I Z A Institute
of Labor Economics
Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 10591

Zika Virus Prevalence, Correlates and Preventive Behaviors: New Evidence from Survey Data

José Raimundo Carvalho
Victor Hugo de Oliveira
Climent Quintana-Domeque

FEBRUARY 2017

I Z A Institute
of Labor Economics

Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 10591

Zika Virus Prevalence, Correlates and Preventive Behaviors: New Evidence from Survey Data

José Raimundo Carvalho
CAEN/Universidade Federal do Ceará and LECO/CAEN/UFC

Climent Quintana-Domeque
University of Oxford and IZA

Victor Hugo de Oliveira
IPECE, UNIFOR and LECO/CAEN/UFC

FEBRUARY 2017

IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Zika Virus Prevalence, Correlates and Preventive Behaviors: New Evidence from Survey Data*

Brazilian health authorities have recommended that pregnant women take meticulous precaution to avoid mosquito bites, and use contraceptive methods to postpone/delay pregnancies. In this article, we present new estimates on the Zika virus prevalence, its correlates and preventive behaviors in the Northeast of Brazil, where the outbreak initiated, using survey data collected between March 30th and June 3rd of 2016. The target population are women aged 15-49 in the capital cities of the nine states of the Northeast region of Brazil. We find that more educated women are less likely to report suffering from Zika (or its symptoms), and more likely to avoid pregnancy in the last 12 months and being informed about the association between Zika and microcephaly. In addition, more educated women are more likely to follow preventive measures against the Zika virus: having used long and light-colored clothes, having used mosquito repellent or insecticides, having used mosquito protective screens or kept windows closed, and having dumped standing water where mosquitoes can breed.

JEL Classification: I1, J1

Keywords: flavivirus, education, information, prevention, survey data

Corresponding author:
Climent Quintana-Domeque
University of Oxford
Department of Economics
Manor Road
Oxford OX1 3UQ
United Kingdom
E-mail: climent.quintana-domeque@economics.ox.ac.uk

* We thank Diego Andre and Abel Brasil for providing excellent research assistance.

1. INTRODUCTION

Zika virus, a flavivirus, was first identified in the Americas in March 2015, in Bahia, in the Northeast region of Brazil (Campos, Bandeira and Sardi, 2015; Zanluca et al., 2015). In urban and suburban environments, Zika virus is transmitted in a human-mosquito-human transmission cycle, primarily by *Aedes* mosquitoes (Petersen et al., 2015). Transmission of Zika virus from mother to fetus and sexual transmission have both been reported (Calvet et al., 2016; Foy et al., 2011; Jouannic et al., 2016; MMWR, 2016a; MMWR, 2016b; Oliveira et al., 2016; Venturi et al., 2016). Brazil reported an association between Zika virus infection and Guillian-Barré syndrome in July 2015, and an association between Zika virus infection and microcephaly in October 2015 (WHO, 2016).[1]

Brazilian health authorities have recommended that pregnant women take meticulous precaution to avoid mosquito bites, and use contraceptive methods to postpone/delay pregnancies. The emergency protocol, published after the Ministry of Health declared state of emergency in public health of national interest in November 11, 2015, focuses not only on pregnant women and their infants, but also on women in childbearing age.[2] Public health authorities explicitly recommended to increase the access of contraceptive methods in the public health system, and to strengthen preconception counseling in order to inform women who want to get pregnant about the current situation of the cases of microcephaly in the country. On February 1st, 2016, the WHO declared the Zika outbreak as a Public Health Emergency of International Concern (WHO, 2016). By February 9th of 2017, 48 countries and territories have confirmed autochthonous, vector-borne transmission of Zika virus disease in the Region of the Americas (PAHO, 2017).[3]

A potential causal relationship between Zika virus infection during pregnancy and microcephaly, and other serious brain anomalies, was firstly reported in May 2016 by Rasmussen et al (2016). Posterior case-control studies support this causal relationship. For instance, evidence has shown that the microcephaly epidemic is a result of congenital Zika virus infection in Brazil (Araújo et al, 2016). Besides, children with congenital Zika virus but

[1] http://www.who.int/mediacentre/factsheets/zika/en/

[2] http://portalsaude.saude.gov.br/index.php/cidadao/principal/agencia-saude/21241-saude-lanca-protocolo-de-atencao-a-saude-para-microcefalia

[3] http://www.paho.org/hq/index.php?option=com_content&id=11599&Itemid=41691

normal head size at birth can develop microcephaly and have significant neurologic sequelae after birth (van der Linden et al, 2016). In November 18th of 2016, the Emergence Committee of the World Health Organization felt that Zika virus and associated consequences no longer represent a Public Health Emergency of International Concern.[4]

Diagnosing Zika is complicated for several reasons (Petersen et al., 2016). The fact that dengue and chikungunya, which result in similar clinical pictures, have both been epidemic in Brazil confound clinical diagnoses (Fauci and Morens, 2016; Petersen et al., 2016). Moreover, because Zika is closely related to dengue, serologic samples may cross-react in test for either virus (Fauci and Morens, 2016; Petersen et al., 2016).

In this article, we present new estimates on the Zika virus prevalence, its correlates and preventive behaviors in the Northeast of Brazil, where the outbreak initiated, using survey data collected by the authors through the PCSVDF^{Mulher} (*Pesquisa de Condições Socioeconômicas e Violência Doméstica e Familiar contra a Mulher*) survey, conducted between March 30th and June 3rd of 2016. The target population are women aged 15-49 in the capital cities of the nine states of the Northeast region of Brazil. The main objectives of the PCSVDF^{Mulher} survey are to measure the causes and consequences of domestic (and, in particular, intimate partner) violence in Brazil. Given the Zika outbreak, during the development of the PCSVDF^{Mulher} survey, it was decided to incorporate a battery of questions which shall provide useful information regarding the prevalence of Zika virus, its correlates and preventive behaviors.

We study pregnancy status and contraceptive behavior, prevalence of Zika and symptoms, behavioral/preventive responses to Zika, and knowledge on Zika and microcephaly. We find that more educated women are less likely to report suffering from Zika (or its symptoms), and more likely to avoid pregnancy in the last 12 months and being informed about the association between Zika and microcephaly. In addition, more educated women are more likely to follow preventive measures against the Zika virus: having used long and light-colored clothes, having used mosquito repellent or insecticides, having used mosquito protective screens or kept windows closed, and having dumped standing water

[4] http://www.who.int/mediacentre/news/statements/2016/zika-fifth-ec/en/

where mosquitoes can breed. This information may be useful in enhancing family planning and reproductive health policies in Brazil, and more generally, in a context of health shocks or epidemics.

2. DATA

PCSVDF^{Mulher} (Pesquisa de Condições Socioeconômicas e Violência Doméstica e Familiar contra a Mulher)

This study is the result of an international collaboration between researchers of the University of Oxford, IPECE, and the Universidade Federal do Ceará. The findings of this study are obtained from the analysis of survey data: PCSVDF^{Mulher} (*Pesquisa de Condições Socioeconômicas e Violência Doméstica e Familiar contra a Mulher*). This survey was conducted by Datainfo[5], a company with previous experience in victimization surveys, between March 30th and June 3rd of 2016.

Ethical and safety guidelines for the conduct of this research were developed and were adhered to. These emphasized individual informed consent and the importance of ensuring confidentiality and privacy, both as a means to protect the safety of respondents and field staff, and to improve the quality of the data. Ethics permission for the study was obtained from the Brazilian Scientific Ethical Committee (Approval Number 53690816.5.0000.5054).

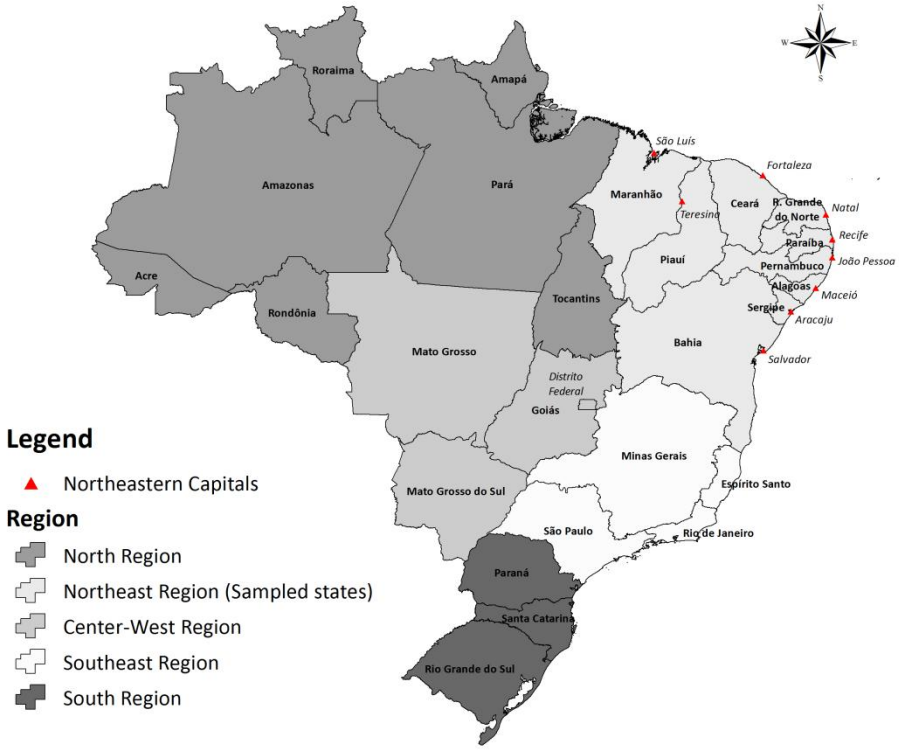
Sample design

The sampling plan was drawn up by stratifying the population of households in three stages. In the first stage, there was a random selection of a sample of census tracts at each state's capital following a design that creates three layers of sectors according to the head of household's average income per capita in the sector. In the second stage, there was a random selection of a sample of households at each of the sectors selected at the previous step. Finally, in the third stage, and to ensure the safety and confidentiality of respondents,

[5] http://www.datainfo.inf.br/

only one woman aged 15-49 was randomly selected per household. **Figure 1** shows the geographical coverage of the PCSVDF[Mulher] survey.

Figure 1: Geographical coverage of the PCSVDF[Mulher] survey



The survey used carefully selected female interviewers and supervisors trained using standardized three-week training, covering issues of gender, violence, ethical and safety issues, as well as interview techniques.[6] The WHO ethics guidelines required that all interviews took place in complete privacy except for infants younger than 2 years. Interviewers were trained in several strategies to ensure such privacy, including use of dummy questions in case someone entered the room, and use of decoy interviewers to ask

[6] A 40-hour training at each one of the nine states, provided to roughly 25 - 35 interviewers per site (256 interviewers in total), and composed of three modules. The first module explored concepts of gender, gender norms, equality, gender based violence and stigma. Instructors addressed how these topics interact at the moment of data collection and how to act during and after interviews (24 hours). The second module presented the technical aspects of the tools used during the field work, such as field and equipment operation, as well as sampling issues, and technical details about all sections of the questionnaire, handling of the tablet and the use of Survey Solutions from the World Bank (12 hours). Finally, the third module dealt with incentives and motivations, and some specific aspects of the questionnaire (4 hours).

questions of mother-in-laws or husbands if this was the only way to ensure privacy with the respondent. All interviews were done in the local language, and information about available local services was provided to all respondents.

Panel: Questions used in the PCSVDFMulher survey to document the prevalence of current pregnancies, the prevalence of Zika cases, behavioral/preventive responses to Zika, and the knowledge on Zika and microcephaly.

A. Pregnancy status and contraceptive behavior

- *Are you pregnant now?*
- *In the past 12 months, have you used any contraceptive (or tried in any way) to delay or avoid getting pregnant?*
    - *If yes, is it because the Zika virus epidemic?*
    - *If yes, for how long?*

B. Prevalence of Zika and symptoms

- *In the past 12 months, have you been diagnosed with Zika virus?*
- *In the past 12 months, have you had mild fever, rash, and/or joint pain?*
- *In the past 12 months, has there been any Zika virus case in your household?*
- *In the past 12 months, have you heard/known about any Zika virus case in your neighborhood?*
- *In the past 12 months, have you received the visit of agents of endemic diseases (dengue, Zika, etc.)?*

C. Behavioral/Preventive responses to Zika

- *In the past 12 months, have you used long and light-colored clothes, even during hot days?*
- *In the past 12 months, have you used mosquito repellent or insecticides?*
- *In the past 12 months, have you used mosquito protective screens or kept windows closed?*
- *In the past 12 months, have you dumped standing water where mosquitos can breed?*

D. Knowledge on Zika and microcephaly

- *Did you know that Zika virus is associated with malformation in newborns (microcephaly)?*

Data entry and analysis

PCSVDF^{Mulher} survey used CAPI (Computer - Assisted Personal Interviewing) data collection technology provided by means of the World Bank's Survey Solutions: a free computer-assisted personal interviewing software developed by the Development Research

Group of the World Bank in collaboration with the Food and Agriculture Organization (FAO).[7]

Role of funding sources

The PCSVDF^{Mulher} survey was funded by the Secretaria Especial de Políticas para as Mulheres - Ministério da Justiça, Brasil. The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, or writing of this article. The authors of this article had full access to all data in the study and had final responsibility for the decision to submit for publication.

3. RESULTS

The sample size of the PCSVDF^{Mulher} survey was established on the basis of required levels of statistical power to meet the primary study objectives. **Table 1** describes the fraction of participants, refusals and not available respondents. A total of 11,570 eligible households were contacted. Among the eligible households, those with at least a woman aged 15-49, 87% of them accepted to participate; 5% of them refused to participate; and 8% of them were not in the household.

Table 1: Fraction of participants, refusals and not available respondents among eligible women

	Frequency	%
Not in the household (NA)	901	7.79
Refused	575	4.97
Accepted	10,094	87.24
Total	11,570	100

Source: Own elaboration using PCSVDF^{Mulher}.

Among those who accepted to participate, 9,624 responded the module on General and Reproductive Health; this amounts to 95.34% of the 10,094 respondents who accepted to participate in our survey. **Table 2** contains the female 15-49 population for each state

[7] The goal of Survey Solutions, accordingly to the World Bank, is to *build capacity in developing countries by providing national statistical agencies and other institutions involved in data collection with cost-effective and sustainable solution for conducting complex and large-scale surveys with minimal or no technical assistance*.

capital (*Pesquisa Nacional por Amostra de Domicílios Contínua*, 2016) and its corresponding sample size (PCSVDF^{Mulher}, 2016).[8]

Table 2: Female population and survey respondents by state capital

	Female Population 15-49*	Eligible sample	Final sample
Aracajú	182,932	1,007	978
Fortaleza	763,145	1,221	1,190
João Pessoa	230,831	1,117	1,107
Maceió	295,015	1,018	995
Natal	251,401	1,078	965
Recife	471,612	1,308	1,202
Salvador	905,401	1,202	1,192
São Luís	342,191	1,143	1,115
Teresina	248,746	1,000	880
Total	3,691,274	10,094	9,624

* Pesquisa Nacional de Amostra por Domicílios Contínua/IBGE, 1st Quarter/2016.

Table 3 contains a summary of the main demographic indicators (age, race, and education) of our respondents. The average women's age is 32, and more than half of the sample (52%) is composed by women who declare themselves to be "Brown" (or "Pardo"). Regarding women's education, about 61% of sampled women have at least a high school degree. Such statistics are in line with those from the *Pesquisa Nacional de Amostra por Domicílios Contínua* (PNAD, quarterly data) that was carried out by the *Instituto Brasileiro de Geografia e Estatística* (IBGE) during January-March 2016, the trimester before the data collection of the PCSVDF^{Mulher}. For instance, the average age of women aged 15-49 in the Northeastern capitals is 31.7, and 61.2% have at least the high school education. While the PNAD Continua (1st Quarter/2016) does not provide information about self-declared color/race, we can access such information in the PAND 2015 (yearly data) at the level of Brazilian States. About 49% of the sampled women with aged between 15 and 49 in Northeastern States declare themselves to be "Brown" (or "Pardo").

[8] The *Pesquisa Nacional por Amostra de Domicílios* is a national representative household survey carried out by the *Instituto Brasileiro de Geografia e Estatística* (IBGE). Currently, there are two versions of the PNAD: i) PNAD *Contínua* that collect data in each trimester of the year (since 2012); ii) PNAD which is the standard version, collecting data once a year (in September of each year, since 1977). In the near future IBGE will replace the PNAD (standard) with the Continuous PNAD.

Table 3: Demographic characteristics

		N	%
Age			
	15-19	1,228	12.76
	20-24	1,461	15.18
	25-29	1,512	15.71
	30-34	1,463	15.20
	35-39	1,354	14.07
	40-45	1,186	12.32
	45-49	1,420	14.75
Race			
	White	2,285	23.74
	Black	2,191	22.77
	Brown	5,009	52.05
	Asian	8	0.08
	Indigenous	40	0.42
	Missing	91	0.95
Education			
Definition 1			
	No education	94	0.98
	Some fundamental school	1,559	16.2
	Fundamental school	632	6.57
	Some high school	1,473	15.31
	High school	3,625	37.67
	Technical course	269	2.80
	Some College	956	9.93
	College	764	7.94
	Some graduate education	231	2.40
	Missing	21	0.22
Definition 2			
	No education or some fundamental school	1,653	17.18
	Fundamental school or some high school	2,105	21.87
	High School, technical course, or some college	4,850	50.39
	College or some graduate education	995	10.34
	Missing	21	0.22
	Observations	9,624	100.00

Source: Own elaboration using $PCSVDF^{Mulher}$.

Using the questions on the panel (p. 6) we can document the following stylized facts:

A. Pregnancy status and contraceptive behavior

1. *4.29% of women 15-49 report being currently pregnant; 0.49% of women 15-49 do not know/maybe.*
2. *50.88% of women report having used any contraceptive (or tried in any way) to delay or avoid getting pregnant in the last 12 months; among those (n=789), 18.32% report this was motivated because of the Zika virus epidemic.*

B. Prevalence of Zika and symptoms

3. *23.40% of women 15-49 report having being diagnosed with Zika virus in the past 12 months.*
4. *34.91% of women 15-49 report having had mild fever, rash, and/or joint pain (typical symptoms associated to Zika) in the past 12 months.*
5. *48.82% of women 15-49 report that there has been a Zika virus case in their households in the past 12 months.*
6. *67.36% of women 15-49 report having heard/known about a Zika virus case in their neighborhood in the past 12 months.*
7. *58.96% of women 15-49 report having received the visit of agents of endemic diseases (dengue, Zika, etc.) in the past 12 months.*

C. Behavioral/Preventive responses to Zika

8. *9.05% of women 15-49 report having used long and light-colored clothes frequently or always, even during hot days, in the past 12 months.*
9. *20.87% of women 15-49 report having used mosquito repellent or insecticides frequently or always in the past 12 months.*
10. *14.10% of women 15-49 report having used mosquito protective screens or kept windows closed frequently or always in the past 12 months.*
11. *78.51% of women 15-49 report having dumped standing water where mosquitoes can breed frequently or always in the past 12 months.*

D. Knowledge on Zika and microcephaly

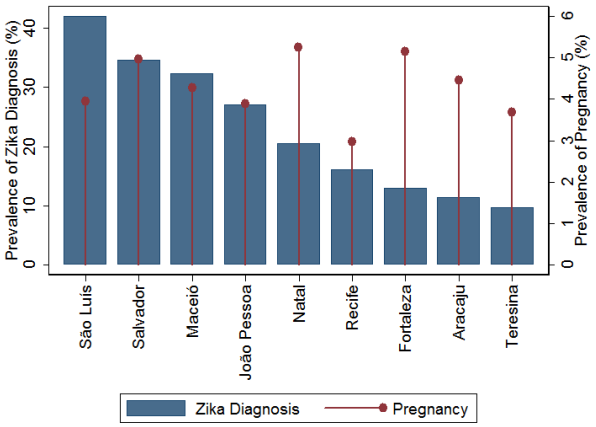
12. *96.13% of women 15-49 report knowing that Zika virus is associated with malformation in newborns (microcephaly).*

Tables A1 to **A3**, in the **Appendix A**, provide disaggregated prevalence by city/State capitals for all reported 12 facts.

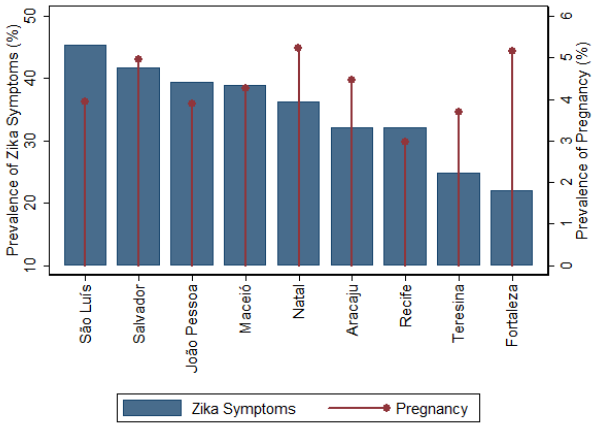
The distribution of Zika diagnosis and symptoms by city/State, as well as the prevalence of pregnancies is displayed in **Figure 2**.

Figure 2: Prevalence of Zika (diagnosis and symptoms) and pregnancy by city/state

(a) Zika Diagnosis vs. Pregnancy



(b) Zika Symptoms vs. Pregnancy



Source: Own elaboration using PCSVDF[Mulher].

In **Table 4** we study the correlates of having been diagnosed with Zika in the last 12 months, having suffered from typical Zika symptoms (e.g., mild fever, rash, and/or joint pain) in the last 12 months, being currently pregnant, having used any contraceptive (or tried in any way) to delay or avoid getting pregnant in the last 12 months, and knowing that Zika virus is associated with malformation in newborns. We run Logit regressions of each of these variables on age binary indicators (20-24, 25-29, 30-34, 35-39, 40-44, 45-49), educational binary indicators (fundamental, high school, college), race binary indicators (black, brown, other), and state binary indicators.[9] The table reports the odds-ratio (OR) for each logit coefficient (i.e., the logit coefficient exponentiated).

[9] The reference categories are women aged 15-19, with no fundamental education, white and living in Teresina, Piauí state capital.

Women with high-school are less likely to report to have been diagnosed with Zika in the last 12 months (OR=0.786, p-value<0.01) and to have suffered from Zika symptoms (OR=0.809, p-value<0.01) than those with no education; qualitatively similar, but quantitatively stronger, results are found for college-educated women (OR=0.542, p-value<0.01 and OR=0.503, p-value<0.01). Education is not found to be a statistically significant predictor of pregnancy (although qualitatively educated women are less likely to report being pregnant). Finally, both high-school and college-educated women are more likely to report having used any contraceptive (or tried in any way) to delay or avoid getting pregnant in the last 12 months (OR=1.22, p-value<0.01 and OR=1.37, p-value<0.01), and knowing that Zika virus is associated with malformation in newborns (OR=1.68, p-value<0.01 and OR=1.60, p-value<0.05), than women without education. The bottom line from **Table 4** is that more educated women are less likely to report suffering from Zika (or its symptoms) and more likely to avoid pregnancy in the last 12 months and being informed about the association between Zika and microcephaly.

Table 4: Logistic regressions of Zika, Zika Symptoms, Pregnancy, Contraceptive Behavior and Information on socio-demographic variables

	Has been diagnosed with Zika virus	Typical symptoms of Zika virus	Is currently Pregnant	Is currently using Contracep.	Knows that Zika virus may cause Microcephaly
= 1 if aged 20-24	1.456***	1.234**	1.208	1.077	1.175
	(0.147)	(0.108)	(0.242)	(0.111)	(0.223)
= 1 if aged 25-29	1.455***	1.239**	1.059	0.955	1.676**
	(0.148)	(0.108)	(0.215)	(0.097)	(0.348)
= 1 if aged 30-34	1.341***	1.253**	0.876	0.833*	1.513**
	(0.138)	(0.110)	(0.182)	(0.084)	(0.304)
= 1 if aged 35-39	1.538***	1.563***	0.383***	0.590***	1.230
	(0.158)	(0.137)	(0.095)	(0.060)	(0.240)
= 1 if aged 40-44	1.523***	1.566***	0.404***	0.374***	1.480*
	(0.161)	(0.142)	(0.102)	(0.039)	(0.309)
= 1 if aged 45-49	1.553***	1.652***	0.273***	0.205***	1.311
	(0.157)	(0.143)	(0.073)	(0.022)	(0.252)
= 1 if Fundamental or some high school	0.959	0.931	0.950	1.086	1.086
	(0.079)	(0.067)	(0.162)	(0.081)	(0.168)
= 1 if High school, tech. course, or some college	0.786***	0.809***	0.797	1.216***	1.684***
	(0.057)	(0.050)	(0.122)	(0.079)	(0.243)
= 1 if College or some graduate education	0.542***	0.503***	0.712	1.366***	1.604**
	(0.058)	(0.047)	(0.163)	(0.123)	(0.365)
= 1 if Black	1.061	1.075	1.003	1.043	0.997
	(0.083)	(0.073)	(0.177)	(0.074)	(0.153)
= 1 if Brown	1.093	1.110*	1.195	1.108*	1.604***
	(0.071)	(0.062)	(0.169)	(0.064)	(0.216)
= 1 if other (Natives/Asiatic)	0.864	0.931	1.209	0.708	1.319
	(0.333)	(0.298)	(0.894)	(0.227)	(0.970)
= 1 if Aracajú	1.150	1.414***	1.202	1.662***	0.673
	(0.177)	(0.150)	(0.308)	(0.175)	(0.173)
= 1 if Fortaleza	1.364**	0.855	1.322	1.329***	0.633*
	(0.198)	(0.092)	(0.316)	(0.133)	(0.157)
= 1 if João Pessoa	3.493***	2.048***	1.012	1.141	0.995
	(0.471)	(0.209)	(0.262)	(0.116)	(0.268)
= 1 if Maceió	4.410***	1.981***	1.149	1.058	1.180
	(0.593)	(0.205)	(0.296)	(0.110)	(0.337)
= 1 if Natal	2.416***	1.799***	1.479	1.606***	1.194
	(0.343)	(0.190)	(0.366)	(0.168)	(0.345)
= 1 if Recife	1.780***	1.474***	0.794	1.224**	0.532***
	(0.250)	(0.150)	(0.212)	(0.122)	(0.128)
= 1 if Salvador	4.823***	2.176***	1.373	1.690***	0.521***
	(0.640)	(0.221)	(0.337)	(0.171)	(0.126)
= 1 if São Luís	7.064***	2.714***	1.100	0.866	2.424**
	(0.926)	(0.274)	(0.280)	(0.087)	(0.839)
Log Likelihood	-4,745.74	-5,904.03	-1,440.52	-5,439.55	-1,478.14
Chi-squared	685.38	351.51	106.63	759.18	118.36
N	9,346	9,400	8,434	8,397	9,405

Note. Exponentiated coefficients. Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

In Table 5 we study the correlates of having used long and light-colored clothes, even during hot days in the last 12 months, having used mosquito repellent or insecticides in the last 12 months, having used mosquito protective screens or kept windows closed in the last 12 months, and having dumped standing water where mosquitoes can breed in the last 12 months. As in **Table 4**, we run Logit regressions of each of these variables on age binary indicators (20-24, 25-29, 30-34, 35-39, 40-44, 45-49), educational binary indicators (fundamental, high school, college), race binary indicators (black, brown, other), and state binary indicators.

The results in the Table clearly show that more educated women are more likely to follow preventive measures against the Zika virus. In particular, we observe that women with some high-school or high-school are more likely to report to have used long and light-colored clothes, even during hot days in the last 12 months, (OR=1.48, p-value<0.01; OR=1.63, p-value<0.01) and to have used mosquito repellent or insecticides in the last 12 months (OR=1.46, p-value<0.01; OR=1.91, p-value<0.01) than those with no education; stronger results are found for college-educated women (OR=2.43, p-value<0.01 and OR=2.63, p-value<0.01). Regarding the use of mosquito protective screens or kept windows closed in the last 12 months, college-educated women are more likely to have used them with respect to women with no education (OR=1.58, p-value<0.01). Finally, educated women (some high-school, high-school, and college) are more likely to have dumped standing water where mosquitoes can breed in the last 12 months (OR=1.32, p-value<0.01; OR=1.49, p-value<0.01; OR=1.41, p-value<0.01).

Table 5: Logistic regressions of Preventive/Behavioral Measures/Responses on socio-demographic variables

	Long and light-colored clothes	**Mosquito repellent or insecticides**	**Protective screens or kept windows closed**	**Dumped standing water**
= 1 if aged 20-24	0.931	1.398***	1.370***	1.169*
	(0.131)	(0.147)	(0.161)	(0.111)
= 1 if aged 25-29	0.756*	1.434***	1.124	1.262**
	(0.110)	(0.150)	(0.136)	(0.121)
= 1 if aged 30-34	0.927	1.437***	1.278**	1.384***
	(0.131)	(0.151)	(0.153)	(0.135)
= 1 if aged 35-39	0.986	1.435***	1.213	1.222**
	(0.140)	(0.153)	(0.148)	(0.119)
= 1 if aged 40-44	1.074	1.082	1.034	1.501***
	(0.156)	(0.124)	(0.134)	(0.155)
= 1 if aged 45-49	0.894	1.158	1.049	1.480***
	(0.129)	(0.126)	(0.130)	(0.145)
= 1 if Fundamental or some high school	1.478***	1.460***	1.129	1.325***
	(0.197)	(0.141)	(0.118)	(0.106)
= 1 if High school, tech. course, or some college	1.625***	1.906***	1.178*	1.486***
	(0.192)	(0.160)	(0.107)	(0.105)
= 1 if College or some graduate education	2.433***	2.628***	1.579***	1.410***
	(0.354)	(0.279)	(0.185)	(0.145)
= 1 if Black	1.137	1.061	1.093	1.014
	(0.123)	(0.083)	(0.099)	(0.079)
= 1 if Brown	0.944	0.997	0.999	1.189***
	(0.086)	(0.065)	(0.074)	(0.076)
= 1 if other (Natives/Asiatic)	0.641	0.978	1.004	1.263
	(0.387)	(0.345)	(0.419)	(0.478)
= 1 if Aracajú	0.878	3.134***	1.472**	0.990
	(0.151)	(0.448)	(0.223)	(0.118)
= 1 if Fortaleza	0.543***	1.510***	1.033	0.565***
	(0.100)	(0.227)	(0.160)	(0.062)
= 1 if João Pessoa	0.812	2.294***	1.637***	1.097
	(0.137)	(0.329)	(0.239)	(0.129)
= 1 if Maceió	1.459**	3.939***	2.660***	0.728***
	(0.227)	(0.552)	(0.375)	(0.083)
= 1 if Natal	1.244	2.746***	1.645***	1.399***
	(0.201)	(0.398)	(0.247)	(0.178)
= 1 if Recife	1.405**	4.065***	1.549***	0.868
	(0.212)	(0.555)	(0.224)	(0.098)
= 1 if Salvador	1.248	3.293***	1.173	0.720***
	(0.194)	(0.460)	(0.179)	(0.081)
= 1 if São Luís	0.646**	2.645***	2.145***	1.637***
	(0.112)	(0.370)	(0.302)	(0.207)
Log Likelihood	-2,763.46	-4,610.96	-3,731.85	-4,725.96
Chi-squared	127.37	3,74.47	142.02	227.97
N	9,321	9,367	9,351	9,321

Note. Exponentiated coefficients. Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

4. DISCUSSION

This article provides new information on Zika patterns, fertility and preventive behaviors, and their correlates from a representative sample of women aged 15-49 in the capital cities of the nine states of the Northeast region of Brazil. We find that more educated women are less likely to report suffering from Zika (or its symptoms) and more likely to avoid pregnancy in the last 12 months and being informed about the association between Zika and microcephaly. In addition, more educated women are more likely to follow preventive measures against the Zika virus: having used long and light-colored clothes, even during hot days in the last 12 months, having used mosquito repellent or insecticides in the last 12 months, having used mosquito protective screens or kept windows closed in the last 12 months, and having dumped standing water where mosquitoes can breed in the last 12 months.

Diniz et al (2017) report findings from a national survey in Brazil in June 2016 using mixed methods. They document that 56% of women reported that they had avoided (or tried to avoid) pregnancy because of the Zika epidemic. Our results are quite different. We document that 51% of women report having used any contraceptive (or tried in any way) to delay or avoid getting pregnant in the last 12 months, and that among this 51%, only 18% reported this behavior to be motivated because of the Zika epidemic. The discrepancy between their findings and ours does not seem to be driven by the fact we focus on the Northeast. If anything, the discrepancy is larger in the Northeast: Diniz et al (2017) document that 66% of women reported trying to avoid pregnancy. Perhaps the discrepancy is driven by the different survey designs, including different wording of questions, and more importantly, different sampling procedures. While Diniz et al (2017)'s sample is restricted to literate women aged 18-39 in urban areas, our sample is representative of the Northeast, at least of its urban areas. However, even if we restrict our sample to literate women aged 18-39, the prevalence estimate of women trying to delay or avoid getting pregnant because of the Zika epidemic is 20%.

We see our analysis as an important contribution in trying to describe and understand Zika patterns, fertility and preventive behaviors, and their correlates. This

information, if used effectively, can enhance family planning and reproductive health policies in Brazil, and more generally, in a context of health shocks or epidemics.

Appendix A

Table A1: Prevalence rates and confidence intervals for contraceptive behavior by State capitals

	Woman is currently Pregnant			Woman is currently using contraceptive Methods			Woman was using contraceptive methods due to Zika virus		
	N	**%**	**(95% CI)**	**N**	**%**	**(95% CI)**	**N**	**%**	**(95% CI)**
All capitals	**8,530**	**4.29**	**(3.87 - 4.74)**	**8,492**	**50.88**	**(49.81 - 51.95)**	**4,306**	**18.32**	**(17.18 - 19.51)**
Aracajú	852	4.46	(3.18 - 6.07)	844	56.87	(53.45 - 60.24)	479	15.03	(11.95 - 18.55)
Fortaleza	1,069	5.15	(3.90 - 6.64)	1,061	53.06	(50.01 - 56.10)	554	10.29	(7.89 - 13.12)
João Pessoa	977	3.89	(2.77 - 5.30)	974	48.67	(45.48 - 51.86)	473	10.36	(7.76 - 13.46)
Maceió	868	4.26	(3.02 - 5.83)	867	47.06	(43.69 - 50.44)	408	24.02	(19.95 - 28.47)
Natal	878	5.24	(3.86 - 6.93)	869	55.70	(52.32 - 59.03)	483	15.32	(12.23 - 18.85)
Recife	1,042	2.98	(2.03 - 4.20)	1,041	50.24	(47.16 - 53.32)	522	22.80	(19.26 - 26.64)
Salvador	1,067	4.97	(3.74 - 6.45)	1,067	57.36	(54.33 - 60.35)	612	34.48	(30.71 - 38.39)
São Luís	989	3.94	(2.82 - 5.35)	986	43.71	(40.59 - 46.87)	431	15.08	(11.84 - 18.81)
Teresina	788	3.68	(2.48 - 5.24)	783	44.19	(40.67 - 47.75)	344	12.79	(9.45 - 16.79)

Source: Own elaboration using PCSVDF[Mulher].

Table A2: Prevalence rates and confidence intervals for Zika virus exposure and contraceptive behavior by State capitals

	Woman has been diagnosed with Zika virus			Woman has typical Symptoms of Zika virus			There has been a Zika virus case in the household			Heard/know about Zika virus cases in the community			Household received visits of agents of endemic diseases		
	N	**%**	**(95% CI)**	**N**	**%**	**(95% CI)**	**N**	**%**	**(95% CI)**	**N**	**%**	**(95% CI)**	**N**	**%**	**(95% CI)**
All capitals	**9,451**	**23.40**	**(22.55 - 24.27)**	**9,507**	**34.91**	**(33.95 - 35.88)**	**9,482**	**48.82**	**(47.81 - 49.83)**	**9,174**	**67.36**	**(66.39 - 68.32)**	**9,379**	**58.96**	**(57.96 - 59.96)**
Aracajú	965	11.50	(9.56 - 13.69)	969	32.20	(29.26 - 35.24)	963	32.29	(29.35 - 35.35)	944	45.97	(42.76 - 49.22)	961	66.91	(63.83 - 69.88)
Fortaleza	1,171	13.07	(11.19 - 15.13)	1,178	21.99	(19.65 - 24.46)	1,179	38.00	(35.22 - 40.84)	1,139	47.59	(44.65 - 50.53)	1,172	59.47	(56.60 - 62.30)
João Pessoa	1,092	27.11	(24.49 - 29.85)	1,097	39.47	(36.56 - 42.43)	1,090	50.37	(47.36 - 53.38)	1,042	77.93	(75.28 - 80.41)	1,081	46.44	(43.43 - 49.46)
Maceió	987	32.32	(29.41 - 35.34)	989	38.93	(35.88 - 42.05)	988	61.34	(58.22 - 64.39)	973	84.89	(82.49 - 87.09)	974	37.17	(34.12 - 40.29)
Natal	934	20.56	(18.01 - 23.29)	947	36.33	(33.26 - 39.48)	944	51.38	(48.14 - 54.61)	885	76.16	(73.21 - 78.93)	917	52.24	(48.95 - 55.51)
Recife	1,175	16.17	(14.11 - 18.40)	1,185	32.07	(29.42 - 34.81)	1,182	43.82	(40.97 - 46.71)	1,135	69.96	(67.20 - 72.61)	1,163	58.38	(55.49 - 61.24)
Salvador	1,163	34.57	(31.83 - 37.38)	1,168	41.78	(38.93 - 44.67)	1,169	62.10	(59.25 - 64.89)	1,127	74.98	(72.34 - 77.48)	1,163	67.07	(64.28 - 69.77)
São Luís	1,106	42.04	(39.11 - 45.02)	1,110	45.32	(42.36 - 48.30)	1,107	67.21	(64.36 - 69.97)	1,084	86.62	(84.45 - 88.59)	1,095	69.32	(66.49 - 72.04)
Teresina	858	9.79	(7.88 - 11.98)	864	24.88	(22.03 - 27.91)	860	28.14	(25.16 - 31.27)	845	37.16	(33.89 - 40.52)	853	73.74	(70.65 - 76.67)

Source: Own elaboration using PCSVDF[Mulher].

Table A3: Prevalence rates for behavioral response and knowledge regarding to Zika virus exposure by State capitals

	Use of long and light-colored clothes			Use of mosquito repellent or insecticides			Use of protective screens or kept windows closed			Dumped standing water			Woman knows that Zika virus may cause microcephaly		
	N	**%**	**(95% CI)**	**N**	**%**	**(95% CI)**	**N**	**%**	**(95% CI)**	**N**	**%**	**(95% CI)**	**N**	**%**	**(95% CI)**
All capitals	**9,428**	**9.05**	**(8.48 - 9.64)**	**9,474**	**20.87**	**(20.05 – 21.70)**	**9,511**	**14.10**	**(13.40 - 14.81)**	**9425**	**78.51**	**(77.67 - 79.34)**	**9,511**	**96.13**	**(95.72 - 96.51)**
Aracajú	946	7.93	(6.29 - 9.84)	959	22.73	(20.11 - 25.52)	969	13.28	(11.20 - 15.60)	949	79.66	(76.96 - 82.18)	969	95.36	(93.84 - 96.59)
Fortaleza	1,172	4.86	(3.70 - 6.26)	1,172	12.37	(10.54 - 14.39)	1,178	9.39	(7.78 - 11.20)	1,169	68.86	(66.12 - 71.51)	1,178	95.16	(93.78 - 96.31)
João Pessoa	1,094	7.22	(5.76 - 8.92)	1,099	18.29	(16.05 - 20.70)	1,095	14.66	(12.62 - 16.90)	1,091	81.58	(79.15 - 83.84)	1,095	96.89	(95.69 - 97.84)
Maceió	979	12.16	(10.17 - 14.37)	983	27.67	(24.89 - 30.58)	988	21.77	(19.23 - 24.48)	980	74.29	(71.43 – 77.00)	988	97.37	(96.17 - 98.27)
Natal	939	10.86	(8.94 - 13.03)	940	21.06	(18.50 - 23.81)	942	14.57	(12.38 - 16.99)	933	84.67	(82.20 - 86.93)	942	97.24	(95.98 - 98.19)
Recife	1,176	11.99	(10.19 - 13.98)	1,184	28.13	(25.58 - 30.78)	1,189	13.91	(11.98 - 16.02)	1,169	77.42	(74.91 - 79.78)	1,189	94.20	(92.71 - 95.46)
Salvador	1,164	11.34	(9.58 - 13.30)	1,169	24.47	(22.03 - 27.03)	1,184	11.05	(9.31 - 12.99)	1,168	74.06	(71.44 - 76.55)	1,184	93.83	(92.31 - 95.14)
São Luís	1,103	6.35	(4.98 - 7.95)	1,110	22.16	(19.75 - 24.72)	1,103	18.97	(16.70 - 21.41)	1,108	87.45	(85.36 - 89.35)	1,103	98.82	(97.99 - 99.37)
Teresina	855	9.12	(7.28 - 11.25)	858	9.09	(7.25 - 11.22)	863	9.47	(7.59 - 11.64)	858	80.65	(77.85 - 83.25)	863	97.10	(95.75 - 98.12)

Source: Own elaboration using PCSVDF^{Mulher}.

REFERENCES

de Araújo T.V.B., Rodrigues L. C., Ximenes R. A. A., et al (2016) "Association between Zika virus infection and microcephaly in Brazil, January to May, 2016: preliminary report of a case-control study," *Lancet Infectious Diseases*, 16(12):1356-1363.

Calvet G, Aguiar RS, Melo AS, et al. (2016) "Detection and sequencing of Zika virus from amniotic fluid of fetuses with microcephaly in Brazil: a case study," *Lancet Infectious Diseases*, 16(6):653-660.

Campos G.S., Bandeira A.C. and Sardi S.I. (2015) "Zika virus outbreak, Bahia, Brazil," *Emerging Infectious Diseases*, 21(10):1885-1886.

Diniz D, Madeiros, M, and A Madeiro (2017) "Brazilian women avoiding pregnancy during Zika epidemic," *Journal of Family Planning and Reproductive Health Care*, 43:80.

Fauci AS, Morens DM. (2016) "Zika virus in the Americas — yet another arbovirus threat," *New England Journal of Medicine*, 374:601-604.

Foy BD, Kobylinski KC, Chilson Foy JL, et al. (2016) "Probable non-vector-borne transmission of Zika virus, Colorado, USA," *Emerging Infectious Diseases*, 17: 880-2.

Jouannic JM, Friszer S, Leparc-Goffart I, Garel C, Eyrolle-Guignot D. (2016) "Zika virus infection in French Polynesia," *Lancet*, 387(10023):1051-1052.

MMWR (2016a) "Transmission of Zika virus through sexual contact with travelers to areas of ongoing transmission — continental United States, 2016," *Morbidity and Mortality Weekly Report*, 65: 215-216.

MMWR (2016b) "Zika virus infection among U.S. pregnant travelers — August 2015–February 2016," *Morbidity and Mortality Weekly Report*, 65: 211-4.

Oliveira Melo AS, Malinger G, Ximenes R, Szejnfeld PO, Alves Sampaio S, Bispo de Filippis AM. (2016) "Zika virus intrauterine infection causes fetal brain abnormality and microcephaly: tip of the iceberg?" *Ultrasound in Obstetrics & Gynecology*, 2016, 47: 6-7.

Petersen L.R., Jamieson, D.J., Powers, A.M. and Honein M.A. (2016) "Zika virus," *New England Journal of Medicine*, 374(16):1552-1563.

Rasmussen S.A., Jamieson D.J., Honein M.A., and Petersen, L.R. (2016) "Zika Virus and Birth Defects — Reviewing the Evidence for Causality," *New England Journal of Medicine*, 374(20):1981-1987.

van der Linden V, Pessoa A, Dobyns W, et al. (2016) "Description of 13 Infants Born During October 2015–January 2016 With Congenital Zika Virus I nfection Without Microcephaly at Birth — Brazil," MMWR *Morbidity and Mortality Weekly Report*, 65(47):1343-1348.

Venturi G, Zammarchi L, Fortuna C, et al. (2014) "An autochthonous case of Zika due to possible sexual transmission, Florence, Italy," *Eurosurveillance*, 21(8).

WHO (2015) "Zika virus outbreak in the Americas," *Weekly Epidemiological Records, World Health Organization*, 45(6): 609-616.

Zanluca C., Andrade de Melo V.C., Mosimann A.L.P, dos Santos G.I.V., dos Santos C.N.D and Luz K. (2015) "First report of autochthonous transmission of Zika virus in Brazil," *Memórias do Instituto Oswaldo Cruz*, 110:569-72.