

The Importance of Local Violence for the Uptake and Timing of Female Sterilization: Evidence from the Colombian Armed Conflict 1989–2016

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Abstract

Altered fertility behavior has been observed in many conflict settings but few studies have empirically addressed fertility control or teased out differences between postponement, spacing and stopping in relation to conflict. This is the first study to empirically investigate the relationship between conflict and uptake of sterilization, which is the only contraceptive method that reflects a definitive and irreversible stop in childbearing. The study uses data from the Demographic and Health Surveys and the Uppsala Conflict Data Program with a sample of 11,648,913 woman-months (from 142,373 women) at ages 13–49 during the period 1991–2016. Results from the department fixed-effects linear probability regressions show that local conflict events generally increased women's uptake of sterilization. Conflict thus alters women's fertility choices and/or self-determination, but the available data cannot determine whether this reflects a willingness to definitely reduce births, forced sterilizations due to lack of reproductive autonomy, or a lack of access to reversible contraceptive methods. The effect of conflict may vary depending on the exposure time, as health care facilities may be more sensitive to the direct impact of conflict, while the psychological mechanisms related to empowerment and how women judge their situation may be more cumulative. The findings suggest that conflict has a more direct impact on the uptake of sterilization.

Introduction

Altered fertility behavior has been observed in low, middle and high income countries affected by conflicts since World War II. The results have been mixed, suggesting both positive and negative effects on childbearing. Proximate determinants to fertility such as family planning have gained less attention in empirical research. Observing women's fertility control during armed conflict may indicate how a violent social context shapes both reproductive autonomy and fertility desires. Women faced with conflict may want to postpone, space or limit births due to social insecurity, increase their demand for children to seize the moment, replace lost family or rebuild the community, be forced (not) to use contraception if conflict increases gender inequality, or lose contraceptive choices if health care goods and services are reduced. These mechanisms have not been fully addressed yet.

Two studies to date have directly measured exposure armed conflict violence to address fertility control responses, in settings which vary significantly in terms of contraceptive and conflict profiles. In the Nepalese civil war, first contraceptive uptake increased in relation to violent and political events of conflict (Williams et al. 2012). In Colombia, exposure to local conflict was linked to a decrease in the use of short- and long-term reversible modern contraception at time of interview, partially reflecting an increased fertility demand but possibly also a reduction in access due to health system failure (Svallfors and Billingsley 2019). Assessment of family planning programs and contraceptive knowledge in Sub-Saharan conflict and post-conflict environments suggests that women will use contraception if it becomes available, which points towards an unmet need (Casey et al. 2013; Casey and Tshipamba 2017; McGinn et al. 2011; Orach et al. 2015). None of the available studies have been able to tease out the differences between fertility postponement, spacing or limiting.

Female sterilization is the only contraceptive method that reflects a definitive and irreversible stop in fertility. This study is the first to explore stopping behavior in conflict, by measuring how local violence relates to the timing of women's sterilizations. This is done in the case of Colombia, a middle-income country where contraceptive knowledge is well-established and contraceptive use is generally socially accepted. Sterilization is the most common family planning method, but past literature has only studied reversible methods at time of interview (Svallfors and Billingsley 2019) which omits an important part of how family planning decisions and opportunities have played out during war. Whereas use of other modern

contraceptive methods may reflect changes in postponement, spacing or stopping, sterilization is the only method that decisively reflects the end of women's childbearing.

The study focuses on the case of Colombia, which is an interesting case for four primary reasons. First, Colombia has had a uniquely longstanding conflict since the 1960s with extensive tempo-spatial variation in conflict violence intensity. Second, women's experiences from war was given an unprecedented focus in the Colombian peace treaty adopted 2017 between the government and the left-wing guerrilla FARC (Gindele et al. 2018; Salvesen and Nylander 2017), but there is still little research about how war has affected women's reproductive health and rights. Third, analyzing Colombia helps us better understand the relationship between war and family planning in a replacement fertility context (Colombia's total fertility rate hovers around two children per woman on average (DHS 2000, 2005, 2011, 2017)), since lot of the existing literature has focused on high-fertility settings. Fourth, Colombia is one of the few settings where collection of nationally representative data has gone on virtually uninterrupted, despite ongoing conflict.

This study explores the uptake of sterilization due to armed conflict, using discrete-time hazard analysis on data from six rounds of the Demographic and Health Surveys combined with the Uppsala Conflict Database Program Georeferenced Event Dataset. The main research question is: *How did conflict violence affect the uptake of sterilization among Colombian women during 1991–2016?* Based on the literature, there are two opposing hypotheses in this study, set against the null-hypothesis of no relationship: local violence due to armed conflict may either increase or decrease sterilization uptake among Colombian women. The data used in this study does not allow for empirical tests of which mechanism(s) operate between conflict and sterilization, so the study leaves to future research to investigate the causal links.

Female sterilizations in Colombia

Sterilizations have played an important part in the development of family planning programs in Colombia. Voluntary female sterilization (VFS) was considered illegal and immoral in most countries until 1969, when Singapore and the US state Virginia introduced the first non-eugenic, non-restrictive laws. During the 1970s, sterilization programs were introduced worldwide through national family planning initiatives, often motivated by high levels of

fertility and maternal mortality. Sterilization was portrayed as a good option in developing settings with low access to reversible contraception (Nortman 1980). VSF was first introduced in Colombia in 1972 by the private non-profit family planning organization Profamilia, when two medical doctors were sent to train in the US. The initiative followed the introduction of a vasectomy program two years earlier. Both were widely available but especially aimed at the poor as a cost-effective and permanent form of avoiding unwanted pregnancies. While religious, medical and target-group opposition hindered the success of the vasectomy program, the uptake of VFS grew large (Hollerbach 1989; Williams, Ojeda, and Trias 1990).

The Colombian government sponsored its first free-of-charge VSF program in 1979, largely as a response to the high maternal mortality rate. The program explicitly targeted women who would have high risk pregnancies in terms of both morbidity and mortality, were they to become pregnant. A point system was introduced through which factors such as a woman's age, number of children, pregnancy intervals, nutritional status, and number of people in the household would determine their risk level. Women had to be at least 25 years old and have at least three living children to be eligible for the program. Women at lower or medium risk would instead be offered reversible modern contraceptive methods. Colombia's then 1,200 rural health centers and 800 local hospitals would refer the women to one of the country's 108 regional hospitals, where obstetricians, surgeons and operating room nurses newly trained by Profamilia would perform outpatient laparoscopic sterilization (Guttmacher 1979; Rizo and Roper 1986). The sterilization rate was estimated to be 16 percent among married, fecund women in 1982 (Trias et al., 1987) and 18.3 percent as of 1986, thus the most frequently used method (Hollerbach 1989). Profamilia provided 599,018 female sterilizations between 1972 and 1988, compared to only 19,590 vasectomies (Williams et al. 1990). Between 1977 and 1995, the share of women who were sterilized rose from 6 to 37 percent (Parrado 2000).

In 1986, 19 percent of women were sterilized in Colombia, representing one-third of all contraceptive use (Rutenberg and Landry 1993). One decade later, sterilization was the most common contraceptive method in Latin America. About 16 percent used VSF among married, fecund women aged 20–45 in Colombia, compared to 40 percent in Brazil and the Dominican Republic and 10 percent in Peru. All else equal, Colombian women aged 20–29 or above 40 had a lower propensity for undergoing sterilization compared to ages 30–34. The uptake increased with number of children and was highest for those who had been married 5–9 years

compared to lower and higher durations. There was no statistical difference between urban and rural women (Leite, Gupta, and Rodrigues 2004). Leite and colleagues (2004) observed that women with higher levels of education were more prone to sterilization in the mid-1990s, while Folch et al. (2017) found that women of lower educational and wealth levels were more likely to undergo sterilization compared to using reversible long-acting methods in 2005 and 2010. This difference could be due to different sample selections of the population at risk and not necessarily a period change. Contrary to Leite et al. (2004), Folch et al. (2017) found that husband's level of education influenced women's long-acting contraceptive choice.

Conflict dynamics in Colombia

Colombia has had an unusually longstanding internal armed conflict since 1964 involving the government, paramilitary groups, organized crime groups, and left-wing guerrillas such as *las Fuerzas Armadas Revolucionarias de Colombia-Ejército del Pueblo* (FARC, The Revolutionary Armed Forces of Colombia) and *el Ejército de Liberación Nacional* (ELN, The National Liberation Army).

The conflict has its roots in a decade-long unofficial civil war that started in 1948 known as *La Violencia* over ownership, clientelism, corruption and socioeconomic inequality dating back to Colonial times (Bethell 1995). In 1957, Conservatives and Liberals formed a bipartisan government (Bailey 1967; Hartlyn and Valenzuela 1995) which pacified bipartisan violence. As a response to a governmental vacuum in remote geographic areas, clientelism, socioeconomic injustice, and exclusion of other political views, various left-wing guerrilla movements were born in the mid-1960s (de Roux 1994). During the 1970s drug trafficking emerged in Colombia as an economic alternative to rising poverty, political corruption, and insufficient public services. Left-wing guerrillas turned to drug trafficking, extortion and kidnapping for economic and political purposes. As a response, large landowners and drug traffickers created their own right-wing paramilitary groups in the 1980s. Most of these groups were included in *las Autodefensas Unidas de Colombia* (AUC, The United Self-Defence Forces of Colombia) until it disbanded in 2006. The conflict grew more complex over time because of state corruption and illegitimacy, protracted sociopolitical instability and intolerance, widespread drug trafficking, and judicial impunity (Franco et al. 2006; Jansson

2008; de Roux 1994; Starn, Kirk, and Degregori 2009).

Widespread violence in the forms of homicides, disappearances, forced displacements, use of antipersonnel mines, and kidnapping has seriously affected of the Colombian people (Alzate, 2008; Franco et al., 2006). More than 3,600,000 Colombians have been forcedly displaced during 1985–2005, half of which younger than 18 years (Franco et al., 2006). Colombia has long had the highest mortality level in the Western Hemisphere due to conflict (Garfield & Llantén Morales, 2004). 554,008 homicides were committed in Colombia between 1975 and 2004, representing a mean of one homicide every half an hour and 10–15 percent of the total mortality rate. Homicide rates vary significantly across the regions of the country, representing the level of regional state presence (Franco et al., 2006).

Conflict and contraception

The need for interventions targeting conflict-affected women's reproductive health has been widely acknowledged (Austin et al. 2008; Chynoweth et al. 2018; McGinn 2000; McGinn and Casey 2016; McGinn and Purdin 2004; Palmer, Lush, and Zwi 1999) and there is now a growing literature on women's reproductive choices and issues in conflict and post-conflict settings (e.g. Casey et al., 2013; Casey & Tshipamba, 2017; McGinn et al., 2011; Orach et al., 2015). A common argument is that men are more likely to suffer directly from war and women are more vulnerable to the indirect health consequences of conflict (Aburto et al. 2016; García and Aburto 2019; Ghobarah, Huth, and Russett 2003; Goldstein 2001; Meertens 2001; Østby et al. 2018; Plümper and Neumayer 2006). Despite a growing literature on altered fertility behavior in many conflict and emergency settings, less attention has been paid to empirically investigate how conflict relates to the proximate determinants of fertility, such as contraceptive use.

As a means of fertility control, sterilization uptake may link both positively and negatively to armed conflict. The theoretical framework presented below was developed by Svallfors and Billingsley (2019) based on Coale's (1973) contraception paradigm: women must be ready, willing and able for family planning to occur. Readiness is not likely affected by conflict in Colombia since contraception has long been generally socially accepted and well-known (Prada and Ojeda 1987). The framework thus focuses on how conflict might affect women's

willingness and ability to undergo sterilization as a means of definitely stopping childbearing.

Decline in sterilizations due to armed conflict

Women may have a lower uptake of sterilization if their fertility demands are altered, reinforced, or if their health care access is reduced.

Most Colombians have family or friends who were murdered, kidnapped, displaced or disappeared in the war, which has killed around 200,000 people and displaced millions (Franco et al. 2006). Conflict increases mortality, including infant and child mortality (Elveborg Lindskog 2016; O'Hare and Southall 2007). Losing a child or other family members may lead to a substitution effect by which women want to have more children (Chi et al. 2015a, 2015b), thus lowering the uptake of sterilization.

Women's demand for sterilization may decrease if sexual unions are interrupted. Men's morbidity, mortality, and migration related to conscription in conflict may disrupt unions (Jones and Ferguson 2006) and strengthen fertility intentions or increase the urgency to have a child. In violent areas women's fertility trajectories may be altered because they expect their partner may not survive (Jok 1999; Navarro Valencia 2009). If women lose partners because of conflict their need for contraception in general may diminish. With respect to sterilization, re-partnering is often linked to parity progression to "confirm" the relationship (Schmeer and Hays 2017; Vikat, Thomson, and Hoem 1999). Women who anticipate re-partnering due to the loss of a partner may avoid sterilization to enable future childbearing (Bumpass, Thomson, and Godecker 2000; Godecker, Thomson, and Bumpass 2001). In Colombia, childbearing across partnerships has been discussed in terms of a "marriage squeeze" following conflict-driven excess male mortality (Jones and Ferguson 2006).

Health system failure may reduce women's access to health services such as sterilizations, because of relocated resources to military expenses (O'Hare and Southall 2007), damaged infrastructure, limited human resources, weak management, increased difficulties in coordination among non-governmental organizations (Iqbal 2010:81–82; McGinn et al. 2011), and direct attacks on health care professionals and facilities. The Colombian health sector has indeed suffered both directly and indirectly from war (Franco et al. 2006).

Evidence from Colombia suggest a positive fertility response to local violence in Colombian

rural areas during 2000-2010 hypothetically reflecting higher mortality levels and reduced access to health care and protection. Svallfors and Billingsley (2019) found that conflict reduced the probability of using reversible modern contraception, partially because women want more children soon, which may reflect a replacement effect or union uncertainty. But it is also likely that the health care system failure decreased reversible contraceptive use.

Increase in sterilizations due to armed conflict

Women faced with conflict may want to sterilize instead of using reversible contraception to definitely and permanently reduce births because of deteriorating social conditions, such as a loss of security, certainty, economic opportunities, family, relationships social support, etc. (Chi et al. 2015a, 2015b; Ibáñez, Calderón, and Gafaro 2011; Speizer 2006). Predicting access to health care as well as cost and benefits of children may be more difficult due to the threat of harm and instability in conflict. When choosing between different contraceptive methods, sterilization may be perceived as the most reliable option in an otherwise unstable situation.

Williams et al. (2012) found that political instability and major gun battles due to conflict had a positive effect on the “risk” of first contraceptive use in the Chitwan Valley during the Nepalese civil war, perhaps reflecting decreased desire for children. Evidence from Sub-Saharan Africa show that women choose to use family planning if made available in conflict or post-conflict environments, suggesting that women want to space or limit births but are not always able to (Casey et al. 2013; Casey and Tshipamba 2017; Orach et al. 2015).

According to Potter et al. (1976), the rapid fertility transition in Colombia during the 1960s from seven to four children on average per woman may have been driven in part by conflict-related migration from rural to urban areas. This hypothetically was a symptom of and contributed to the undermining of the traditional rural way of life. If this is true, sterilization uptake could have been a way for women to certainly stop childbearing at lower parities compared to previous generations.

Women’s empowerment and reproductive autonomy

Gender disempowerment and gender-based violence may decrease women’s possibility to make autonomous reproductive choices. Literature on the connection between gender and

conflict has theorized how war perpetuates or creates gender inequality by processes such as: militarization of masculinity ideals (Cockburn and Zarkov 2002; Connell 2002; Enloe 2014; Goldstein 2001; Parpart and Partridge 2014; Roness and Fasting 2017; Wadham 2017), reinforcement of pre-conflict patriarchal attitudes and behaviors (Brownmiller 1976; El Jack 2003; Farwell 2004; Sengupta and Calo 2016), and diversion of governmental resources to the military from other political projects (Franco et al. 2006; O'Hare and Southall 2007) such as gender equality.

Gender-based violence (GBV) often increases in war, both in the private sphere (La Mattina 2017; Noe and Rieckmann 2013; Østby, Leiby, and Nordås 2019; Rieckmann 2014; Svallfors in progress) and related to war (Amnesty International 2004, 2011; Wirtz et al. 2014).

Increased physical and sexual violence during conflict may undermine women's sexual and reproductive health and autonomy, thus affecting sterilization uptake. Victimization to violence is strongly associated with reproductive issues, such as contraceptive discontinuation, parity progression, non-access to antenatal health care (Kishor and Johnson 2004), unwanted pregnancy, as well as spontaneous or induced abortion (Cripe et al. 2008; Gomez 2011; Kishor and Johnson 2004; Pallitto et al. 2013). Young Colombian women who have experienced sexual violence have higher levels of unintended pregnancy and contraceptive non-use (Gomez 2011). Physical GBV linked to a reduced use of reversible modern contraception in Colombia (Svallfors and Billingsley 2019).

Sterilizations in Colombia and elsewhere were not always well-informed or voluntary (Folch et al. 2017; Hollerbach 1989; Jadhav and Vala-Haynes 2018; Rizo and Roper 1986).

Compulsory sterilization impedes women's ability to make informed and autonomous decisions about contraceptive use. Although eugenic sterilization practices have largely ceased, forced and coerced sterilizations are still performed in many parts of the world, particularly against ethnic minorities (Miranda and Yamin 2004; Reilly 2015; Zampas and Lamačková 2011), the disabled (Asdown Colombia et al. 2013; CDR 2014; Zampas and Lamačková 2011), and HIV positive persons (Kendall and Albert 2015; Zampas and Lamačková 2011). In Colombia, female guerrilla soldiers in the FARC ranks have reported forced sterilization as a measure of reproductive control in exchange for participating in the guerrillas (Brodzinsky, 2016; Chaparro González et al., 2015, 22). Forced sterilization is one form of sexual and gender-based violence that could increase in tandem with other forms of abuse against women, including physical violence and rape.

From the onset, the private and public sterilization programs in Colombia specifically targeted poor women (Guttmacher 1979), and observed differences have led to allegations of coercive sterilizations, particularly among disadvantaged groups such as young, poor, rural, Afrocolombian and/or indigenous women (Folch et al. 2017). Since those groups were also more affected by local conflict, it is likely that their probability of sterilization differed from more affluent women with respect to conflict exposure as well as access to health care.

It is not evident what direction patterns of women's empowerment would take. Sterilizations may increase if women are forced to undergo the procedure, but it may decline if women cannot choose sterilization because of limited reproductive choice.

Heterogeneous effects

Conflict may operate differently for different groups of women depending on their socioeconomic status. Women in the countryside might have access to only one clinic and be more exposed to violence, creating more sensitivity to conflict. For the less educated, it may be more difficult to make informed decisions and navigate one's options regarding reproductive health matters. Higher education may also result in higher household wealth. More affluent women are more likely to be able to travel to where health care is accessible and less sensitive to economic busts related to conflict, as well as pay for reproductive goods and services. Finally, young women may be disproportionately affected by armed conflict due to the excess young male mortality that could affect contraceptive choices related to unions. Future versions of this paper will therefore empirically address interaction effects between conflict with residence, education and age.

Empirical approach

Two sets of data are combined in this study to analyze the uptake of sterilization in the Colombian armed conflict.

First, six rounds of the Colombian Demographic and Health Surveys (DHS), conducted every fifth year from 1990 to 2015, offer long-term information on women's reproductive behavior

and characteristics. The sample is nationally representative of Colombia’s population. The DHS are primarily cross-sectional, but some indicators may be used as longitudinal. These are collected retrospectively through a calendar module of reproductive events, with detailed information about the monthly timing of events such as contraceptive method uptake. It relies on the recall of events by the respondent, but is aided by timing events in relation to one another (such as births) to increase reliability (DHS 1991, 1995, 2000, 2005, 2011, 2017).

Like in other studies of war-affected populations, there is likely a survivorship bias in the DHS sample, due to mortality, emigration and internal displacement. This could lead to an underestimation of effects since the worst-off women are not in the sample.

Survey response rates are presented in Table 1.

TABLE 1 Individual response rates by survey round

Survey round	Individual response rate
1990	85.2 %
1995	92.2 %
2000	92.5 %
2005	91.8 %
2010	94.1 %
2015	93.6 %

Sources: DHS 1991, 1995, 2000, 2005, 2011, 2017.

Second, the Uppsala Conflict Data Program Georeferenced Event Dataset (UCDP-GED) contains information from 1989 to 2017 about events of violent conflict in which at least one person was killed, including when and where each event occurred and an estimation of how many casualties there were in each event. The information is primarily based on global newswire reporting, monitoring and translation of local BBC news, and secondarily on local media, NGO and IGO reports, field reports, books, etc. (Croicu and Sundberg 2017; Sundberg and Melander 2013).

The conflict data underestimates the magnitude of violence since it does not account for all homicides that occurred in Colombia, but it also includes violence perpetrated by non-political actors such as narcotraffickers. Events that were unclear with regards to which month and in which administrative unit they happened were dropped from analysis. Events that occurred outside Colombia’s national border were excluded. In total, 2,515 out of 4,578 observations remained. The conflict data is illustrated in Figure 1, where darker colors indicate later events, and the size of the bubbles indicate more casualties in each event.

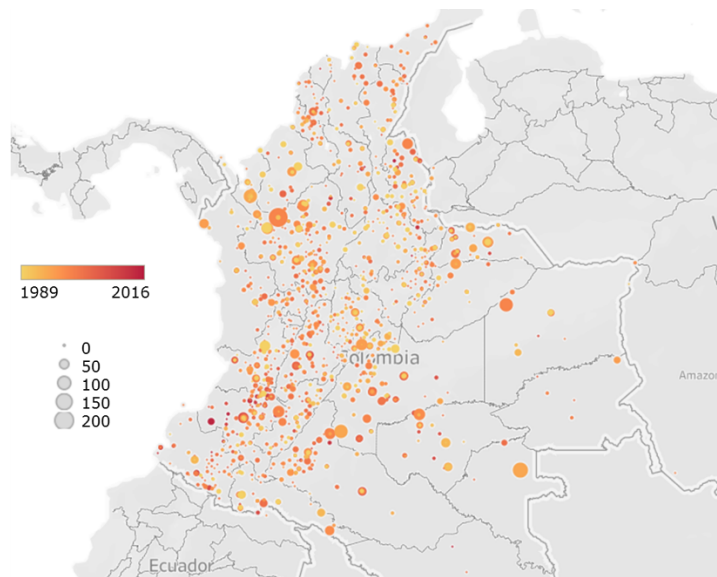


FIGURE 1 Prevalence of conflict events across Colombia 1989–2016.

The datasets are then combined spatially by the lowest geographical level available in all survey rounds: the department where the respondent resided and the conflict event(s) occurred. Respondents are only observed from when they moved to the residence at time of interview.

Main independent variable

The focal independent variable is the number of conflict events in the department where the respondent resides within two years before observation. It spans between 0 and 223 events, as illustrated in Figure 2 grouped into categories by conflict violence intensity. Two thirds of the sample were exposed to 1–24 events in the past two years, indicating low levels of conflict, whereas 11 and 6 percent were exposed to 25–49 or 50–223 events respectively. 16 percent of the population were unexposed.

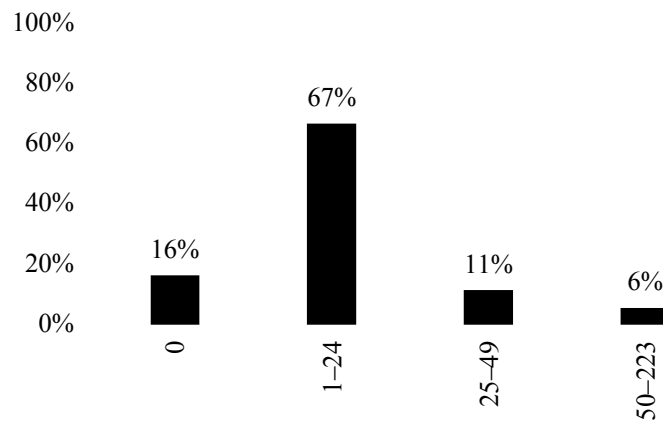


FIGURE 2 Exposure to conflict events in department past two years for women-months.

I used Akaike’s Information Criterion (AIC) to explore which indicator of conflict contributed most to model fit: events vs. deaths, and three, six, twelve or twenty-four months before observation. There were no difference in model fit depending on which conflict indicator was used. See Table B in the Appendix for these results.

Dependent variable

The outcome variable is women’s month of sterilization at any time between age 13 and the age at interview. Women were asked to recall the month and year of when the procedure happened in relation to other reproductive events such as childbirth, using the retrospective calendar module in the DHS. The share of the sample population that used sterilization as their contraceptive method at each year during the observation period is illustrated in Figure 3 with a solid line on the left Y-axis. It shows that the hazard rate hovered around one fifth or one sixth throughout the observation period, with a slight increase after the turn of the millennium. The number of conflict events annually in Colombia is shown with a dashed line on the right Y-axis. It shows that conflict was most intense in the early 21st century.

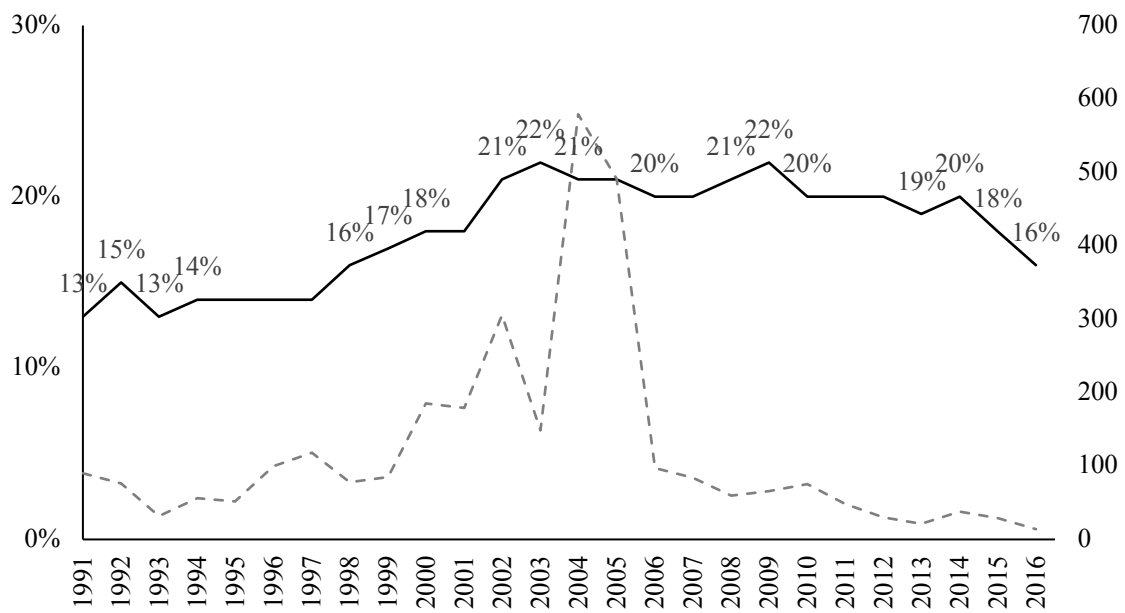


FIGURE 3 Share of sample population that is sterilized (left Y-axis, solid line) and number of conflict events in Colombia (right Y-axis, dashed line) by year

Model

A discrete-time hazard regression model is useful to estimate the time-specific hazards of an event (sterilization) in relation to a social phenomenon (conflict) when these occur grouped in time, in this case at month level. Since the dependent variable is measured dichotomously (either a woman is sterilized, or she is not) linear probability regression models were used.

The observation starts in January 1991 because the focal variable sums the conflict event in the past two years, at age 13, or when a woman who changed place of residence moved to the current location. Women sterilized before observation are excluded from the analysis, i.e. the event happened before the time period of the analysis. The observation ends at the event, age 49 or the age at interview; women sterilized after this time point are right-censored. The unit of analysis is woman-month. This data structure creates 11,648,913 woman-month observations during the period 1991–2016. The model estimates, for each month, whether a woman will “survive” without being sterilized. The process of investigation is non-repeatable or absorbing; unlike other contraceptive methods, a (successful) female sterilization cannot be reversed and after method uptake there can be no discontinuation. A female sterilization can thus only happen once in the life course.

Single-level discrete-time hazard analysis assumes that women behave independently from

one another, but this is not the case in a context of conflict where observations of women within the same area are likely mutually dependent. Women from the same area are likely to exhibit similar sociodemographic characteristics compared to those in other areas because of a range of unmeasured factors. Unobserved contextual heterogeneity in a single-level model “leads to high-risk individuals experiencing the event first, leaving behind a sample that is increasingly composed of low-risk individuals as duration increases” (Steele 2011:6). I use a fixed effects linear regression and clustered standard errors to account for this regional variation, using variation within clusters to generate estimates. The cluster variable department measures in which of Colombia’s 33 departments the respondent resided. Women are clustered in local areas with socioeconomic variation in both levels of violent conflict and fertility control behavior, generating a hierarchically nested structure of the data with individuals at Level-1, grouped into Level-2 units (departments). The department-specific error term represents the effects of omitted department characteristics (Angrist and Pischke 2009; Rabe-Hesketh and Skrondal 2011:71–216; Stock and Watson 2008).

Effects of conflict on health or demographic outcomes are sometimes estimated by pre-post comparisons of affected areas or cross-sectional comparisons between affected and non-affected areas. Such models risk bias from unobserved differences between individuals or local areas and it would be impossible to disentangle whether estimates result from conflict or some individual- or local-level unobserved, confounding factor (Behrman and Weitzman 2016). Such models are also unfeasible in Colombia due to the extensive period and spread of conflict. Local conflict violence is not randomized in Colombia but stratified across sociogeographic factors. The fixed effects approach compensates for contextual omitted factors that could co-determine women’s uptake of sterilization as well as the magnitude of local violence. Fixed effects are preferred over random, since the assumption in the latter model is that all independent variables are uncorrelated with the error term (Allison 2009).

Women may self-select out of treatment, i.e. move to another area, because of conflict. Still, observing the effect of violence in a department rather than at more disaggregated levels may remedy this problem to some extent if women relocate to the nearest urban center within a department instead of in another department.

Covariates

An issue in constructing a person-period data set from retrospective data is the lack of time-varying covariates. In cross-sectional data such as the DHS, individual characteristics are only measured once at the time of interview. Stable characteristics such as ethnicity do not pose a problem, but changeable characteristics that span a long time period might, especially if characteristics are influenced by the event (Reardon, Brennan, and Buka 2002). Since sterilization is a final event, this should not cause a problem in such a non-recurrent analysis. *Year* is included to account for period changes. Respondent's *age*, *educational level* and whether respondent is *in education* (approximated from the age at which women would typically start and finish school in Colombia and the highest level at interview), *parity*¹, and *sex composition of children* are included as time-varying control variables. The time-constant *type of place of residence* (urban or rural) at the time of interview is included since women are only observed during the time they live in their current residence. Respondent's ethnicity is not included in all survey rounds and thus not in this study, but ethnic composition at department level are captured in the error term.

Descriptive statistics

Descriptive statistics of the sample population are displayed in Table 2. Chocó and Cauca have been two of the most conflict-affected departments but has among the lowest shares of sterilizations per woman-month (0.13 and 0.14 percent respectively). Bogotá is also among the departments with fewer (0.14 percent) sterilizations per woman-month but it has also been less affected by conflict. The shares of woman-months when sterilization occurred depending on department strengthens the case for a multi-level model, since patterns according to conflict are inconclusive. Summary statistics of conflict events across departments can be found in Table A in the appendix.

¹ First cohabitation did not contribute to the model when combined with parity.

TABLE 2 Descriptive statistics of sample population.

	Frequency	Percent		Frequency	Percent		
Sterilized							
No	119,108	83.66		No	11,627,924	99.82	
Yes	23,265	16.34		Yes	20,989	0.18	
Total women	142,373	100.00		Total woman-months	11,648,913	100.00	
	Frequency	Share of women-months	Share that experienced event		Frequency	Share of women-months	Share that experienced event
Age							
13–19	2,910,553	24.99	0.01	Sex composition of children			
20–24	2,664,496	22.87	0.12	No children	4,428,933	38.02	0.00
25–29	2,347,393	20.15	0.27	All boys	2,224,411	19.10	0.10
30–34	1,779,155	15.27	0.35	All girls	2,086,324	17.91	0.10
35–39	1,146,462	9.84	0.33	Mixed	2,909,245	24.97	0.50
40–44	614,465	5.27	0.17	Education			
45–49	186,389	1.60	0.05	Primary	5,388,817	46.26	0.15
Year							
1991	413,336	3.55	0.13	Secondary	4,617,478	39.64	0.21
1992	449,889	3.86	0.15	Tertiary	1,642,618	14.10	0.20
1993	477,837	4.10	0.13	In education			
1994	510,590	4.38	0.14	No	9,069,275	77.86	0.23
1995	497,018	4.27	0.14	Yes	2,579,638	22.14	0.01
1996	496,225	4.26	0.14	Department			
1997	537,011	4.61	0.14	Antioquia	869,473	7.46	0.18
1998	568,078	4.88	0.16	Atlántico	550,790	4.73	0.20
1999	600,053	5.15	0.17	Bogotá	1,024,557	8.80	0.14
2000	572,809	4.92	0.18	Bolívar	381,924	3.28	0.23
2001	567,176	4.87	0.18	Boyacá	348,044	2.99	0.16
2002	603,971	5.18	0.21	Caldas	351,664	3.02	0.18
2003	637,233	5.47	0.22	Caquetá	234,04	2.01	0.15
2004	666,888	5.72	0.21	Cauca	365,054	3.13	0.14
2005	501,012	4.30	0.21	Cesar	278,240	2.39	0.21
2006	464,486	3.99	0.20	Córdoba	345,781	2.97	0.24
2007	494,449	4.24	0.20	Cundinamarca	327,295	2.81	0.20
2008	523,180	4.49	0.21	Chocó	272,715	2.34	0.13
2009	555,407	4.77	0.22	Huila	333,981	2.87	0.15
2010	390,764	3.35	0.20	La Guajira	293,374	2.52	0.17
2011	212,753	1.83	0.20	Magdalena	324,421	2.78	0.22
				Meta	242,811	2.08	0.17
				Nariño	415,189	3.56	0.19
				Norte de Santander	346,026	2.97	0.19
2012	227,248	1.95	0.20	Quindío	337,416	2.90	0.19
2013	241,562	2.07	0.19	Risaralda	304,112	2.61	0.19
2014	257,725	2.21	0.20	Santander	411,823	3.54	0.18
2015	173,408	1.49	0.18	Sucre	357,073	3.07	0.22
2016	8,805	0.08	0.16	Tolima	327,402	2.81	0.15
Urban							
No	2,910,765	24.99	0.18	Valle del Cauca	828,841	7.12	0.20
Yes	8,738,148	75.01	0.18	Arauca	177,754	1.53	0.23
Parity							
0	4,428,933	38.02	0.00	Casanare	179,394	1.54	0.15
1	2,855,552	24.51	0.03	Putumayo	211,776	1.82	0.17
2	2,162,178	18.56	0.31	San Andrés y Provincia	260,533	2.24	0.24
3	1,063,380	9.13	0.65	Amazonas	251,358	2.16	0.12
4	526,701	4.52	0.62	Guainía	154,461	1.33	0.16
5+	612,169	5.26	0.55	Guaviare	195,076	1.67	0.20
				Vaupés	204,456	1.76	0.13
				Vichada	142,059	1.22	0.19
Total woman-months	11,648,913	100.00	0.18	Total woman-months	11,648,913	100.00	0.18

Results

Table 3 displays results from a department-effects regression of conflict on women's uptake of sterilization. By each conflict event, the probability of sterilization increases by 0.000003 percentage points. The result is statistically significant ($p=0.002$). This points towards that conflict indeed alters women's fertility choices and/or self-determination, but the available data cannot determine whether this reflects a willingness to definitely reduce births, forced sterilizations due to lack of reproductive autonomy, or a lack of access to reversible contraceptive methods. It is also possible that the negative mechanisms are still operative. If access to sterilization clinics is reduced or if women want to keep the door open to future childbearing because of substitution or re-partnering, sterilization uptake could decline. However, these patterns are not stronger than the positive effect of conflict on sterilization.

The uptake of sterilization is, surprisingly, higher at the youngest ages and lowest at the oldest. There's no statistical difference between the reference group, women aged 24–29, compared to those aged 25–34. The uptake of sterilization has increased over time. The sterilization uptake is largest at second parity² with mixed composition of children, confirming the hegemonic status of the one-of-each two-child norm in Colombia. There is no son preference in Colombia, but rather women want to have one child of each sex before sterilization. Further, uptake is biggest among urban residents, the highly educated, and those currently in education, suggesting that women in higher socioeconomic positions are more prone to sterilize.

To contextualize the social significance of the relationship between sterilization and conflict, Figure 4 shows the predicted probabilities of sterilization at each woman-month by different levels of conflict violence intensity. Women-months with zero exposure to conflict violence have a 0.0018 percentage points' probability of sterilization, while the probability is 0.0024 for women-months with the highest exposure observed in the sample (at 220 events).

² When parity is excluded from the model, the effect of whether respondent is in education at that month changes direction, possibly because women in education have fewer children.

TABLE 3 Department-fixed effects linear probability model of women's uptake of sterilization in relation to armed conflict in Colombia (N=11,648,913 woman-months).

	Probability	95 % CI	
Age (ref. 20–24)			
13–19	0.0007***	0.0005	0.0008
25–29	0.0001	-0.00006	0.0002
30–34	-0.0001	-0.0003	0.00005
35–39	-0.001***	-0.0012	-0.0008
40–44	-0.003***	-0.0033	-0.0026
45–49	-0.004***	-0.0049	-0.0040
Year	0.000058***	0.000047	0.000068
Parity (ref. 2)			
0	-0.003***	-0.004	-0.003
1	-0.003***	-0.004	-0.003
3	0.004***	0.003	0.005
4	0.004***	0.003	0.005
5+	0.004***	0.003	0.005
Sex composition (ref. all boys)			
All girls	0.000002	-0.0001	0.0001
Mixed	0.0005***	0.0003	0.001
Urban (ref. rural)	0.0008***	0.0006	0.0009
Education (ref. primary or less)			
Secondary	0.0011***	0.0010	0.0012
Tertiary	0.0020***	0.0014	0.0020
In education (ref. not)	-0.0001*	-0.0002	-0.00002
Conflict events	0.000003**	0.000001	0.000004
Constant	-0.11***	-0.13	-0.09
Rho	0.0003		

*Significant at $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

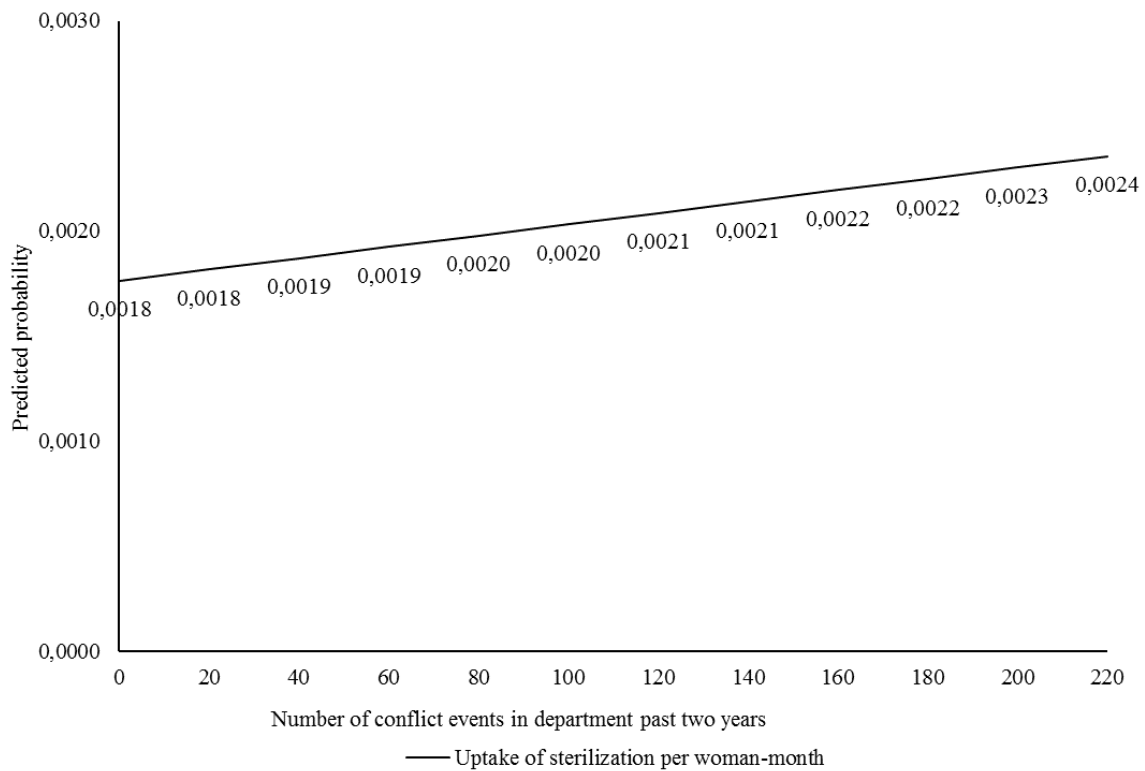


FIGURE 4 Predicted probabilities of sterilization according to conflict violence intensity.

Future work

Even though this study cannot decisively say which mechanism(s) determines the relationship between sterilization and conflict, the data allows to further explore how the relationship varies between groups of women. Since poor women in rural areas have been particularly affected by conflict, future work will explore how the effect of conflict has varied across place of residence and level of education. Young women may also be especially affected, because excess young male mortality could affect contraceptive choices related to unions.

More work is needed to contextualize the presented results. Since the unit of observation is woman-months, it is difficult to make a substantive interpretation of the findings.

In these analyses, women were only observed during the time they lived in their residence at the time of interview. Future robustness checks will reveal the link between conflict and sterilization uptake for a subsample of never-movers.

Appendix

Table A presents descriptive summary statistics of the number of conflict events across Colombian departments. Conflict violence intensity varies substantially between departments. In most departments, there are women-months without exposure to conflict violence, except for Caquetá, Cauca, Meta, and Norte de Santander. Antioquia, Meta and Cundinamarca are the departments with highest levels of conflict violence in the sample. The sparsely populated remote rural areas Amazonas, Guainía, Guaviare, Vaupés and Vichada have the lowest levels of conflict intensity, together with the urban-dominated department Atlántico.

TABLE A Descriptive statistics of conflict across departments in Colombia.

	No of woman-months	Mean	Std. Dev.	Min.	Max.
Antioquia	869,473	69.05	53.16	0	223
Atlántico	550,790	1.25	1.57	0	7
Bogotá	1,024,557	7.29	3.58	0	27
Bolívar	381,924	14.42	13.97	0	61
Boyacá	348,044	7.35	6.87	0	44
Caldas	351,664	7.55	9.75	0	92
Caquetá	234,040	22.45	22.52	1	87
Cauca	365,054	21.52	16.82	1	64
Cesar	278,240	10.73	9.28	0	37
Córdoba	345,781	4.59	5.04	0	52
Cundinamarca	327,295	14.46	14.78	0	170
Chocó	272,715	8.46	7.08	0	34
Huila	333,981	12.56	10.84	0	61
La Guajira	293,374	5.93	6.36	0	20
Magdalena	324,421	14.56	19.27	0	81
Meta	242,811	23.01	19.02	2	182
Nariño	415,189	12.83	11.25	0	42
Norte de Santander	346,026	20.18	16.44	2	69
Quindío	337,416	1.35	2.41	0	29
Risaralda	304,112	4.93	7.07	0	75
Santander	411,823	15.14	11.16	0	38
Sucre	357,073	7.35	8.81	0	39
Tolima	327,402	17.67	17.92	0	81
Valle del Cauca	828,841	16.34	13.73	0	50
Arauca	177,754	16.20	14.32	0	59
Casanare	179,394	5.86	4.39	0	16
Putumayo	211,776	11.18	9.17	0	33
San Andrés y Provincia	260,533	0.16	2.26	0	43
Amazonas	251,358	0.15	0.36	0	1
Guainía	154,461	1.01	1.36	0	5
Guaviare	195,076	4.44	3.47	0	11
Vaupés	204,456	0.56	1.01	0	3
Vichada	142,059	1.42	1.25	0	5
Total	11,648,913	14.60	24.53	0	223

Table B displays the results from multiple department-fixed effect models, adjusted for year, respondent's age, educational level and whether respondent is in education, parity, sex composition of children, and type of place of residence.

AIC shows no difference in model fit depending on what conflict indicator was used.

Only the specifications measuring number of events were statistically significant. The effects are stronger with shorter retrospect. The effect of conflict may vary depending on the exposure time, as health care facilities may be more sensitive to the direct impact of conflict, while the psychological mechanisms related to empowerment and how women judge their situation may be more cumulative. These findings suggest that conflict has a more direct impact on the uptake of sterilization.

The conflict deaths and dummy specifications are consistently insignificant as the confidence intervals overlap the zero. This suggests that the size of conflict events in terms of fatalities do not matter for women's sterilization uptake, nor whether or not there was any conflict in the department, compared to the continuous measures of conflict events.

Future versions of this paper will address how sterilization links to other categorical measures of armed conflict, divided into e.g. terciles or quartiles.

TABLE B Discrete hazard analysis with department-mixed effects of women's risk of sterilization in relation to measures of armed conflict (N=11,648,913).

Conflict measure	Time specification	Probability	P-value	95 % CI		AIC
Conflict events	Same month	0.00002*	0.031	0.000006	0.0001	0.0000004
	Past three months	0.00001*	0.043	0.000007	0.00002	0.0000004
	Past six months	0.000007**	0.008	0.000002	0.00001	0.0000004
	Past twelve months	0.000003*	0.010	0.000001	0.000006	0.0000004
	Past twenty-four months	0.000002**	0.002	0.000001	0.000004	0.0000004
Conflict deaths	Same month	-0.0000007	0.733	-0.000004	0.000002	0.0000004
	Past three months	0.0000004	0.596	-0.000001	0.000002	0.0000004
	Past six months	0.0000007	0.641	-0.0000007	0.000006	0.0000004
	Past twelve months	0.0000007	0.670	-0.0000004	0.0000006	0.0000004
	Past twenty-four months	0.000002	0.162	0.0000001	0.0000005	0.0000004
Conflict dummy	Same month	0.0001	0.067	-0.000005	0.0002	0.0000004
	Past three months	0.000005	0.893	-0.0001	0.0001	0.0000004
	Past six months	0.0001	0.214	-0.00003	0.0001	0.0000004
	Past twelve months	0.0001	0.070	-0.000006	0.0002	0.0000004
	Past twenty-four months	0.0001	0.245	-0.00004	0.0001	0.0000004

Significant at * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$.

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