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Fertility Attitudes amid Successive Novel Infectious Disease Outbreaks

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Introduction

The Covid-19 pandemic is history's most recent example of how epidemics of novel infectious diseases can produce a great deal of uncertainty that severely ruptures the social order (Strong 1990). Although uncertainty permeates life in the modern world (Beck 1999; Giddens and Pierson 1998; Halpern 2005), novel infectious disease outbreaks exacerbate this uncertainty by disturbing assumptions of the known universe of risk and disrupting well-known strategies for managing everyday life (Strong 1990). Because of these disruptions, such outbreaks induce periods of chaos during which routine social responses might be unavailable and information is limited, at least until knowledge about the disease and measures for controlling it are developed and disseminated. Until then, the uncertainty brought about by novel infectious disease outbreaks creates a vacuum of social norms that might force people to devise new strategies of action at the personal level. When defining new strategies, people might make use of information about and/or individual or collective memory of the experiences of living through a previous epidemic to inform their thinking and attitudes about the current outbreak, even if the disease context is different. In this way, epidemics can leave lasting social-psychological imprints, or scarring effects, that emerge as a frame of reference for navigating a subsequent epidemic of a different yet equally novel disease.

To test this assumption, we examine attitudes about a major life decision—childbearing—during the Covid-19 pandemic among women of reproductive age, who less than three years before the start of the pandemic in 2020 lived in the epicenter of another novel infectious disease outbreak: the Zika virus epidemic of 2015-2017. Integrating a sociology of epidemics framework with an innovative survey experiment from a sample of 3,998 women in Pernambuco, the Brazilian state hardest hit by the Zika epidemic, we examine whether and how a reminder of the reproductive consequences and uncertainty of the Zika epidemic shape women's attitudes toward childbearing during the Covid-19 pandemic.

Although the uncertainty brought on by epidemics can infiltrate seemingly all aspects of life, we examine attitudes toward childbearing for three important reasons. First, the decision about whether to have children at all or when to have a child is central in many women's lives and is time-constrained by the biological bounds of women's reproductive life span. In Brazil, most women report that they want to have a child at some point in their lives, but at the same time, nearly half of

pregnancies in Brazil are unintended (Lee et al. 2014), underscoring the importance of the timing dimension of childbearing intentions. Second, childbearing, by its nature, is rife with personal uncertainty. Pregnancy, childbirth, and childrearing can bring unknown health, social, and economic risks to the mother and baby. As such, attitudes toward childbearing can provide an important lens into how women are thinking about navigating personal uncertainty during periods of heightened societal uncertainty brought on by novel infectious disease outbreaks. Third, during the Zika epidemic, navigating childbearing decisions became especially fraught once scientists established that the ZIKV can cause serious birth defects including microcephaly and other types of congenital Zika syndrome (CZS) (Brasil et al. 2016; Ramussen et al. 2016).

Although scientific knowledge of the health impacts of Covid-19 on pregnant women and birth outcomes is still emerging, we now know that pregnant women are at higher risk of developing severe illness from Covid-19 (CDC 2020), and there is evidence of increases in stillbirth and preterm birth during the pandemic (Khalil et al. 2020). The vacuum of knowledge about Covid-19 and pregnancy early on in the pandemic may have triggered the recent collective memory of the severe risks of Zika to fetal health, which in turn might consciously or unconsciously guide women's thinking about childbearing during the Covid-19 pandemic.

This study makes three important contributions to the understanding of the sociology of epidemics. First, by focusing on the compounding effects of successive outbreaks of novel infectious diseases, our work highlights how the experience of living through the uncertainty and risks associated with one epidemic can have lingering effects that shape attitudes during a subsequent epidemic. The compounding effects of consecutive outbreaks are particularly important given the uptick in novel infectious disease outbreaks and a predicted increase in pandemic frequency, which together suggest that much of the world is now at greater risk of experiencing back-to-back infectious disease outbreaks (Baqui et al. 2020). Second, our survey experiment provides an innovative methodological approach for operationalizing uncertainty. By randomly assigning half of our survey respondents be prompted to recall the uncertainty and severity of Zika, we provide institutional memory on the previous novel infectious disease crisis as an anchor that shapes attitudes during a moment of vaccum of knowledge and information. Because the survey was fielded in the six months of the very first wave of the Covid-19 pandemic, there is high heterogeneity in the amount of information available on the disease infection and transmission. We

argue that, as the new outbreak runs its course, there is less need of institutional memory from previous epidemics.

We find that women who are reminded of the degree of uncertainty that permeated the beginning of the Zika epidemic and the severity of the consequences of the virus, particularly in Pernambuco, are more likely to agree that women should avoid childbearing during the Covid-19 pandemic. This suggests that more than three years after the Zika epidemic ended, the specter of Zika remains salient and influences how women think about childbearing during public health crises.

Conceptual Framework

Sociology of Epidemics

An important characteristic of novel infectious disease epidemics is the widespread fear that the disease may be transmitted through several different routes, as well as the consequences for specific groups. There is a great deal of uncertainty and fear regarding prevention and infection in the early stages of a novel infectious disease outbreak. This so-called epidemic of fear is matched by an epidemic of interpretation (Strong 1990). When an epidemic is novel, a hundred different theories may be produced about the origins of the disease and its potential effects, with escalating confusion and uncertainty. Thus, when a disease is new and there are no routine collective ways of handling it, a thousand different ways of dealing with it may appear, drawn from every part of society, each with different strategies for containing and controlling the epidemic.

We extend this framework to suggest that people use recent experiences with novel infectious disease outbreaks as anchors to shape their attitudes during a subsequent novel disease crisis. This hypothesis becomes even more relevant in the context of the frequent recent resurgence and emergence of infectious disease outbreaks. The frequency of emergence and re-emergence of novel infectious disease epidemics makes it more likely that people will use information on previous recent epidemics to help shape attitudes when faced by a new novel infectious disease outbreak.

Literature Review

Epidemics and Fertility

There is a great deal of research on how fertility preferences, intentions and behaviors vary across the life course, and respond to shifting circumstances such as relationships, family structure and structural conditions (Hayford 2009). Structural conditions such as epidemics, in particular, may shift fertility preferences, intentions and behaviors through biological and behavioral components, affecting these processes both directly and indirectly. The direct effects of epidemics on fertility can happen via mortality and migration if areas affected by epidemics experience out migration or high mortality levels, for example. Structural conditions may also change fertility preferences, intentions and behaviors through behavioral mechanisms particularly if such conditions change expectations about the future, economic circumstances, and the cost of bearing children, for example (Becker and Lewis, 1973; Hayford, 2009; Jones et al., 2015; Johnson-Hanks et al., 2011; Preston, 1978; Schultz, 1997).

The effects of structural conditions on fertility attitudes have been less studied. Most of the research looking at fertility attitudes has centered around attitudes regarding adolescent fertility or unmarried fertility. At the same time, some of the mechanisms that explain changes in fertility preferences, intentions and behaviors can also affect fertility attitudes.

Risk insurance frameworks of fertility, f or example, suggest that childbearing is used to diversify risk as people aim at minimizing uncertainty by planning a number of surviving healthy children (Cain 1983; Caldwell et al 1992; LeGrand et al. 2003; Randall and LeGrand 2003; Robinson 1986; Sandberg 2006). These "insurance" frameworks suggest that people would prefer to bear more children to account for low child survival rates (Cain 1981; Montgomery and Cohen 1998; Paloni and Rafalimanana 1999; Portner 2007; Preston 1978; Rosenzweig and Schultz 1983). Proponents of this view might argue that if people perceive Zika and Covid-19 as associated with infant mortality, they might believe that women should get pregnant and bear more children during these crises as a way to ensure that at least some would survive and be healthy.

Following similar rationales, some have argued that during periods of crisis, childbearing may be seen as a mechanism to reduce uncertainty (Friedman, Hechter and Zanazawa 1994). In situations of normalized structural uncertainty and risk, childbearing could be seen as a buffer. In fact, childbearing has been found as a strategy to deal with the uncertainty regarding child survival generated by the HIV epidemics in Malawi (Trinitapoli and Yeatman 2011; Trinitapoli and

Yeatman 2018) and among minority women in the U.S. (Burton and Tucker 2009; Edin and Kefalas 2005).

Others have suggested that a desire to replace lost children is the key motivation behind how structural crises affect fertility (Nobles et al 2015). Fertility increases can stem from a desire to rebuild communities, replace lost children (Nobles et al. 2015), and renew investments in family in response to events highlighting human frailty (Fritsche et al. 2007; Nakonezny et al. 2004; Rodgers et al., 2005). Wars and famines have also led to declines in fertility, overall and for specific areas or subgroups (Agadjanian and Prata 2002; Blanc 2004; Caldwell 2004; Heuveline and Poch 2007; Lindstrom and Berhanu 1999; Hill, 2004).

Declines in fertility during economic downturns, on the other hand, likely occur as a result of lower economic prospects relative to expected aspirations, as economic crises are often associated with increasing unemployment and lower income (Sobotka et al. 2011). Periods of economic shocks also lead to anxiety and stress such that the expectation of lower life prospects and well-being might lead to childbearing re-evaluations.

In addition to economic downturns, environmental shocks have been associated with declining fertility. Scholars have documented these patterns following high-severity storm advisories (Evans 2010) hurricanes (Portner 2008) and earthquakes (Finlay 2009; Hosseini-Chavoshi and Abbasi-Shavazi 2013). Similarly, live birth rates have risen and then fallen as a long-term response to hurricane Hugo, suggesting that people change childbearing attitudes and behaviors in response to life-threatening shocks (Cohan and Cole 2002).

Important for this research, past studies have reported declines in fertility related to epidemics and disease burdens. For example, people feel constrained to have fewer children by the responsibilities of caring for AIDS orphans (Rutenberg, Biddlecom, and Kaona 2000). The prospective burden of caring for a child with microcephaly or other congenital Zika syndrome may have been a motivation for pregnancy avoidance during the Zika epidemic, and a similar rationale is ` likely to have played during the Covid-19 pandemic. In the case of the pandemic, however, the mechanisms are more dramatic due to potential loss of available child care and caring for elderly parents.

This same body of research also suggests differential effects of structural crises on fertility depending on their magnitude and severity. For instance, low-severity storm advisories are

associated with higher fertility change while high-severity-advisory storm advisories are associated with fertility declines (Evans 2010). Similarly, Agadjanian and Prata (2002) found more pronounced declines in areas more-affected by the war in Angola and Hauveline and Poch (2007) estimated a sharp decline in fertility during the Khmer Rouge regime in Cambodia followed by a rebound.

More recent work has explored how differing degrees of exposure to natural disasters may cause different magnitudes of fertility responses. Nobles and colleagues (2015) found that Indonesian communities experiencing greater mortality after the 2004 Indian Ocean tsunami saw an uptick in fertility rates compared to areas that saw no deaths. Berhman and Weitzman (2016) demonstrated differences in current and unwanted pregnancies according to levels of disruption by the 2010 earthquake in Haiti.

These crises differ in important ways from exposure to the severity of the Zika and Covid-19 outbreaks, most importantly in the duration of risk exposure and the degree to which individuals can take action to protect themselves. Even so, they provide a background for the perspective that fertility responses may vary according to exposure to a gradient of risk. Both Zika and Covid-19 are spatially variegated. Because of differences in the severity of each of these outbreaks across geographical regions, their effects might differ depending.

Fertility Attitudes

Little is known, however, about how *norms* regarding fertility change in response to structural shifts brought about by epidemics. It is possible that some of the mechanisms described above that determine fertility preferences, intentions and behaviors also explain fertility attitudes in general.

We follow a more recent line of inquiry that focuses on fertility attitudes and how orientations favoring or contesting childbearing are part of broader cultural schemas (Johnson-Hanks et al. 2011). Beliefs about having children are understood as part of an interconnected set of beliefs about family, work, religion, and other domains (Johnson-Hanks et al. 2011). As such, attitudes about fertility during epidemics may reflect not only an assessment of the costs and benefits of childbearing, but also a more nuanced understanding of the meaning of childbearing in ways that it is connected to larger social meanings.

Back-to-back novel infectious disease outbreaks: Zika and Covid-19

The ZIKV epidemic brought about devastating consequences for child development and overwhelmed families in affected areas (Diniz 2017). Less than three years after the end of the ZIKV epidemic, on March 11, 2020, the World Health Organization (WHO) declared the coronavirus outbreak a pandemic.

Brazil was the epicenter of the ZIKV (Zika Virus) epidemic and the devastating consequences of its accompanying surge in congenital Zika syndrome (CZS) in 2015-2017. 3,474 confirmed cases of newborn ZIKV-related growth and developmental abnormalities were confirmed in the country (Brasil 2019). The threat of congenital malformations owing to prenatal ZIKV infection have led some women to delay childbearing or to terminate pregnancies (Aiken et al. 2016), with documented significant declines in fertility (Marteleto et al. 2020; Rangel et al. 2020).

Brazil is now one of the countries most afflicted by the Covid-19 pandemic. At the time of writing (April 2021), Brazil's number of confirmed cases is second only to that of the United States (Johns Hopkins University Coronavirus Resource Center 2021), with more than 369,000 deaths due to Covid-19, and no sign of deacceleration[5].

Early on in the Zika crisis there was a lot of uncertainty about whether the ZIKV could be transmitted from a pregnant woman to her fetus, and whether the ZIKV was harmful to babies in other ways. The release of scientific information during the pandemic is no different from the ZIKV epidemic in that knowledge dissemination follows the course of knowledge production.

The specific risk of Covid-19 to pregnant women and their infants, who are typically high-risk groups during infectious disease threats, is not yet entirely clear (Kimberlin and Stagno 2020). Early in the pandemic, evidence suggested that pregnancy posed no greater risk in terms of catching COVID-19 or suffering worse symptoms than the general population. In June 2020, however, the U.S. Centers for Disease Control added pregnancy to the list of health conditions that make COVID-19 patients more likely to be hospitalized and admitted to the intensive care unit. There is also evidence of increased stillbirths and preterm deliveries during the pandemic though it is not entirely clear whether these increases result from SARS-CoV-2 infection or indirect effects such as reluctance to seek medical care or stress (Khalil et al. 2020).

Hypotheses

We advance four hypotheses.

1. Uncertainty during a recent epidemic shapes childbearing attitudes throughout a successive novel infectious disease epidemic (Model 1 ~ Table 2);
    - Uncertainty during a recent epidemic is associated with attitudes *avoiding* childbearing during a successive novel infectious disease epidemic (Model 1 ~ Table 2);
2. The effect of uncertainty during a recent epidemic on childbearing attitudes throughout a successive novel infectious disease epidemic persists despite virus knowledge and severity (Model 2 ~ Table 2);
    - Virus knowledge over time is associated with attitudes *favoring* childbearing throughout the current epidemic (Model 2 ~ Table 2);
    - Severity throughout the current epidemic is associated with attitudes *avoiding* childbearing throughout the current epidemic (Model 2 ~ Table 2);
3. As the new epidemic intensifies, the less important uncertainty in the previous epidemic becomes in shaping childbearing attitudes (Model 3 ~ Figure 1).
4. As virus knowledge becomes available over time, the less important uncertainty in the previous epidemic becomes in shaping childbearing attitudes (Model 4 ~ Figure 2).

Data and Methods

Data & Analytical Sample

Between May and September 2020, the Decode Project conducted a 25-minute phone interview with women ages 18 and 34 in the state of Pernambuco, Brazil. The survey included questions about family and household background, current and prospective reproductive health and childbearing measures, and questions on Zika and Coronavirus knowledge and perceptions.

Respondents were recruited using a Random Digit Dialing technique and interviews were conducted through Computer Assisted Telephone Interviewing (CATI). We used a list of randomly-generated cell phone numbers from Brazil's governmental concession of cell phones with more than 19 million numbers to recruit a probabilistic sample of women ages 18-34 living in Pernambuco, in the mesoregions of Agreste, Mata and Metropolitan Area of Recife, the state capital. Importantly, 94% of women in this age group own a cell phone in the metropolitan region of the capital, Recife, and in the overall state, respectively.

Measures

Dependent Variables

At the end of the survey, we asked respondents their level of agreement with two statements (variables Y_j): Women should avoid childbearing during the ZIKV epidemic ($j = 1$); and Women should avoid childbearing during the Covid-19 pandemic ($j = 2$). The answers ranged in Likert scale with 5 categories (k): totally disagree ($k = 0$), disagree ($k = 1$), undecided ($k = 2$), agree ($k = 3$), and totally agree ($k = 4$).

Independent Variables

A binary indicator of exposure to the survey experiment prompt about the uncertainty and severity of Zika during the pandemic served as our focal independent variable. Immediately prior to be asked the aforementioned attitudinal questions, interviewers read the following statement (statement A) to half of the randomly-assigned respondents:

> "Between 2015 and 2017, Brazil went through the Zika virus epidemic. To finalize the questionnaire, I will read a few sentences on this subject and I would like you to tell me, for each of them, if you totally disagree, partially disagree, agree in part, or totally agree."

The other half of respondents, selected randomly, received the following statement (statement B), which included three additional sentences about the Zika epidemic:

> "Between 2015 and 2017, Brazil went through the Zika virus epidemic. *There was a lot of uncertainty in the beginning of the epidemic whether Zika could be transmitted from the mother to the fetus or if it could cause any health issue for the baby. Scientists eventually discovered that Zika during pregnancy could cause microcephaly or other diseases in the baby. The state of Pernambuco presented the most cases of babies with microcephaly in Brazil.* To finalize the questionnaire, I will read a few sentences on this subject and I would lie you to tell me, for each of them, if you totally agree, partially agree, partially disagree, or totally disagree."

We designed the text of the Zika statement B to provide respondents with information on the high uncertainty early on in the ZIKV epidemic about whether the virus could be transmitted in-utero, and whether it could cause health issues for newborns. The statement states that, eventually, scientists confirmed that Zika during pregnancy could cause microcephaly and other

fetus malformation, and that the state of Pernambuco presented the highest rate of microcephaly in the country.

Our main independent variable is a binary variable which assumes 1 when respondent was randomly assigned to receive information about the uncertainty, risks, and consequences of ZIKV (Zika Statement B) and 0 when respondent was randomly assigned not to receive information about the uncertainty, risks and consequences of ZIKV (Zika Statement A).

There are two additional independent variables of interest. The first variable is month of interview, a proxy of the scientific knowledge available regarding the novel virus SARS-Cov-2. The omitted category is May and June, and additional months of interview are July, August and September. The second independent variable of interest is the cumulative number of deaths in respondent's specific municipality of residence in the month of interview. Our control variables include education, age, income, race, parity, relationship status, and religion.

Methods

We regressed the three ordinal outcomes of interest using ordered proportional-odds logit (POL) models. The dependent variable in the POL model is the log odds (logit) of $P(Y_j \leq k)/P(Y_j > k)$. Our POL models assume that the impacts of the regressors (vector $\mathbf{x}$) on the logit is the same for all functions of k. In other words, our models are given by $log\left(\frac{P(Y_j \leq k)}{P(Y_j > k)}\right) = \alpha_j + \mathbf{x}'\boldsymbol{\beta}$, where the vector of coefficient $\boldsymbol{\beta}$ is constant, no matter the value of k.

Results

Table 1 shows the distribution of our analytical sample by the main variables of interest. The majority of respondents report that they believe that women should avoid a pregnancy during the Zika epidemic (75.2%) and the Covid-19 pandemic (79.3%).

In general, the less educated, poorest and oldest women are more likely to favor childbearing avoidance during the ZIKV epidemic and the Covid-19 pandemic.

Table 2 shows the results of models with childbearing attitudes as main dependent variables—favoring childbearing avoidance during the Zika epidemic (columns 1 to 4) and favoring childbearing avoidance during the Covid-19 pandemic (columns 5 to 8).

Column 1 to 4 shows results for models including the controls and our main independent variable representing the Zika statement B.

Columns 4 to 8 present models with the dependent variable favoring childbearing avoidance during the Covid-19 pandemic. The Model in Column 1 shows that information on the initial uncertainty of ZIKV's consequences for fetus and newborns during the Zika epidemic influences childbearing attitudes during the Covid-19 pandemic. The coefficient for the statement variable suggests that the uncertainty and severity of the ZIKV epidemic is associated with the idea that women should avoid childbearing during the Covid-19 pandemic (Hypothesis 1).

In Column 2 we add variables representing the severity of the ZIKV and the Covid-19 outbreaks in the month of interview in each respondent's municipality of residence. The addition of the severity of each outbreak does not alter the significance of uncertainty during the Zika epidemic in shaping childbearing attitudes throughout the pandemic (Hypothesis 2).

Results in Column 2 also show that respondents are less likely to agree with the idea of avoiding childbearing during the pandemic as more scientific information on SARS-Cov-2 becomes available than in the early months of the pandemic (Hypothesis 2.1). The month of interview reflects the knowledge available regarding the consequences of Covid-19, particularly fetal transmission of the virus. Respondents who answered the survey in August or September are less likely to report that women should avoid pregnancy during the Covid-19 pandemic, reflecting that there was more information available then than early on in the pandemic, in May or June.

The coefficients representing the severity of the epidemic shows that the higher the number of cumulative deaths in the month and municipality of respondent's residence, the more likely respondents are with favoring avoiding childbearing during the Covid-19 pandemic (Hypothesis 2.2).

Column 7 shows models with interactions between the variable measuring the Zika statement and the knowledge available on SARS-Cov-2 infection and transmission (month of interview), with marginal effects displayed in Figure 1 (Hypothesis 3). Figure 1 shows that, as the pandemic progressed and scientific knowledge was created and made available to the general public, the less important uncertainty in the previous epidemic became in shaping childbearing attitudes.

Column 8 shows models with interactions between the variable measuring the Zika statement and the severity of the pandemic—cumulative deaths in the month of interview in each respondent's municipality of residence—with marginal effects displayed in Figure 2 (Hypothesis 4). Figure 2 shows that, as the pandemic became more severe, the less important uncertainty in the previous epidemic became in shaping childbearing attitudes.

Discussion and Conclusions

Novel infectious disease epidemics exacerbate everyday life uncertainty by disturbing social norms and inducing periods of chaos during which familiar social responses are unavailable and information is limited. We argue that, in such periods of disorder and confusion, people might use memory from recent novel disease epidemics as an anchor to navigate the unknown aspects of the current crisis. To test this hypothesis, we designed and implemented an experiment as part of a unique data collection that took place in the early stages of the Covid-19 pandemic.

We focus on the case of Brazil because the country was recently affected by another novel infectious disease epidemic, the Zika epidemic, and is an epicenter of the Covid-19 pandemic. While Covid-19 and ZIKV are distinct viruses with different modes of transmission, symptoms, and effects, the novelty of such diseases generates similar uncertainty over infection risks and a chaotic prevention response, especially for typically high-risk groups like pregnant people and their babies. We used data from 3,998 women ages 18 to 34 and logistic regression models to examine the scaring effects of epidemics on attitudes.

Our study contributes to the theoretical and empirical literature in at least four key ways. First, our findings show that information on the severity and uncertainty faced during a previous epidemic—Zika epidemic—are related to attitudes favoring childbearing avoidance during both Zika and Covid-19 crises. Fertility attitudes are dynamic processes that are influenced by structural conditions such as epidemics. Our findings show that such effects of epidemics on fertility attitudes become scars that go beyond a single epidemic. During times of vacuum of knowledge that characterize novel infectious disease outbreaks, people use information on a recent similar outbreak to inform their childbearing attitudes. For Brazilian women of childbearing age, they are changing whether they favor childbearing when another novel infectious disease epidemic emerges.

We also find that the scars of the Zika epidemic on childbearing attitudes during the pandemic persist even when more information about Covid-19 becomes available. Our methodological design, with interviews taking place over six months early on in the pandemic, allows us to measure heterogeneity in the availability of scientific knowledge. The more information available, the less women agreed with childbearing avoidance. That month of interview is not important for childbearing attitudes during the Zika epidemic while it is during the Covid-19 pandemic strengthens this conclusion. We contend that this is the case because three years after the end of the Zika epidemic and after massive information circulated, women in Brazil likely have enough knowledge about the risks of ZIKV on childbearing in a way that month of interview is unimportant. In other words, by now there is little uncertainty regarding the effects of the ZIKV on pregnant women, fetus and newborns. In addition, the ways to prevent *Aedes Aegypti* infestation and bites (ZIKV's main vector) are widely mastered by the general population (our data points to that). Providing additional support to the idea that women had already received enough information regarding Zika, Zika outbreak severity in the municipality of residence is unrelated to shaping childbearing attitudes related to Zika.

This is not the case for childbearing attitudes during Covid-19. Our third contribution is to show the relevance of outbreak severity in the municipality of residence for measuring its impact on shaping attitudes. That is, as the number of deaths due to Covid-19 accumulate at the local level throughout the pandemic, people favor childbearing avoidance. We interpret this as a gradient of the effects of mortality on fertility.

Fourth, our analysis shows the value of examining attitudes. When examining fertility responses throughout periods of crises such as the ZIKV and Covid-19, it is important to consider not only overall trends that reflect *whether* women avoided childbearing, but also to examine *whether* they favored childbearing (or not). Structural conditions affect fertility in dynamic ways, and we show that this is the case for fertility attitudes as well.

Given that Brazil is one of the world's most unequal countries and that the pandemic has exacerbated social and economic inequities, it is likely that such disparities also condition fertility attitudes during this period. For example, with respondents of high SES believing that women should avoid childbearing during epidemics because of health concerns, but not aligning with their individual behaviors or intentions.

Early on in the Zika crisis, it was unclear whether a fetus in utero could get the virus. Later, fetal transmission was confirmed – along with the risk of severe abnormalities at birth. The uncertainty brought on by the Zika epidemic has already left imprints on fertility in Brazil (Marteleto et al 2017; Marteleto et al. 2020; Rangel et al. 2020; Castro et al. 2018). Now, just a few years later, COVID-19 is bringing similar uncertainty. Considering that the spread of Covid-19 through Brazil has accelerated in 2021 and that large proportions of women favor childbearing avoidance during these crises, the pandemic is likely to be even more consequential for fertility trends, accentuating socioeconomic and racial inequities.

The mechanisms driving the effects of the pandemic on fertility go beyond the uncertainty that has permeated childbearing during these outbreaks. Severe interruptions in health care access, loss of child care provision, social isolation, and economic and political crises are likely to indirectly affect fertility in Brazil during this period as well (in addition to the direct effect of Covid-19 mortality). Yet, the uncertainties generated by novel epidemics have tangible consequences for fertility that have been even more dramatic in Brazil because of the back-to-back timing of ZIKV and Covid-19.

Combined, our findings advance the idea of a sociology of epidemics as a framework for understanding the effects of recurrent epidemics that now characterize our lives. By showing how people use recent experiences with novel infectious disease outbreaks as anchors to shape attitudes during a subsequent novel disease crisis, we contend that the effects of epidemics transcend a single outbreak, leaving scars that go beyond mortality and health. Shaping attitudes is another facet of the long reach that successive epidemics have on how we live.

Tables & Figures

Table 1. Mean and Standard Deviation. Brazil, DeCodE ZC, 2020

Variable	Mean	Std. Dev.
Women should avoid childbearing during the ZIKV epidemic	0.752	0.432
Women should avoid childbearing during the Covid-19 pandemic	0.793	0.405
Zika Statement B	0.499	0.500
Maximum rate Zika, Chikungunya, Dengue cases (/1,000)	17.563	12.353
Cumulative rate of Covid-19 deaths (/1,000) up to interview month	1.008	0.293
Education		
Primary or less	0.066	0.248
Secondary	0.467	0.499
Some college	0.371	0.483
Post-graduation	0.095	0.294
Monthly Per Capita Income		
<1 MW	0.251	0.433
1-3 MW	0.408	0.492
>3 MW	0.229	0.420
Age		
18-26	0.415	0.493
27-35	0.585	0.493
Race/color		
White/Asian	0.332	0.471
Black	0.150	0.358
Brown	0.518	0.500
Religion		
Catholic	0.363	0.481
Protestant	0.160	0.367
Pentecostal	0.198	0.399
Others	0.279	0.448
Living arrangements		
Live with partner/spouse	0.478	0.500
Month interview		
June	0.208	0.406
July	0.144	0.351
August	0.154	0.361
September	0.494	0.500
[N]	3,802	

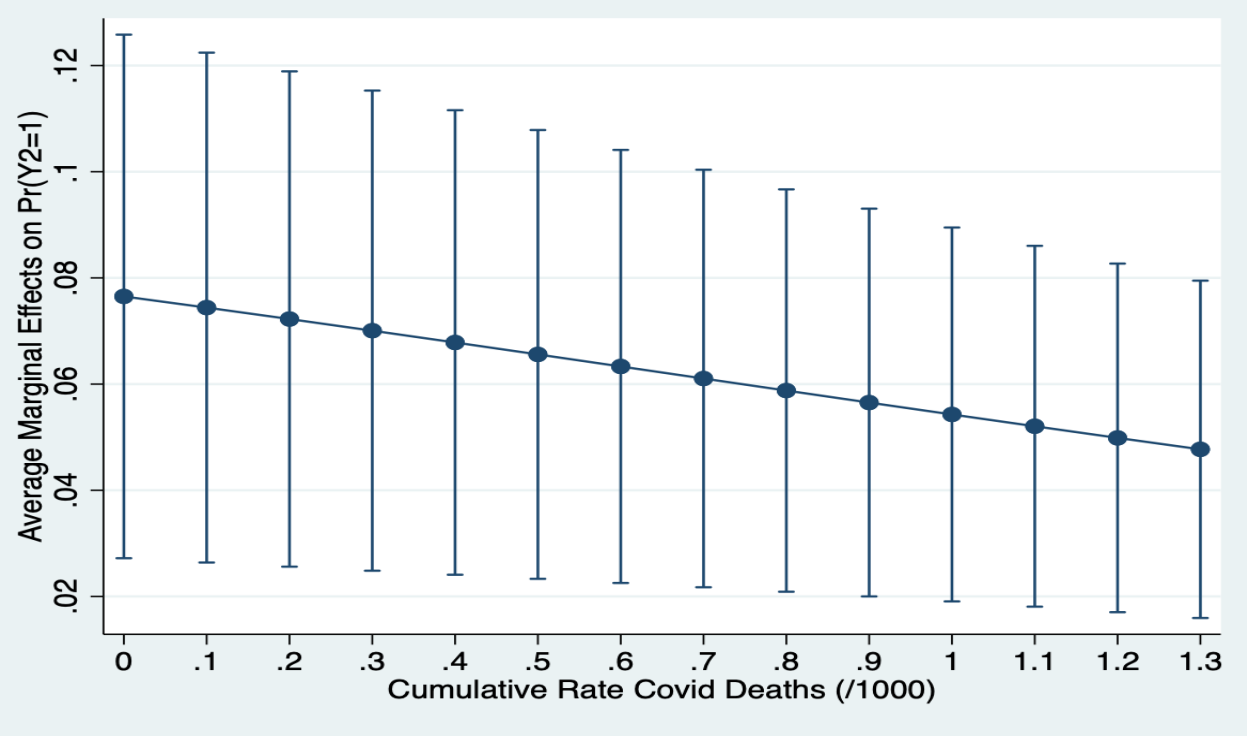
Source: DeCodE ZC, 2020

Table 2. Estimates of Logistic Models for the Dependent Variables: Women should avoid childbearing during….

	Zika Epidemic				Covid-19 Pandemic			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Zika Statement B	0.227*	0.226*	0.443	0.243	0.377**	0.384**	1.176**	1.184***
	(0.114)	(0.114)	(0.374)	(0.265)	(0.120)	(0.121)	(0.386)	(0.283)
Arbovirus Annual Rate/1,000		0.004	0.004	0.004		0.000	0.000	-0.001
		(0.006)	(0.006)	(0.006)		(0.005)	(0.005)	(0.005)
Cum. Covid-19 Deaths/1,000		0.156	0.273	0.157		0.675*	1.073***	0.691*
		(0.267)	(0.314)	(0.268)		(0.271)	(0.318)	(0.272)
Cum Covid-19 Deaths × Statement B			-0.242				-0.889*	
			(0.347)				(0.361)	
Statement B × Month Interview								
July				0.263				-1.151**
				(0.409)				(0.430)
August				0.014				-0.874*
				(0.406)				(0.431)
September				-0.122				-0.927**
				(0.305)				(0.326)
Education								
Secondary	-0.258	-0.288	-0.288	-0.272	0.485	0.405	0.405	0.398
	(0.260)	(0.260)	(0.260)	(0.259)	(0.256)	(0.252)	(0.252)	(0.252)
Superior	-0.646*	-0.662*	-0.664*	-0.647*	0.035	-0.015	-0.025	-0.028
	(0.270)	(0.270)	(0.270)	(0.269)	(0.265)	(0.261)	(0.260)	(0.259)
Monthly Per Capita Income								
1-3 MW	-0.321*	-0.330*	-0.330*	-0.334*	-0.512**	-0.551**	-0.557**	-0.541**
	(0.155)	(0.156)	(0.156)	(0.155)	(0.171)	(0.172)	(0.172)	(0.170)
>3 MW	-0.365*	-0.379*	-0.377*	-0.383*	-0.828***	-0.901***	-0.898***	-0.892***
	(0.178)	(0.179)	(0.180)	(0.179)	(0.189)	(0.190)	(0.192)	(0.189)
Missing	-0.331	-0.333	-0.335	-0.334	-0.436	-0.467	-0.482*	-0.485*
	(0.217)	(0.217)	(0.217)	(0.217)	(0.238)	(0.239)	(0.241)	(0.241)
Age 27-34	0.523***	0.519***	0.522***	0.519***	0.387**	0.376**	0.385**	0.380**
	(0.116)	(0.115)	(0.115)	(0.115)	(0.122)	(0.122)	(0.123)	(0.123)
Race								
Black	-0.451*	-0.456*	-0.460*	-0.454*	0.043	0.024	0.015	0.009
	(0.214)	(0.216)	(0.216)	(0.215)	(0.236)	(0.237)	(0.238)	(0.233)
Parda	0.228	0.221	0.220	0.218	0.178	0.158	0.157	0.160
	(0.125)	(0.125)	(0.125)	(0.124)	(0.132)	(0.132)	(0.133)	(0.131)
Interview Month								
July	-0.263	-0.307	-0.310	-0.432	-0.398	-0.590*	-0.615**	-0.130
	(0.211)	(0.231)	(0.231)	(0.317)	(0.219)	(0.231)	(0.232)	(0.305)
August	-0.370	-0.422	-0.422	-0.428	-0.586**	-.836***	-.848***	-0.517
	(0.202)	(0.232)	(0.232)	(0.295)	(0.217)	(0.246)	(0.246)	(0.296)
September	-0.380*	-0.472*	-0.473*	-0.412	-.596***	-.970***	-.982***	-0.630*
	(0.157)	(0.214)	(0.214)	(0.257)	(0.170)	(0.231)	(0.231)	(0.265)
AIC	840,207	839,431	839,197	838,855	766,446	762,799	759,977	758,957
BIC	840,320	839,556	839,328	838,999	766,559	762,924	760,108	759,100
[N]	3,802							

Source: DeCodE ZC, 2020. Note: Also controlling for religion and living with partner/spouse.

Figure 2. Marginal Effects of Zika Statement & Month of Interview on Favoring Childbearing Avoiding during the Covid-19 Pandemic: Brazil, May-September 2020, DeCodE ZC



Literature Cited

Agadjanian, V., & Prata, N. (2002). War, peace, and fertility in Angola. *Demography, 39,* 215–231.

Aiken, A. R., Scott, J. G., Gomperts, R., Trussell, J., Worrell, M., & Aiken, C. E. (2016). Requests for abortion in Latin America related to concern about Zika virus exposure. *New England Journal of Medicine, 375,* 396–398.

Araújo, T. V., Ximenes, R. A., Miranda-Filho, D. d., & Souza, W. V., Montarroyos, U. R., Lopes Melo, A. P., . . . Rodrigues, L. C. (2017). Association between microcephaly, Zika virus infection, and other risk factors in Brazil: Final report of a case-control study. *Lancet Infectious Diseases, 18,* 328–336. 328–336.

Behrman, J. A., & Weitzman, A. (2016). Effects of the 2010 Haiti earthquake on women's reproductive health. *Studies in Family Planning, 47,* 3–17.

Bongaarts, J. (1978). A framework for analyzing the proximate determinants of fertility. *Population and Development Review, 4,*105–132.

Castro, M. C., Han, Q. C., Carvalho, L.R., Victora, C. G., & França, G. V. A. (2018). Implications of the Zika virus and congenital Zika syndrome for the number of live births in Brazil. *Proceedings of the National Academy of Sciences, 115,* 6177–6182.

Diniz, D. (2016). *Zika: Do sertão nordestino à ameaça global* [Zika: From the Brazilian Backlands to Global Threat]. Rio de Janeiro, Brasil: Civilização Brasileira.

Finlay, J. E. (2009). *Fertility response to natural disasters: The case of three high mortality earthquakes* (Policy Research Working Paper No. 4883). Washington, DC: World Bank. Retrieved from http://documents.worldbank.org/curated/en/118031468284119109/Fertility-response-to-natural-disasters-the-case-of-three-high-mortality-earthquakes.

Johnson-Hanks, J. (2004). Uncertainty and the second space: Modern birth timing and the dilemma of education. *European Journal of Population/Revue Européenne de Démographie, 20*(article 351). https://doi.org/10.1007/s10680-004-4095-5

Johnson-Hanks, J. (2006). *Uncertain honor: Modern motherhood in an African crisis*. Chicago, IL: University of Chicago Press.

Le, H. H., Connolly, M. P., Bahamondes, L., Cecatti, J. G., Yu, J., & Hu, H.X. (2014). The burden of unintended pregnancies in Brazil: A social and public health system cost analysis. *International Journal of Women's Health, 6,* 663–670. https://doi.org/10.2147/IJWH.S61543

Lin, H. Z., Tambyah, P. A., Yong, E. L., Biswas, A., & Chan, S. (2017). A review of Zika virus infections in pregnancy and implications for antenatal care in Singapore. *Singapore Medical Journal, 58,* 171–178.

Marteleto, L., Weitzman, A., Coutinho, R., & Alves, S. (2017). Women's reproductive intentions and behaviors during the Zika epidemic in Brazil. *Population and Development Review, 43,* 199–227.

Nobles, J., Frankenberg, E., & Thomas, D. (2015). The effects of mortality on fertility: Population dynamics after a natural disaster. *Demography, 52,* 15–38.

Rangel, M., J. Nobles & A. Hamoudi. (2019). Brazil's missing infants: Zika risk changes reproductive behavior. Working Paper, SocArXiv fu8bp, Center for Open Science.

Schuck-Paim, C., López, D., Simonsen, L., & Alonso, W. (2016). Unintended pregnancies in Brazil: A challenge for the recommendation to delay pregnancy due to Zika. *PLoS Currents, 16*(8). https://doi.org/10.1371/currents.outbreaks.7038a6813f734c1db547240c2a0ba291

Sobotka, T., Skirbekk, V., & Philipov, D. (2011). Economic recession and fertility in the developed world. *Population and Development Review, 37,* 267–306.

Trinitapoli, J., & Yeatman, S. (2011). Uncertainty and fertility in a generalized AIDS epidemic. *American Sociological Review, 76,* 935–954.