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The fertility-inhibiting effect of mosquitoes: Socio-economic differences in response to the Zika crisis in Colombia

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ABSTRACT

We estimated the impact of the Zika virus outbreak on birth rates and demand for health care services in Colombia. Our analysis exploits the variation in the level of natural protection against mosquito-transmitted diseases across the country. This characteristic induced exogenous variation in Zika incidence, which allows us to construct a control group of municipalities with similar historical fertility trends but with differential exposure to the Zika crisis. We implemented a difference-in-differences model after matching, as well as synthetic control. We found a decrease in birth rates of approx. 10% in the last two quarters of 2019. The impact of the virus was similar irrespective of the women's education level, and we found no discernible impact on teenage pregnancy.

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1. Introduction

In the last several years, the range of the Zika virus (ZIKV) has expanded across several countries throughout the Americas, reaching 86 territories by 2018 (World Health Organization [WHO], 2018). Both the symptoms and diffusion process of ZIKV are similar to those of other vector viral infections, such as dengue or chikungunya. Its main vector, the mosquito *Aedes aegypti*, reproduces easily in urban areas of tropical countries, and, consequently, is very difficult to control through public health authorities (Paniz-Mondolfi et al., 2016). ZIKV closely resembles other urban tropical diseases in terms of clinical management. However, because a link was established between ZIKV-induced fever in pregnant women and neonatal microcephaly during the 2015–16 Latin American epidemic, researchers have argued that the reaction in terms of population behaviour is more similar to fertility-inhibiting responses to diseases such as HIV/AIDS (Johnson et al., 2009; Kaida et al., 2011). Microcephaly is a condition that severely affects brain development and cognitive function (Chang et al., 2016). In response, public health authorities recommended that individuals postpone fertility during the epidemic due to the suspected link between the two diseases.

Although it has been well established that individuals tend to overreact to the emergence of “new” health risks (Viscusi, 1997), it

is important to assess the population response to this call from public health authorities, and to understand whether the nature of the response varied across the socio-economic gradient. Because individual responses depend on a person's expected individual consequences, as well as a range of factors including preferences, access to information, risk attitudes), the cumulative effects of individual behavioural change might have important social implications. In particular, a lower response in socio-economically disadvantaged households could increase health and welfare gaps that already exist in tropical countries (de Andrade et al., 2015; Fotso, 2006; Murray et al., 2013; Sachs and Malaney, 2002). Quintana-Domeque et al. (2018), using a survey from northeast Brazil, found an educational gradient for preventive responses to ZIKV, revealing that more educated women were more likely to report avoiding pregnancy because of the link with microcephaly. In the current study, we extended this work by providing causal estimates of the impact of the ZIKV crisis on fertility in Colombia, another country affected by the outbreak, using the policy recommendation to postpone pregnancies as the initial date of the crisis. In addition, we explored the response variation among different population groups according to educational background and age range.

Understanding the effects of ZIKV in Colombia is of particular interest for several reasons. First, the ecological conditions of the country are relatively diverse. Although Colombia is a tropical country, its geographical features mean that a considerable proportion of its urban centres are naturally protected by being 1800 m above sea level (masl), making these areas unsuitable vector habitats (Padilla et al., 2012). For example, Bogota, the

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capital and most populated city, is out of range for the virus because it is located at 2600 masl (average annual temperature, 14 °C), while Medellin, the second largest city, is susceptible to many tropical disease outbreaks (1500 masl, annual average, approximately 22 °C). Second, Colombia is a middle-income country with high levels of economic inequality, which has major social consequences, such as economic segregation and limited access to public goods. Finally, Colombia has a history of managing outbreaks of diseases that share the same vector.

Our empirical strategy involved comparing inter-annual quarterly variations in birth rates between areas which experienced ZIKV cases in 2016, with areas that could not be affected by the outbreak due to their natural protection by altitude. This strategy allowed us to isolate the impact of the crisis from potential divergent fertility trends between municipalities with and without reports of ZIKV. As affected (*treated*) municipalities, we selected only those municipalities where the primary vector can reproduce (i.e., areas located <1800 masl). As a control group, we selected municipalities where inhabitants were not exposed to the vector, and weighted them in such a way that they resembled pre-outbreak trends of birth rates, birth-rate variation, and fixed characteristics of the affected municipalities (e.g., more urban and closer to major cities). Finally, we estimated the existence of heterogeneous effects according to mothers' education level and age.

We found a sharp decrease of approximately 10% in birth rates during the second half of 2016, which we expected given the announcement of the health authorities' recommendations in December 2016. This is in line with recent studies for the Brazilian case (Quintana-Domeque et al.'s, 2018; Junior and Rasul, 2019). However, our results are based on the presence of Zika cases, without any differential effect by the local intensity of the outbreak. This finding is in accord with the response patterns associated with HIV/AIDS, which have also been reported to induce an inhibition of fertility, although the reduction was considerably smaller. In contrast, Kaida et al. (2011) found that HIV-positive women were almost 60% less likely to report childbearing intentions compared with HIV-negative women in South Africa. In the case of HIV patients, AIDS may reduce desired family size and the observed demand for children for individual women because of its impacts on current household income and the labour

participation for surviving adults (National Research Council, 1998), and also because of delayed onset of sexual relations, reduced premarital sexual relations, and increased use of contraceptive methods (Ploem and Byers, 1997; Reitman et al., 1996). Moreover, Johnson et al. (2009) proposed that knowledge of one's own HIV status is associated with limited childbearing.

Our estimates did not allow us to fully assess Quintana-Domeque et al.'s (2018) observation with respect to the heterogeneity of the impact according to the level of vulnerability of women. First, we did not find differential responses by education level. Second, with respect to the age of the mother, although we observed larger estimated reductions for non-teenage women, the precision of the estimates did not allow us to reject a similar impact between age groups.

This paper is organised as follows: Section 2 briefly describes the geographical characteristics in Colombia that make it a good case study for behavioural responses to the ZIKV outbreak. Section 3 describes the data sources, limitations, and empirical strategies we adopted to obtain an unbiased causal effect of ZIKV on fertility behaviour. Section 4 presents our results, and the final section discusses our findings and outlines our main conclusions.

2. Context

Individuals react differently to the presence of external health shocks according to their degree of risk aversion and the probability of each possible resulting outcome (Viscusi, 1997) because each person rates their own risks across a range of health dimensions. There are many reports of behavioural responses to viral outbreaks in the literature (Adda, 2007, 2016; Barron et al., 2019). These responses are often influenced by the ways in which mass media delivers information about new outbreaks (Collinson and Heffernan, 2014; Yan et al., 2016). In the Americas, the threat of new viruses and their interactions with existing diseases (co-infection and co-circulation) is increasing, given the greater mobility of populations and the increasing rate of urbanisation (Paniz-Mondolfi et al., 2016).

The ZIKV outbreak generated a massive response from both public health authorities and mass media. While the illness itself is not particularly severe or costly in terms of healthcare (although a link with the uncommon but severe Guillain-Barre Syndrome has

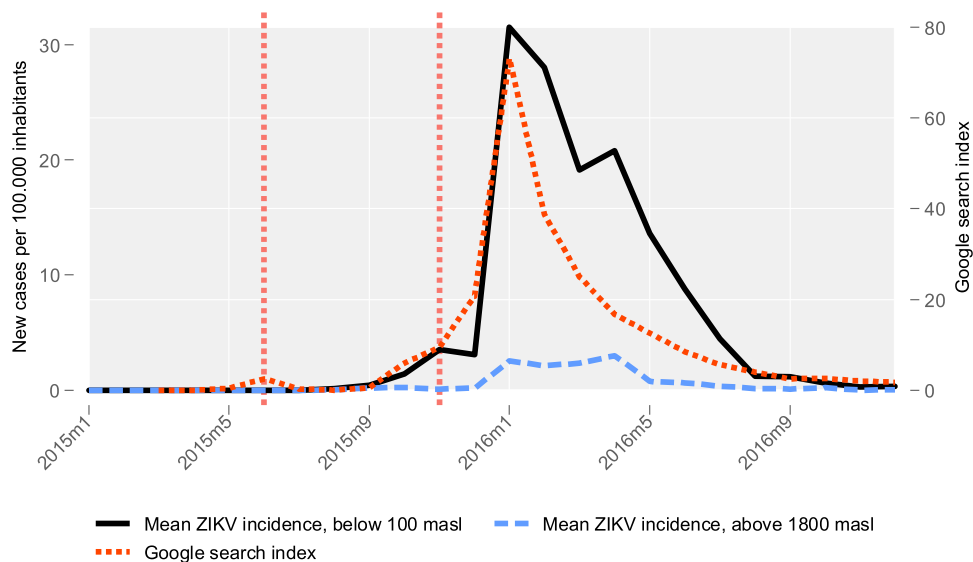


Fig. 1. Zika virus monthly incidence and Google searches for “Zika virus” and “microcephaly”.

Notes: Vertical lines represent (i) June 2015: Ministry of health alerts of the arrival of ZIKV to Colombia, (ii) November 2015: first news regarding the potential link between ZIKV and microcephaly