The causal effect of contraceptive efforts on intimate partner violence: evidence from the Zika crisis in Colombia – Very preliminary version (please do not cite) –

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November 16, 2018

Abstract

We estimate the impact of increased efforts by women for controlling their reproductive behaviour on intimate partner violence. In order to provide identification for this link, we exploit the rapid diffusion of Zika virus and the reports of its link with microcephaly in Colombia which prompted a reduction on the fertility rate of affected areas of the country. We deal with potential selection of municipalities which are affected by the outbreak by instrumenting municipality-level 2016 zika incidence with a non-parametrically estimated index on the propensity to be affected by the illness on the basis of temperature, altitude, rurality and rainfall. This external and unexpected pressure on fertility control resulted on heterogeneous responses, which we can measure using DHS data collected before and during the outbreak in both affected and naturally-protected zones of the country. First, birth control strategy depended on civil status: single women reduced their sexual activity while married women increased their contraceptive use rates. This results on single teenagers to forced by the partners into sexual activity, while married womens suffered from violence due to other causes.

JEL: D10, I15, J12

Keywords: violence against women, contraception, intimate partner violence, reproductive health, outbreak

1 Introduction

There is a well-known association between contraceptive use, unintended pregnancies and violence (Gazmararian et al., 2000; Olorunsaiye et al., 2017). There is evidence that women who experience physical or emotional abuse are less likely to use their preferred contraception method (Williams et al., 2008). This link could arise from men using violence in order to exert reproductive control over women (Moore et al., 2010). However, it is not straightforward to establish the magnitude of this link. For instance, women who experience intimate partner violence and unintended pregnancies are, on average, younger and less educated. These variables are known to be predictors of misuse of oral contraceptives and lack of information about contraceptive options (Cramer, 1996; Dardano and Burkman, 2000). Moreover, the onset of intimate partner violence (IPV) can also modify contraceptive decisions of women. We estimate the causal effect of increased contraceptive efforts by women on IPV by exploiting a natural experiment where the expected value of pregnancy changed dramatically, without any substantial alteration on economic activity.

There is evidence in the literature on how viruses outbreaks trigger strong responses on human decisions such as purchase of potentially contaminated food (Adda, 2007), economic activity (Adda, 2016), or even taking standardised school tests (Barron et al., 2018). While such cases are normally short term responses to short term events, in this paper we show how the 2015-2016 outbreak of zika virus (ZIKV) and its media coverage resulted on changes on contraceptive use, sexual activity, and IPV. This *new* virus found its way into the public consciousness, as during this crisis it expanded

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thorough the Americas and was first associated with fetal neurological complications (brain damage and microcephaly), and Guillain-Barre syndrome in adults (Chang et al., 2016). This is in line with correlated found for Northeast Brazil by Quintana-Domeque et al. (2018), which found that women living in ZIKV affected areas knew about the link, and reported to have taken actions in order to prevent pregnancy.

In the tropical areas of the Americas, the ZIKV is mainly transmitted by a mosquito knows ad the *Aedes Aegypti*. This vector has proved to be hard to control due to its capacity of reproduction in small amounts of water in urban and suburban places. In general it manifests like many other tropical diseases well-known to these countries such as the Chikungunya or the widely spread and well-known Dengue fever. Its main symptoms include fever, rash, joint pain and conjunctivitis; but 80% of cases are completely asymptomatic (Paniz-Mondolfi et al., 2016). The diffusion of the ZIKV though the continent responds not only to the presence of the vector, but also to human activity. In particular, places with high circulation of people from different and distant locations are normally more likely to be affected by new illness (Bogoch et al., 2016). We cannot discard that differential patterns on sexual activity and contraceptive methods are also present, basically because locations with relative high migration might be also particular on other characteristics such as age composition. For this reason, in order to avoid spurious correlations, we need to isolate the effect of the ZIKV outbreak media coverage on the variables of interests.

A tropical country such as Colombia provides an useful setting for analyzing urban-mosquito-transmitted diseases (Barron et al., 2018). Its population is distributed in varied ecological zones, with wide differences on average rainfall, humidity and temperature. In some of them, the vector cannot live and reproduce. Using vital statistics and taking advantage of the natural protection of those areas, Gamboa and Rodriguez-Lesmes (2018) has shown that birth-rates in affected areas of the country reduced by 4% to 6%, specially for highly-educated women and those above the age of 20. Instead, in this paper we non-parametrically estimate the role of temperature, rurality and altitude of each Colombian municipality on the likelihood to suffer from the Zika outbreak. The prediction, which by construction is free of human-activity considerations, is interacted with the time period where the news about the microcephaly-link appeared (around November 2015), and constitute an instrumental variable for ZIKV incidence which can only affect sexual behaviour and IPV via the Zika outbreak link, once pre-existing differences are considered.

The impact of zika incidence on sexual behaviour and IPV is estimated via two stage least squares by using data on sexual and reproductive health from the *National Demographic and Health Survey* (DHS) for Colombia (2010-11, 2015-16), with municipality-level zika incidence from the National Service of surveillance in Health (SIVIGILA) for 2016. Data from 2010-11 DHS wave provides an additional check as it allows us to control for seasonality effects that are specific to each region of the country. Furthermore , we also make a second specification where we use the same instrument described above, interacted with a categorical variable of age groups, to assess that the existence of heterogeneous responses, given it is expected that fertility decisions change with respect to the age of women.

We found a non-straightforward response pattern to the outbreak. First, we found a reduction of 4.3 percentage points (*pp*) on the proportion of single women who had sexual activity during the last 4 weeks for each standard deviation on the monthly municipality-level incidence of ZIKV, which is not the case for married women. Instead, this last group were 3.7 *pp* more likely to be using a contraceptive method regardless of their age. Second, we found an increase of 1.7 *pp* on the proportion of teenagers who reported having been forced into unwanted sex by their partners. For non-teenage married women the opposite happens: a reduction of 1.6 *pp* on the probability of such event. However, married women were more likely to suffer from domestic violence in 2.9 *pp*.

In the spirit of a Wald estimate, reducing sexual activity increased in 39 *pp* the probability of being the victim of IPV among teenagers. One potential mechanism for this finding is that men coerce women to maintain sexual activity levels via violence, and as a result women are forced to the usage of contraceptive methods in order to reduce the odds of pregnancy. Vulnerability is extreme for teenagers who are already mothers, who are willing to sustain more violence in order to control their fertility.

Women in stable marriages who are already familiar with contraceptive methods use this alternative, which allows women to avoid violence derived from efforts by men who want full control of reproductive behaviour. Yet, there is an increase on the probability to be victims of general IPV which might signal that the usage of contraception might result on men being more willing to exert control over the household choice via force.

The rest of the article is structured as follows. Section 2 presents the context of the ZIKV during the period in which it appear in the massive media. Section 3 explains in detail the empirical strategy based on a instrumental variable methodology. Section 4 describes the Demography and Health Survey (DHS) and the sexual and reproductive health module. Section 5 discusses the results and finally, section 6 concludes.

2 Context

The threat of new viruses such as ZIKV and their interaction with existing diseases (co-infection and co-circulation) are becoming more complex to properly diagnose and treat affected individuals in America (Paniz-Mondolfi et al., 2016). In addition, policy makers react to outbreaks according to the present and future costs of the disease (i.e. Outbreaks as Dengue Fever or Ebola have different implications on morbidity and mortality rates and therefore public policy initiatives should take into account the role played by the media and the population reaction to them). There are several studies dealing with the study of the cost associated with Dengue and Chikunguya (Vijayakumar et al., 2013; Castro-Rodriguez et al., 2015; Packierisamy et al., 2015) but no much about how people react to them. Some recent works make formal analysis about the patterns of diffusion in health-related behaviours (Cui et al., 2008; Wang et al., 2013; Viswanath et al., 2007; Tchuenche et al., 2011; Liu et al., 2007).

After World Health Organization (WHO) issued a global alert to address the outbreak, there was a growing penetration of the mass media and a proliferation of truthful information and misinformation, which accelerated the reactions to the disease. In response, some governments such as Colombia, alerted the pregnant women about the virus. One of the most prestigious newspaper El Espectador stated: "The lack of medical and scientific certainties, as well as the fear and misinformation, are creating the perfect storm within the health system" (El Espectador, Zika: reason for an abortion?). At the end of January 2016, it was estimated that 1911 pregnant women had contracted the ZIKV in Colombia and, according to the National Institute of Health there were about 18165 confirmed cases in both men and women.

As a result, governments such as Colombia, by means of the Ministry of Health designed campaigns to control the vector of the disease, with a focus on stopping the spread of the mosquito ("Plan of Response to the fever by the Virus ZIKA", January 2016), but in his mission also proposed to postpone the decisions of fertility in the mothers: "it is recommended to all inhabitants of the national territory not to become pregnant during this phase, which can go up to the month of July 2016". (Circular No. 2. January- 2016, Ministry of Health). An additional element is that the relation between ZIKV and microcephaly took place over the cycle and it implies that the patterns of behaviour will be different before and after the information published in mass media.

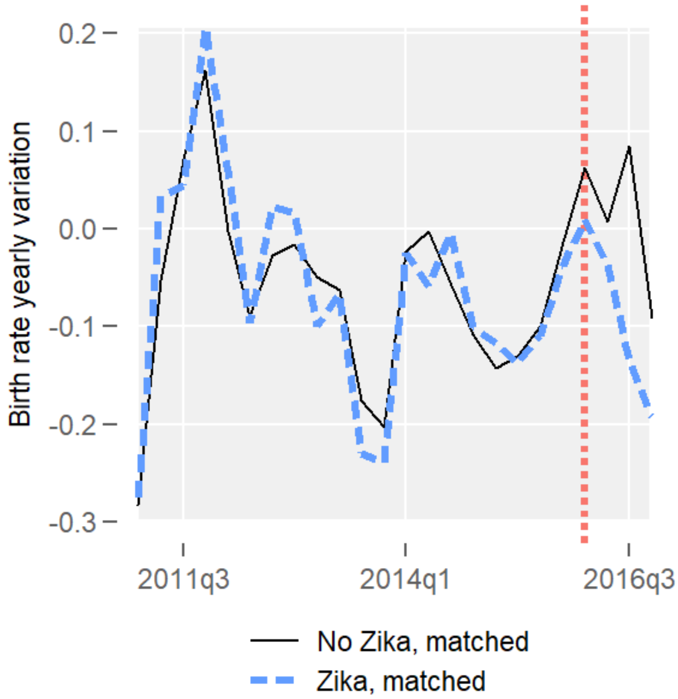
Using a matching and difference in differences, Gamboa and Rodriguez-Lesmes (2018) constructed a counterfactual fertility rate for municipalities affected by Zika using municipalities non-exposed to the crisis due because of the natural protection of altitude. They found a reduction on the fertility rate of 4% to 6% (see figure 1). In this paper we study how such reduction was attained, and how it affected couples' relations.

2.1 Contraception in Colombia

During the last decades, as in other developing countries, fertility rates have been decreasing as a consequence of multiple factors (higher female labor participation, better knowledge about contraceptive methods, childhood economic costs). However, fertility rate remain higher in rural and less developed regions, and in the lower quintiles of wealth and human capital. In general terms, Colombian fertility rates has not only decreased in every age group but the pace of the decline in fertility is becoming slower, from 2.6 in 2000 to 2.0 in 2015 according to the DHS 2015. The total fertility rate of 2.0 children per woman in 2015 is below the replacement level reached in 2010 (2.1 children per woman).

Among other factors, the knowledge and use of contraception methods explain, at least, a fraction of this trend. The knowledge and use of traditional contraceptive methods (*Fertility awareness and withdrawal*) or modern methods (*tubal ligation,vasectomy, the pill, the Depo Provera injection, Intra Uterine Device -IUD, Implants and, condoms*) is growing in all the areas of the country in spite of the prevailing cultural patterns as male chauvinist, in which dominate social

Figure 1: The impact of the Zika crisis on fertility rates in Colombia



Notes: This figure is reproduced from Gamboa and Rodriguez-Lesmes (2018), Figure 4 panel B.

values that discriminate against women. However, there have been some important changes in the use of contraceptive methods in the recent 15 years in Colombia.[1]

The most recent information about reported use of contraceptive methods comes from the DHS 2015 survey. According to that data, there are statistically significant differences of of contraceptive use between women and men. Most of the policies and actions about use of contraceptive methods have been focused on women, and among them, has recently been emphasized in the younger group because of the prevalence of teenager pregnancy.

The use of modern contraceptive is more frequent (90%) than the traditional ones (50%) among women older than 25 years. Male condoms, the pill and female sterilization are the most reported modern methods (all above 90%). Female sterilization reaches 34.9 percent on average between different age groups. For people from 13-39 years, male sterilization (vasectomy) is of 3.9 percent and female sterilization (tubal ligation) is only 17.1 per cent in total. The most widely used modern contraceptive methods correspond to the injectables, implants, IUD, and sterilization.

These facts, suggest that it is not only important to deal with a reduction in the use of contracteptives but, it is also necessary to know which person responded more actively to the ZIKV fear.

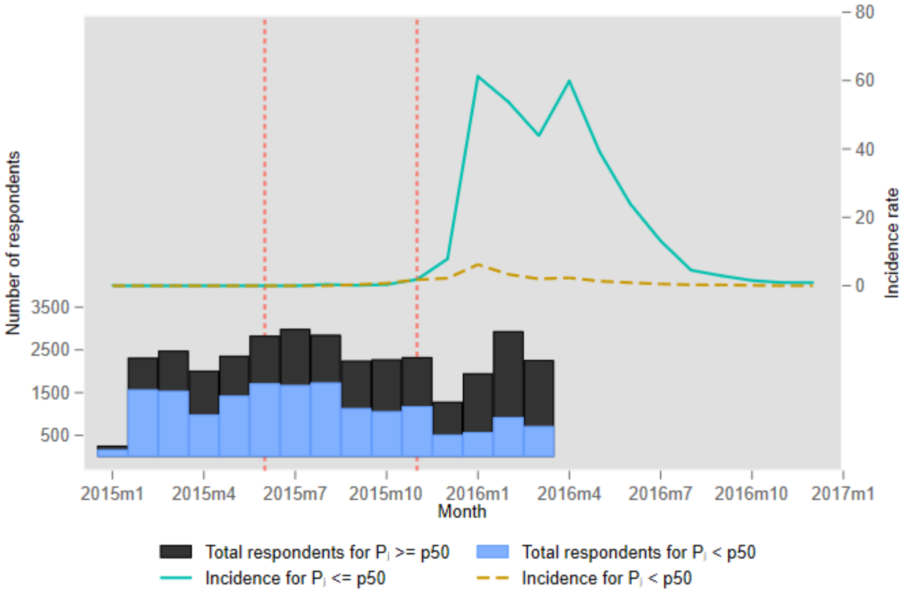
3 Empirical Strategy

3.1 Data

Our main source of information comes from the data collected by the National Demographic and Health Survey (DHS) carried out each 5 years in Colombia. Since the ZIKV crisis occurred in 2015, the surveys carried out in 2009-2010 and 2015-2016 allow us to collect the behavior of individuals before and during the ZIKV episode. DHS survey has a specific module on reproductive and sexual health that is implemented exclusively for women in 2009-2010, then, in 2015-2016 this module was also applied to men and that contains information on knowledge, use of contraceptive methods

[1] The current use of contraceptive methods is defined in the DHS survey as the percentage of women/men who reported current use (30 days before the survey) of any contraceptive method, of a modern method of contraception, and some traditional method

Figure 2: Zika 2015 and 2016 monthly incidence and DHS date of interview



Notes: This figure presents two pieces of information. First, the line plots present the total number of reported Zika cases per 100.000 inhabitants per month (incidence rate) for the set of municipalities below and above the median predicted incidence rate $\hat{P}_j$ (0.38 cases). Observed rates were derived from SIVIGILA official epidemiological records and DANE population data, and the predicted rate comes from a non-parametric model which includes altitude, temperature, precipitation and rurality. Second, the bars show the total number of women interviewed for the DHS survey per month, once again depending of the predicted incidence rate. The vertical lines correspond to: June 2015, when the Ministry of health issued an alert of the arrival of zika to Colombia; and November 2015, when the first news regarding the potential link between ZIKV and microcephaly appeared.

and sexual activity. This data lets us to cover the first five months after the microcephaly alert as shown in Figure 2. It shows that the start of the officially recorded outbreak is directly related to the first news of microcephaly, and it finishes around August 2016. This figure also shows that there is substantial variation among municipalities in terms of incidence of the illness, based on their environmental characteristics, and the DHS covers such heterogeneity for every month. The exact variable used for the classification will be presented in section 3.3.

Table 1 contains the descriptive statistics of the women sample for 2010 and 2015 source. According to this, from 2010 to 2015, the use of contraceptive methods increased in 4pp from 67% to 71%. The proportion of women who are mothers remained relatively stable, as did the number of children, where in both surveys approximately 79% of women have more than one child. In the same way, the proportion of pregnant women surveyed was the same, approximately 5%.

The sample is composed mainly of women with an average level of education, with more than 30 years, with average income, married, without current work, not heads of household. In general, they live in the urban areas, with low Poverty index (Unsatisfied Basic Needs Index, NBI) and below 1800 masl.

Table 2 contains the descriptive statistics for the incidence of ZIKV in 2016 for every 1,000 inhabitants, where an average of 858 cases is evident, that is, almost 8% of the population was affected by the ZIKV virus between January and March 2016.

3.2 Main procedure: IV estimation

In order to estimate the effect of the zika epidemic in Colombia on sexual behaviour, the equation to be estimated for an individual i living in municipality j, interviewed in month t can be described as follows:

$$reph_{ijt} = \beta_0 + \beta_1 * ZIKV_{jt} + \beta_2 \hat{P}_j + \gamma * X_{ijt} + \mu_t + \mu_a + \epsilon_{ijt} \quad (1)$$

Table 1: DHS women level descriptive statistics

	DHS 2010		DHS 2015	
	Obs	Mean (SD)	Obs	Mean (SD)
Currently use any contraceptive method	44,249	0.67 (0.47)	32,075	0.71 (0.45)
Recent sexual activity	44,249	0,66 (0,47)	32,075	0,67 (0,47)
Ethnicity (Gypsy)	44,249	0.001 (0.03)	32,075	0.00 (0.02)
Ethnicity (Raizal)	44,249	0.01 (0.09)	32,075	0.01 (0.11)
Ethnicity (Palanquero)	44,249	0.00 (0.02)	32,075	0.002 (0.04)
Ethnicity (Afro-Colombian)	44,249	0.10 (0.30)	32,075	0.10 (0.30)
Ethnicity (Other)	44,249	0.79 (0.40)	32,075	0.78 (0.42)
Educational level (primary)	44,249	0.28 (0.45)	32,075	0.21 (0.41)
Educational level (secondary)	44,249	0.48 (0.50)	32,075	0.46 (0.50)
Educational level (higher)	44,249	0.22 (0.41)	32,075	0.31 (0.46)
Age group (More than 19)	44,249	0.88 (0.32)	32,075	0.89 (0.32)
Wealth Index	44,249	2.68 (1.34)	32,075	2.54 (1.26)
Children	44,249	0.79 (0.40)	32,075	0.79 (0.41)
Pregnant	44,249	0.05 (0.21)	32,075	0.04 (0.19)
Marital status	44,249	0.62 (0.49)	32,075	0.61 (0.49)
Currently working	44,249	0.56 (0.50)	32,075	0.59 (0.49)
Head of household	44,249	0.19 (0.39)	32,075	0.22 (0.42)
Urban zone	44,249	0.73 (0.45)	32,075	0.75 (0.43)
Distance to the capital	42,775	58.55 (91.25)	30,405	60.66 (94.57)
Distance to the nearest market	42,377	403.5 (217.28)	30,114	412.97 (210.66)
NBI	44,249	35.03 (23.67)	32,075	36.28 (23.61)
Metropolitan area	44,249	0.35 (0.48)	32,075	0.33 (0.47)
Municipality area	44,249	2884.1 (7536.5)	32,075	2576 (5715.11)
Altitude (below 1800msnm)	44,057	0.82 (0.39)	31,743	0.83 (0.38)
Start using method in 2016			32,075	0,006 (0,78)
Zika Incidence*2016			28,793	0.25 (0.91)

Source: Own calculations based on the DHS 2010 and 2015 for Colombia.

Table 2: Statistics for ZIKV incidence 2016 (1000h)

Mean	0.649
Stand. Dev	1.753
Minimum	0
Percentile 50	0.116
Percentile 75	0.505
Percentile 99	8.11
Maximum	30.109

Source: Own calculations based on SIVIGILA data and DANE national census 2005 population numbers.

Our dependent variable is represented by $reph_{ijt}$, which is a dummy variable for three different characteristics of reproductive health: recent sexual activity, current use of contraceptive methods, and IPV. The regressor of interest is $ZIKV_{jt}$, which represents the number of Zika cases per 1.000 inhabitants reported in month t. Variable $\hat{P}_j$ is the predicted zika incidence based on ecological characteristics, a variable that will be described below in detail. The vector that contains the control variables is X_{ijt}, which are ethnicity, educational level, wealth index, number of children, distance to the capital, distance to the nearest market and a set of dummy variables for pregnant women, marital status, household head, urban area, NBI (poverty variable), metropolitan area and municipality area. The estimated coefficients also include time-fixed effects μ_t, and age group μ_a fixed effects. Notice that we do not use municipality fixed effects as DHS collects information from different areas of the country each month.

A particular concern is that sexual and contraceptive activity use might be correlated to the zika expansion. Contrary to endemic diseases such as Dengue, Zika was a new illness an the outbreak spread responds to a particular dynamic. The source are the passengers in flights traveling from Brazil into Colombian airports, and the movement of infected individuals into Colombian cities where the *Aedes Aegypti* mosquito lives. Then, infected individuals move into smaller towns and residential neighbours, and then the outbreak cycle would work as Dengue. Thus, while ecological conditions are relevant, it is also important the role of each town on local, national and international trade. Such characteristics are also related to the age, education level, and other observed and unobserved characteristics of the municipalites which might be correlated to differential trends on sexual and contraceptive activity. To start with, Gamboa and Rodriguez-Lesmes (2018) show that those areas below 1800 masl have a significantly lower birth rate. While they deal with endogeneity using a synthetic control strategy, this strategy is not available in our present setup as constructing parallel trends is difficult given that DHS municipalities above and below 1800 masl are not evenly sampled every month during the study period. Instead, we rely on an instrumental variables approach.

The parameters of equation 1 are estimated via two stage least squares, where $ZIKV_{jm}$ is the endogenous variable. The first stage is constructed at municipality-year level, as presented in equation 2. Here, the instrument is the predicted incidence $\hat{P}_j$ interacted with a dummy that indicates the year 2016. Errors are clustered at municipality level and DHS individual weights are considered. A similar specification but using only 2015-16 data is used for males.

$$ZIKV_{jt} = \alpha_0 + \alpha_1 \hat{P}_j \times \mathbb{1}(y = 2016) + \alpha_2 \hat{P}_j + \eta * X_j + \mu_t + \epsilon_{jt} \quad (2)$$

In addition, since women's fertility choices are related to age, it is also tested a second specification (see equation 3), which includes the interaction between the incidence of $ZIKV_{jm}$ and a categorical variable for two *age-groups* AGE^k_{ijt}: 13 to 19 years and more than 19 years.

$$\begin{aligned} reph_{ijt} = {} & \beta_0 + \sum_{k=1}^{2} \left(\beta_k * ZIKV_{jt} \times AGE^k_{ijt} + \iota_k AGE^k_{ijt}\right) + \beta_2 \hat{P}_j \\ & + \gamma * X_{ijt} + \mu_t + \epsilon_{ijt} \end{aligned} \quad (3)$$

In the same way of equation 2, two stage least squares is used for estimating the parameters. The sole difference is that the instrument is interacted with age categories just as the endogenous variable.

3.3 Instrument construction: predicted Zika incidence

As explained above, the instrument consists of the product of an index of ecological conditions for the expansion of ZIKV ($\hat{P}_j$) with a *time-dummy* variable. The dummy takes the value of 1 between January 2016 and March 2016. We chose this period since it was public knowledge in Colombia, that the ZIKV could have a relationship with microcephaly as of November 2015, which increased the concern of citizens and especially of the pregnant women or who were looking to be pregnant.

This index $\hat{P}_j$ comes after fitting a non-parametric model that combines the following characteristics of a municipality: altitude above the sea level, average yearly temperature and rainfall, and rurality. As explained above, the idea is collect ecological characteristics that predict the yearly

Table 3: Results first step

	ZIKV incidence
Instrument: $\hat{P}_j \times \mathbb{1}(y = 2016)$	0.474***
	(0.042)
Controls	X
Month-Year of DHS Interview Fixed Effects	X
Observations	833
F	18.8 6

Notes: The dependent is the Zika virus incidence for the first three months of 2016 in municipalities for which there is at least one surveyed women/men (incidence takes the value of 0 prior to January 2016). The instrument is the interaction between predicted values of Zika incidence and the time variable, that is a dummy variable, which is activated between January 2016 and March 2016. Controls include: dummies for being urban and of being part of metropolitan area, distance to the department capital, distance to the nearest market, poverty index, whether the municipality is located below 1800 masl, and total area of the municipality. Robust standard errors are presented in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

incidence of Zika for 2016, but avoiding the transmission channel based on movements of individuals which might hide characteristics correlated with different sexual and contraceptive trends. It is estimated using a Multivariate Mixed Data Local Constant Regression with optimal bandwidths.[2] The advantage of fitting this model is that we are able to account for highly non-linear relationships. For instance, mosquitoes prefer certain temperature range, they are not monotonically better of with growing temperatures. Notice that variable $\hat{P}_j$ is fixed on time, thus it is not capturing specific weather events that might be related with economic shocks contemporaneous to the ZIKV crisis.

4 Results

In this section we will first discuss the relevance of the instrument for explaining ZIKV incidence. Second, we will analyse how the outbreak affected sexual behaviour: sexual activity and contraceptive usage. Third, the impact on IPV is presented. Fourth, a placebo exercise is conducted as a robustness check.

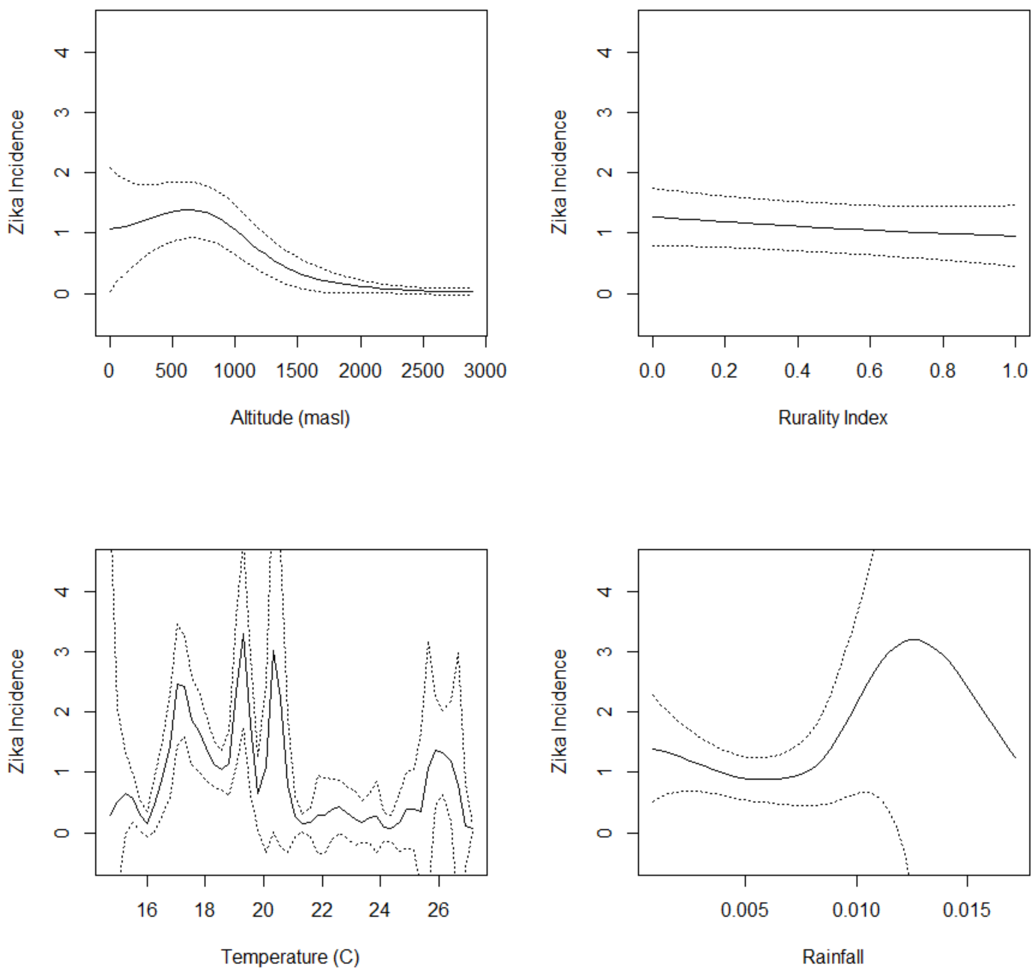
4.1 First stage

Figure 3 shows the conditional relationship between the four ecological characteristics considered and the incidence of ZIKV. It shows that, as is well known, municipalities below 1800 masl have on average a higher incidence, but as documented in Barron et al. (2018) for Dengue, the relationship is non-monotonic. Average rainfall connection with ZIKV is as well non-monotonic, with a first decreasing and then increasing pattern. The relationship is even noisier for temperature, where a specific range seems to be ideal. Conditional on those characteristics, the more rural is the municipality, less cases of ZKIV are reported. This three variables capture nearly 40% of the total variation, as shown by the R^2 of the non-parametric regression.

Table 3 presents the results of regressing the instrument based on the ecological-based index against actual observed incidence per municipality (equation 2). There is a column for women and another for men as the second group was not surveyed in all the municipalities where women were surveyed. We observe a clear relation of the instrument with the incidence rate for the first three months of 2016, conditional on all other characteristics of the municipalities. This is effectively the first stage for all the instrumental variable exercises which follow.

[2]Estimated using the `npreg` command from `np` package in `R` (Hayfield et al., 2008).

Figure 3: 2016 incidence of Zika and ecological variables



Notes: Estimates from a local-constant non-parametric regression using a second-order gaussian kernel. Bandwidths of 264.5882 masl for altitude, 0.3112892 Kelvin grades for temperature, 0.01569182 for rainfall, and 0.08794013 for rurality index (ranges from 0 to 1).

Table 4: Monthly ZIKV incidence impact on birth control

Panel A: Recent sexual activity

	All		Single		Married	
	(1)	(2)	(3)	(4)	(5)	(6)
Zika Incidence (1 sd)	-0.008		-0.043**		0.014	
	(0.009)		(0.020)		(0.012)	
Zika Inc, G1: 13 to 19		-0.029		-0.035		-0.045
		(0.028)		(0.036)		(0.040)
Zika Inc, G2: More than 19		-0.005		-0.045**		0.018
		(0.009)		(0.019)		(0.012)
Controls	X	X	X	X	X	X
Observations	66,329	66,329	25,887	25,887	40,442	40,442
N Municip	331	331	330	330	331	331
Y bar	0.66	0.66	0.37	0.37	0.87	0.87
F-1st	17.9		17.8		17.2	
F-1st step G1		10.3		10.0		9.59
F-1st step G2		11.0		11.5		9.79
P-val G1=G2 test		0.42		0.73		0.10

Panel B: Currently use any contraceptive method beyond restricting sexual activity

	All		Single		Married	
	(1)	(2)	(3)	(4)	(5)	(6)
Zika Incidence (1 sd)	0.025		-0.003		0.037*	
	(0.017)		(0.029)		(0.022)	
Zika Inc, G1: 13 to 19		0.043		0.023		0.039
		(0.034)		(0.046)		(0.044)
Zika Inc, G2: More than 19		0.023		-0.010		0.037*
		(0.017)		(0.028)		(0.022)
Controls	X	X	X	X	X	X
Observations	66,329	66,329	25,887	25,887	40,442	40,442
N Municipalities	331	331	330	330	331	331
Y bar	0.71	0.71	0.58	0.58	0.80	0.80
F-1st	17.9		17.8		17.2	
F-1st step G1		10.3		10.0		9.59
F-1st step G2		11.0		11.5		9.79
P-val G1=G2 test		0.53		0.38		0.96

Notes: This table presents coefficients from two stage least squares regressions. Columns 1, 3 and 5 regress the dependent variable on monthly zika incidence by municipality in standard deviations (1 SD = 1.48 cases per 100.000 inhabitants). This regressor is instrumented with the predicted incidence based on ecological conditions ($\hat{P}_j$) interacted with a dummy that indicates that the survey took place in 2016, which corresponds to the period of zika activity and media coverage of the zika-microcephaly link. The differences between the columns correspond to the selected subsample of women. Columns 2, 4 and 6 presents coefficients from the interaction of zika incidence with the age group of women, which are variables instrumented with the interaction of the original instrument with the same age-group dummies. For those regressions, the last line of the panel presents the p-value from a Wald test where the null is the equality of the coefficients of each interaction. Controls include ethnicity, educational level, wealth index, number of children, pregnant dummy, marital status, head of household dummy, and age-group effects. At municipality level, the level variable $\hat{P}_j$, poverty index (NBI), distances to the capital of department and to the nearest market, as well as dummies for being on an urban area, a metropolitan area. The estimates also include month-year of interview fixed effects. Clustered standard errors at municipality level in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.2 (Preliminar) Impacts on Behaviour

Table 4 presents results for the different strategies for controlling birth rates: panel A presents recent sexual activity (lat 4 weeks) and panel B the usage of other contraceptive methods. It presents the 2SLS coefficients associated to zika incidence in standard deviations (1 sd = 1.48 cases per 100.000 inhabitants), and to its interaction with age-group dummies. The table also presents the corresponding F statistics: around 18 for the non-interacted version (as the first stage results presented above), and around 10 for the interacted ones, showing the validity of the strategy.

We found that single women have less sexual intercourses after the zika outbreak: around 18% of single women reported sexual activity in the last 4 weeks, a number that drops in 4 percentage points for each standard deviation of zika incidence. While the effect is significant only for teenagers, the point estimate cannot be rejected to be the same for older women. The alternative strategy is the use of contraceptive methods such as oral contraceptives or condoms. In this case, the impact is only for married women. Again, we cannot assert whether it is different according to age.

Table 5 presents the impact of ZIKV incidence on IPV. First, we consider sexual violence in Panel A, and general reported violence in Panel B. With respect to sexual violence, on one hand we observe an increase on violence against single teenagers. It has an important magnitude: from a prevalence of 8% on this type of violence, there is an increase of 1.7 percentage points. As the variable is measured as been ever being affected by such type of violence, this coefficient does not take into account the intensity of abuse for women are regularly victims of it. On the other hand, we observe a decline of this type of violence for married women. Panel B shows that violence against married women increased, but there is no evidence that it was different according to age.

Table 5: ZIKV incidence impact on women reports of violence

Panel A: Ever been physically forced into unwanted sex by husband/partner						
	All		Single		Married	
	(1)	(2)	(3)	(4)	(5)	(6)
Zika Incidence (1 sd)	-0.008		0.004		-0.014^{***}	
	(0.005)		(0.010)		(0.005)	
Zika Inc, G1: 13 to 19		0.017^{**}		0.017^{**}		0.025
		(0.007)		(0.009)		(0.020)
Zika Inc, G2: More than 19		-0.012^{**}		0.000		-0.016^{***}
		(0.005)		(0.012)		(0.005)
Controls	X	X	X	X	X	X
Observations	66,329	66,329	25,887	25,887	40,442	40,442
N Municip	331	331	330	330	331	331
Y bar	0.067	0.067	0.085	0.085	0.055	0.055
F-1st	17.9		17.8		17.2	
F-1st step G1		10.3		10.0		9.59
F-1st step G2		11.0		11.5		9.79
P-val age-coeff test		0.000019		0.12		0.048
Panel B: Experienced any less severe violence						
	All		Single		Married	
	(1)	(2)	(3)	(4)	(5)	(6)
Zika Incidence (1 sd)	0.014		0.007		0.029^{**}	
	(0.011)		(0.012)		(0.013)	
Zika Inc, G1: 13 to 19		0.025^{*}		-0.002		0.039
		(0.015)		(0.011)		(0.051)
Zika Inc, G2: More than 19		0.013		0.009		0.028^{*}
		(0.013)		(0.015)		(0.015)
Controls	X	X	X	X	X	X
Observations	66,329	66,329	25,887	25,887	40,442	40,442
N Municipalities	331	331	330	330	331	331
Y bar	0.26	0.26	0.23	0.23	0.28	0.28
F-1st	17.9		17.8		17.2	
F-1st step G1		10.3		10.0		9.59
F-1st step G2		11.0		11.5		9.79
P-val G1=G2 test		0.52		0.52		0.85

Notes: This table presents coefficients from two stage least squares regressions. Columns 1, 3 and 5 regress the dependent variable on monthly zika incidence by municipality in standard deviations (1 SD = 1.48 cases per 100.000 inhabitants). This regressor is instrumented with the predicted incidence based on ecological conditions ($\hat{P}_j$) interacted with a dummy that indicates that the survey took place in 2016, which corresponds to the period of zika activity and media coverage of the zika-microcephaly link. The differences between the columns correspond to the selected subsample of women. Columns 2, 4 and 6 presents coefficients from the interaction of zika incidence with the age group of women, which are variables instrumented with the interaction of the original instrument with the same age-group dummies. For those regressions, the last line of the panel presents the p-value from a Wald test where the null is the equality of the coefficients of each interaction. Controls include ethnicity, educational level, wealth index, number of children, pregnant dummy, marital status, head of household dummy, and age-group effects. At municipality level, the level variable $\hat{P}_j$, poverty index (NBI), distances to the capital of department and to the nearest market, as well as dummies for being on an urban area, a metropolitan area. The estimates also include month-year of interview fixed effects. Clustered standard errors at municipality level in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Putting together both exercises, we observe that single women strategy is linked to a reduction on sexual activity which for teenagers results on more sex-related violence. Instead, married women increase the usage of contraceptive methods and while sex-related violence decrease, there is a puzzling increase in violence non-directly related to sexual activity. This result might be related to bargaining power at the household level: by temporally loosing their ability to give birth, other choices might be imposed over them via force. We are still working on understanding with more detail this mechanism.

5 Final Remarks

External shocks seems to generate heterogeneous responses in people according to factors that in many times are beyond the scope of the individual as intercourse sexual behavior. In the case of Zika virus spread, it took place an additional concern due to the uncertainty exhibited by the authorities about other collateral problems who, among other factors, claims for a delay in pregnancy choices. However, the observed behavior in people along the country suggest that the decrease in natality trends was accompanied by other factors experienced within the households.

One of the more important spheres for the person development is her ability to make free choices and to feel comfortable with its consequences. However, there are several concerns about the unequal conditions faced by women and men in less developed countries because of the bargaining power in multiple dimensions of the couples reduces her empowerment.

Through this document we have provided new evidence about the consequences of ZIKV (most importantly, microcephalia of newborns) on sexual behavior and it suggest that women are more vulnerable when they already have children. Although contraceptive use grows over the population, there are heterogeneous reactions among population groups (married and non-married with and without children). Unequal empowerment is a reflect of development problems in a society, but it is most important when some specific groups are more constrained in its choices than others.

While women seems to have a more strategic sexual behavior and, particularly single women opt to have less sexual intercourses and married women opt to increase the usage of contraceptives.

The use of any contraceptive method should be a sign of empowerment, but what we found is that can be a response of the impossibility of reducing sexual activity forced by her couples. Therefore, it seems that single women can control their sexual activity without being affected by IPV because of the ability to make free choices and the existence of children might modify the strength of the responses, which highlights the vulnerability of teenagers to this phenomenon. Vulnerability is extreme for teenagers who are already mothers, who are willing to sustain more violence in order to control their fertility.

Briefly, our results suggest that it is necessary to carry out public initiatives to provide information about people rights and their different spheres to empower people's choices and, particularly to highlight the type of situations in which women can be forced to modify their behavior. These initiatives should be targeted to teenagers who are having their sexual relations in countries such as Colombia with a considerable incidence of teenager pregnancy. This is a novel evidence about the heterogeneous abilities to manage with activities under uncertain risks and the consequences of different levels of bargaining between women and men.

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