**
	(0.015)	(0.016)	(0.035)	(0.039)
Mother’s WHZ	-0.749	-0.769	-0.657	-0.111**
	(0.015)	(0.016)	(0.039)	(0.042)
Never married=1, married=0	0.018	0.017	0.020	0.002
	(0.002)	(0.002)	(0.004)	(0.005)
Wealth index	0.002	0.057	-0.253	-0.309***
	(0.026)	(0.030)	(0.040)	(0.050)
Type of residence (1=urban, 0=rural)	0.241	0.249	0.204	-0.045
	(0.012)	(0.013)	(0.030)	(0.033)

Note: Cluster (PSU)-level robust standard errors in parentheses. ***, **, *, and † represent significance levels of 0.1%, 1%, 5%, and 10%, respectively.

Table A3: Explanatory variables (urban sample)

Variable	Full sample (1)	Non-conflict region (2)	Conflict region (3)	Difference (4)=(3)-(2)
N	824	216	608	
Child characteristics				
Birth order	4.216	4.339	3.947	-0.393*
	(0.132)	(0.194)	(0.117)	(0.226)
Sex; 0=male, 1=female	0.534	0.570	0.454	-0.116**
	(0.033)	(0.038)	(0.035)	(0.051)
Twin; 0=single, 1=multiple	0.033	0.040	0.019	-0.021
	(0.014)	(0.021)	(0.008)	(0.022)
Mother's age at the child's birth (months)	328.821	329.993	326.261	-3.732
	(8.639)	(12.641)	(3.512)	(13.120)
Household characteristics				
Mother's highest education in single years	1.325	1.222	1.550	0.329
	(0.146)	(0.173)	(0.231)	(0.289)
Mother's HAZ	-0.354	-0.387	-0.282	0.105
	(0.090)	(0.133)	(0.049)	(0.142)
Mother's WHZ	-0.190	-0.132	-0.317	-0.184
	(0.096)	(0.131)	(0.123)	(0.180)
Never married=1, married=0	0.046	0.045	0.048	0.003
	(0.016)	(0.022)	(0.013)	(0.026)
Wealth index	0.455	0.453	0.458	0.004
	(0.104)	(0.139)	(0.132)	(0.192)

Note: Cluster (PSU)-level robust standard errors in parentheses. ***, **, *, and † represent significance levels of 0.1%, 1%, 5%, and 10%, respectively.

Table A4: Outcomes of the robustness checks

Variable	Full sample (1)	Non-conflict area (2)	Conflict area (3)	Difference (4)=(3)-(2)
Panel A: Fertility				
N	2353	1660	693	
Number of births in the past five years				
All periods	1.677	1.673	1.719	0.047
	(0.019)	(0.021)	(0.033)	(0.039)
Not exposed (a)	1.663	1.661	1.681	0.020
	(0.024)	(0.026)	(0.045)	(0.052)
Exposed (b)	1.710	1.699	1.795	0.096*
	(0.026)	(0.030)	(0.032)	(0.043)
Diff. in mean (b)-(a)	0.046	0.038	0.114†	0.076
	(0.034)	(0.038)	(0.059)	(0.068)
Highest education of the mother				
All periods	0.572	0.479	1.408	0.929***
	(0.055)	(0.058)	(0.179)	(0.189)
Not exposed (a)	0.605	0.501	1.575	1.074***
	(0.066)	(0.068)	(0.245)	(0.254)
Exposed (b)	0.500	0.427	1.078	0.651***
	(0.090)	(0.101)	(0.148)	(0.182)
Diff. in mean (b)-(a)	-0.105	-0.074	-0.497†	-0.422
	(0.126)	(0.137)	(0.291)	(0.307)
HAZ of the mother				
All periods	-0.460	-0.480	-0.278	0.202***
	(0.033)	(0.036)	(0.042)	(0.055)
Not exposed (a)	-0.440	-0.452	-0.325	0.127†
	(0.040)	(0.044)	(0.040)	(0.060)
Exposed (b)	-0.505	-0.545	-0.186	0.359***
	(0.049)	(0.053)	(0.085)	(0.100)
Diff. in mean (b)-(a)	-0.065	-0.093	0.139	0.232*
	(0.061)	(0.067)	(0.083)	(0.112)
Wealth index				
All periods	-0.261	-0.310	0.182	0.492***
	(0.039)	(0.043)	(0.085)	(0.096)
Not exposed (a)	-0.250	-0.293	0.154	0.447*
	(0.046)	(0.050)	(0.118)	(0.128)
Exposed (b)	-0.285	-0.351	0.236	0.586***
	(0.075)	(0.084)	(0.096)	(0.130)
Diff. in mean (b)-(a)	-0.036	-0.058	0.082	0.140
	(0.103)	(0.114)	(0.154)	(0.191)
Panel B: Mortality				
N	4215	2957	1258	
Neonatal mortality (<=1 month)				
All periods	0.068	0.067	0.068	0.001
	(0.005)	(0.005)	(0.019)	(0.020)
Not exposed (a)	0.069	0.070	0.069	-0.001
	(0.006)	(0.006)	(0.025)	(0.025)
Exposed (b)	0.062	0.061	0.068	0.006
	(0.009)	(0.010)	(0.022)	(0.024)
Diff. in mean (b)-(a)	-0.007	-0.008	-0.001	0.007
	(0.011)	(0.012)	(0.035)	(0.035)
Infant mortality (<=12 months)				
All periods	0.135	0.137	0.121	-0.016
	(0.007)	(0.007)	(0.021)	(0.022)
Not exposed (a)	0.140	0.143	0.122	-0.021
	(0.008)	(0.008)	(0.028)	(0.029)
Exposed (b)	0.120	0.120	0.118	-0.002
	(0.012)	(0.013)	(0.019)	(0.024)
Diff. in mean (b)-(a)	-0.020	-0.023	-0.003	0.019
	(0.015)	(0.016)	(0.035)	(0.037)

Under-five mortality (<=60 months)				
All periods	0.171	0.173	0.159	-0.013
	(0.007)	(0.007)	(0.020)	(0.021)
Not exposed (a)	0.174	0.176	0.161	-0.015
	(0.008)	(0.008)	(0.026)	(0.027)
Exposed (b)	0.163	0.163	0.155	-0.008
	(0.014)	(0.015)	(0.020)	(0.025)
Diff. in mean (b)-(a)	-0.012	-0.012	-0.006	0.007
	(0.016)	(0.018)	(0.034)	(0.037)
Panel C: Healthcare				
Delivery at hospital (Yes=1, No=0)				
All periods	0.178	0.168	0.268	0.101†
	(0.021)	(0.024)	(0.036)	(0.044)
Not exposed (a)	0.173	0.166	0.240	0.074
	(0.024)	(0.027)	(0.048)	(0.055)
Exposed (b)	0.192	0.172	0.340	0.168***
	(0.031)	(0.035)	(0.049)	(0.061)
Diff. in mean (b)-(a)	0.018	0.006	0.100	0.066
	(0.045)	(0.049)	(0.073)	(0.089)
Number of antenatal classes taken				
All periods	1.305	1.157	2.628	1.471***
	(0.115)	(0.125)	(0.251)	(0.281)
Not exposed (a)	1.311	1.164	2.701	1.536***
	(0.131)	(0.139)	(0.324)	(0.353)
Exposed (b)	1.287	1.134	2.446	1.312***
	(0.191)	(0.216)	(0.289)	(0.367)
Diff. in mean (b)-(a)	-0.024	-0.030	-0.255	-0.224
	(0.241)	(0.266)	(0.440)	(0.510)
Delivery with assistance (Yes=1, No=0)				
All periods	0.147	0.130	0.296	0.166***
	(0.017)	(0.019)	(0.045)	(0.049)
Not exposed (a)	0.148	0.132	0.300	0.169***
	(0.022)	(0.023)	(0.059)	(0.063)
Exposed (b)	0.146	0.127	0.286	0.159***
	(0.022)	(0.024)	(0.045)	(0.051)
Diff. in mean (b)-(a)	-0.002	-0.005	-0.015	-0.021
	(0.035)	(0.039)	(0.073)	(0.087)
Prenatal care (Yes=1, No=0)				
All periods	0.200	0.164	0.525	0.361***
	(0.020)	(0.022)	(0.041)	(0.046)
Not exposed (a)	0.213	0.179	0.537	0.358***
	(0.025)	(0.026)	(0.054)	(0.060)
Exposed (b)	0.162	0.118	0.495	0.377***
	(0.023)	(0.026)	(0.037)	(0.045)
Diff. in mean (b)-(a)	-0.051	-0.061	-0.043	0.145†
	(0.035)	(0.037)	(0.064)	(0.069)
Subjective birth (small=1, average or large=0)				
All periods	0.182	0.177	0.451	0.274***
	(0.006)	(0.006)	(0.036)	(0.037)
Not exposed (a)	0.199	0.195	0.433	0.238***
	(0.008)	(0.008)	(0.040)	(0.041)
Exposed (b)	0.141	0.135	0.497	0.362***
	(0.008)	(0.008)	(0.059)	(0.059)
Diff. in mean (b)-(a)	-0.058***	-0.060***	0.064	0.103†
	(0.011)	(0.011)	(0.057)	(0.058)

Note: Cluster (PSU)-level robust standard errors in parentheses. ***, **, *, and † represent significance levels of 0.1%, 1%, 5%, and 10%, respectively.

Table A5: Exposure variables with a different distance (20 km)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Dependent variable: HAZ								
Dummy within 20 km in utero	-0.546**		-0.558*					
	(0.205)		(0.215)					
Dummy within 20 km after birth		0.076	0.134					
		(0.253)	(0.271)					
Dummy within 20 km in utero or after birth				-0.297*				
				(0.144)				
Total deaths of violence within 20 km in utero					-0.010*		-0.009*	
					(0.004)		(0.004)	
Total deaths of violence within 20 km after birth						0.005	0.002	
						(0.005)	(0.005)	
Total deaths of violence within 20 km in utero or after birth								-0.006
								(0.004)
N	2899	2899	2899	2899	2899	2899	2899	2899
R-squared	0.341	0.341	0.341	0.341	0.341	0.341	0.341	0.341

Note: All the controls used in Table 2 are included as well as covariates, ethnicity dummies, region fixed effects, birth fixed effects, and birth cohort-region fixed effects. Cluster (PSU)-level robust standard errors in parentheses. ***, **, *, and † represent significance levels of 0.1%, 1%, 5%, and 10%, respectively.

Table A6: Estimation results using the number of exposure months

	HAZ		WHZ	
	(1)	(2)	(3)	(4)
Number of months exposed in utero	-0.250†		-0.176	
	(0.149)		(0.140)	
Number of months exposed after birth	0.246		-0.041	
	(0.182)		(0.150)	
Number of months exposed in utero or after birth		-0.081		-0.130
		(0.135)		(0.125)
N	2899	2899	2899	2899
R-squared	0.341	0.341	0.239	0.239

Note: The key variables use the number of months exposed as the intensity variables following previous studies (Akresh et al. 2014). The key variables indicate the number of months that a child living within 10 km of the conflict area was exposed in utero or after birth. All the controls used in Table 2 are included as well as covariates, ethnicity dummies, region fixed effects, birth fixed effects, and birth cohort-region fixed effects. Cluster (PSU)-level robust standard errors in parentheses. ***, **, *, and † represent significance levels of 0.1%, 1%, 5%, and 10%, respectively.

Table A7: Robustness check (region-level identification using national sample)

	HAZ			WHZ		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Post- vs. During- the conflict datasets						
Exposure to the conflict in Utero	-0.483*			-0.681***		
	(0.199)			(0.170)		
Exposure to the conflict after birth		-0.478			-0.399+	
		(0.364)			(0.222)	
Exposure to the conflict in Utero or after birth			-0.483			-0.681***
			(0.199)			(0.170)
N	14059	14059	14059	14059	14059	14059
R-squared	0.189	0.189	0.189	0.103	0.101	0.103
Panel B: Pre- vs. During- the conflict datasets						
Exposure to the conflict in Utero	-0.483*			-0.624*		
	(0.210)			(0.170)		
Exposure to the conflict after birth		-0.474			-0.402+	
		(0.370)			(0.218)	
Exposure to the conflict in Utero or after birth			-0.483*			-0.624***
			(0.210)			(0.170)
N	5646	5646	5646	5646	5646	5646
R-squared	0.242	0.241	0.242	0.087	0.083	0.087

Note: Robust standard errors in parentheses. ***, **, *, and † represent significance levels of 0.1%, 1%, 5%, and 10%, respectively. This table shows the estimation results using nationwide sample with conflict exposure defined by all parts of the states (Kidal, Gao, Timbuktu, and Mopti) as the conflict region and the entire period of 1990-1994 as the conflict period. In Panel A, the surveys conducted during the conflict (MDHS 1995/96) and post-conflict (MDHS 2001) are used as in the main analysis. In Panel B, the pre-conflict survey (MDHS 1987) is also used for comparison.

Table A8: Robustness check for HAZ (placebo treatment shifting 48 to 72 months)

	Dependent variable: HAZ							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Placebo shifting 48 months								
Placebo dummy within 10 km in utero	0.216		0.217					
	(0.247)		(0.260)					
Placebo dummy within 10 km after birth		-0.001	-0.015					
		(0.382)	(0.385)					
Placebo dummy within 10 km in utero or after birth				0.182				
				(0.212)				
Placebo: Total deaths of violence within 10 km in utero					0.005		0.006	
					(0.005)		(0.005)	
Placebo: Total deaths of violence within 10 km after birth						-0.009	-0.010	
						(0.009)	(0.009)	
Placebo: Total deaths of violence within 10 km in utero or after birth								-0.003
								(0.005)
N	4904	4904	4904	4904	4904	4904	4904	4904
R-squared	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252
Placebo shifting 52 months								
Placebo dummy within 10 km in utero	0.235		0.224					
	(0.267)		(0.268)					
Placebo dummy within 10 km after birth		0.184	0.171					
		(0.284)	(0.287)					
Placebo dummy within 10 km in utero or after birth				0.220				
				(0.207)				
Placebo: Total deaths of violence within 10 km in utero					-0.001		-0.002	
					(0.005)		(0.005)	
Placebo: Total deaths of violence within 10 km after birth						-0.003	-0.003	
						(0.008)	(0.008)	
Placebo: Total deaths of violence within 10 km in utero or after birth								-0.002
								(0.004)
N	4904	4904	4904	4904	4904	4904	4904	4904
R-squared	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252
Placebo shifting 56 months								
Placebo dummy within 10 km in utero	0.065		0.061					
	(0.223)		(0.220)					
Placebo dummy within 10 km after birth		0.175	0.174					
		(0.211)	(0.212)					
Placebo dummy within 10 km in utero or after birth				0.131				
				(0.185)				
Placebo: Total deaths of violence within 10 km in utero					0.000		0.000	
					(0.003)		(0.003)	
Placebo: Total deaths of violence within 10 km after birth						-0.003	-0.003	
						(0.004)	(0.004)	
Placebo: Total deaths of violence within 10 km in utero or after birth								-0.001
								(0.003)
N	4904	4904	4904	4904	4904	4904	4904	4904
R-squared	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252
Placebo shifting 60 months								
Placebo dummy within 10 km in utero	-0.028		-0.038					
	(0.213)		(0.211)					
Placebo dummy within 10 km after birth		0.168	0.171					
		(0.254)	(0.252)					
Placebo dummy within 10 km in utero or after birth				0.138				
				(0.214)				
Placebo: Total deaths of violence within 10 km in utero					-0.003		-0.003	
					(0.005)		(0.005)	
Placebo: Total deaths of violence within 10 km after birth						0.005	0.005	
						(0.004)	(0.004)	
Placebo: Total deaths of violence within 10 km in utero or after birth								0.002
								(0.003)
N	4904	4904	4904	4904	4904	4904	4904	4904
R-squared	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252
Placebo shifting 64 months								
Placebo dummy within 10 km in utero	-0.263		-0.279					
	(0.227)		(0.231)					

Placebo dummy within 10 km after birth		0.138	0.167					
		(0.237)	(0.233)					
Placebo dummy within 10 km in utero or after birth				-0.003				
				(0.195)				
Placebo: Total deaths of violence within 10 km in utero					-0.004		-0.004	
					(0.005)		(0.005)	
Placebo: Total deaths of violence within 10 km after birth						-0.001	-0.001	
						(0.004)	(0.004)	
Placebo: Total deaths of violence within 10 km in utero or after birth								-0.002
								(0.003)
N	4904	4904	4904	4904	4904	4904	4904	4904
R-squared	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252
Placebo shifting 68 months								
Placebo dummy within 10 km in utero	-0.040		-0.039					
	(0.313)		(0.311)					
Placebo dummy within 10 km after birth		0.058	0.058					
		(0.208)	(0.208)					
Placebo dummy within 10 km in utero or after birth				-0.056				
				(0.182)				
Placebo: Total deaths of violence within 10 km in utero					-0.008*		-0.008*	
					(0.004)		(0.004)	
Placebo: Total deaths of violence within 10 km after birth						0.001	0.000	
						(0.003)	(0.003)	
Placebo: Total deaths of violence within 10 km in utero or after birth								-0.003
								(0.003)
N	4904	4904	4904	4904	4904	4904	4904	4904
R-squared	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252
Placebo shifting 72 months								
Placebo dummy within 10 km in utero	-0.347		-0.344					
	(0.295)		(0.293)					
Placebo dummy within 10 km after birth		-0.061	-0.048					
		(0.200)	(0.194)					
Placebo dummy within 10 km in utero or after birth				-0.142				
				(0.199)				
Placebo: Total deaths of violence within 10 km in utero					-0.006		-0.007	
					(0.006)		(0.006)	
Placebo: Total deaths of violence within 10 km after birth						-0.003	-0.003	
						(0.004)	(0.004)	
Placebo: Total deaths of violence within 10 km in utero or after birth								-0.005
								(0.004)
N	4904	4904	4904	4904	4904	4904	4904	4904
R-squared	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252

Note: The placebo treatment is assigned to each child so that each conflict occurred 48–72 months later than the actual conflict. All coefficients are estimated as in Table 2. All the controls used in Table 2 are included as well as covariates, ethnicity dummies, region fixed effects, birth fixed effects, and birth cohort-region fixed effects. Cluster (PSU)-level robust standard errors in parentheses. ***, **, *, and † represent significance levels of 0.1%, 1%, 5%, and 10%, respectively.