Fertility Delay Among Married Singaporean Women During Zika and COVID: Roles of infection risk and uncertainty

Poh Lin Tan, Joan Ryan, Jeremy W. Lim-Soh

When faced with uncertainty, individuals adjust their desired fertility levels to adapt to changing physical and social environments. In this paper, we use a longitudinal survey spanning three waves from 2018 shortly after the Zika epidemic of 2016-2017 to 2020 during the COVID-19 pandemic to examine stated fertility responses to these two separate disease outbreaks among married women aged 25-34. In the case of COVID-19, there was an added layer of disruption to daily life when a nation-wide lockdown was implemented from April-June 2020, with residual movement restrictions even after it was lifted. Our early analysis suggests three main sets of results: first, those who stated that they delayed childbearing due to Zika were also more likely to state that they delayed or accelerated childbearing in response to COVID-19. Second, the proportion of respondents who state that they brought forward childbearing during COVID-19 increased after the lockdown ended. Third, anxiety about the virus was a significant predictor for whether a woman delays childbearing in response to Zika, but for not COVID19; conversely, stress and income loss were more important predictors of whether a woman stated that she reduced childbearing intentions during COVID-19. In addition, sociodemographic characteristics including achievement of fertility ideals, marriage duration, educational and income levels were predictive of changes in childbearing in response to COVID-19.

Changes in fertility behavior and intentions have been observed after epidemics and disasters as individuals adjust their planned or desired levels of fertility in response to changing circumstances and their implications for the expected survivorship of offspring and wellbeing of existing family members. The strategic flexibility of fertility allows individuals to alter their prior intentions in both the short and long terms (Johnson-Hanks 2011; Trinitapoli and Yeatman 2011) and allows individuals room to accommodate the ongoing complexities and uncertainty of their social environments. Scholars have pointed to the important role of uncertainty about the future in explaining the contemporary below-replacement fertility levels prevalent among developed nations (Vignoli et al. 2020). Given the forward-looking nature of fertility planning, the study of fertility behavior and intentions should accommodate behavioural responses to contingencies, inputs, and shifts that occur both at the micro and macro levels (Trinitapoli and Yeatman 2018), including exogenous shocks such as natural disasters and epidemics. In this paper, we use a longitudinal dataset to analyze the trajectories of self-reported changes in childbearing plans among 381 Singaporean women aged 25-34 in response to two separate but closely paced disease outbreaks: the Zika epidemic of 2018 and the COVID19 pandemic of 2020.

The Zika epidemic which started in 2015 largely affected tropical and subtropical regions where the disease vector—the Aedes mosquito—thrived (WHO 2018). Brazil was most heavily affected and saw an unambiguous decline in fertility as the disease had a direct link to an increase in microcephaly and other congenital malformations (Borges et al. 2018; Coelho et al. 2017; Diaz-Quijano, Pelissari, and Chiavegatto Filho 2018; Diaz-Quijano et al. 2018; Ryu 2020; Taitson, de Souza, and Santos 2017). The overall decline in births following the onset of the epidemic was especially pronounced among more highly educated and older women (Marteleto et al. 2020; Rangel, Nobles, and Hamoudi 2020) who likely had higher access to reliable information and family planning services. The long-term fertility effects of Zika are less clear, with some suggesting that fertility reductions are unlikely to continue (Castro et al. 2018).

Unlike Zika, which can result in congenital and neurological malformations among newborns to infected women (CDC 2014), COVID-19 does not present a disproportionate burden of adverse health outcomes to pregnant women or in-utero children and therefore arguably has a less direct impact on individuals' adjustment of fertility preferences in response to health risks associated with childbearing. In fact, COVID-19 saw higher mortality rates among higher age groups while children and infants remained relatively unscathed (Lee et al. 2020). Another key distinction between the COVID-19 and Zika outbreaks is the extent of disruption on individuals' daily lives at the societal level. Whereas the Zika epidemic occurred while Brazil's economy was already in recession (Gómez, Perez, and Ventura 2018) and saw relatively few closures of businesses and public events, the COVID-19 pandemic had a far more encompassing impact on human populations. On top of the mortality shock

from the infectious disease, widespread and prolonged periods of lockdowns, school closures, and migratory restrictions have also resulted in large economic losses (Aassve et al. 2020). The pandemic has extensively disrupted individuals' work and social lives, resulted in the unemployment of a large proportion of the adult population for many months at a time (Parker, Minkin, and Bennett 2020), and singlehandedly precipitated a deep global recession with lasting deleterious effect on human capital development arising from interruptions in schooling and primary healthcare access (The World Bank 2020). Contextualized within these wide-ranging fallouts from COVID-19, individuals might adjust their fertility preferences in the face of higher levels of uncertainty regarding their futures despite the relatively lower health risks associated with childbearing when compared to the Zika epidemic.

Contrary to the popular idea that couples forced to spend more time with each other during lockdowns might produce more babies, recent data has revealed a fertility decline (Aassve et al. 2020; Berrington et al. 2021; Hegarty 2021; Levine 2020). COVID-19's relatively weak impact on child mortality has also removed the replacement and hoarding motives that explain fertility spikes documented by past literature on natural disasters and health shocks (Aassve et al. 2020). School closures imposed heavier burdens on parents by reducing access to formal childcare outside the home while home isolation had the potential to both improve and deteriorate familial (Voicu and Bădoi 2021). The larger economic impact of the pandemic also caused more uncertainty for the future which in turns negatively impacts fertility decisions (Lebel et al. 2020; Trinitapoli and Yeatman 2018). The impact of COVID-19 on fertility responses is also likely to be heterogenous—in the US, for example, women with lower educational attainment are predicted to experience larger declines in fertility due to COVID-19 (Wilde, Chen, and Lohmann 2020). In light of the likely fertility decline, low-fertility contexts are at particular risk of fertility loss induced by the COVID-19 pandemic (Luppi, Arpino, and Rosina 2020).

Zika and COVID in Singapore

Singapore encountered the Zika virus in 2016-2017 and the COVID-19 virus in early 2020. Owing to its tropical climate and the presence of Aedes mosquitos, a total of 458 confirmed Zika cases were reported between 2016-2017 (Singapore Ministry of Health 2018), leading to swift public health responses including patient isolation, widespread media coverage, and measures to mitigate the breeding of mosquitos. Less than three years after the Zika epidemic died down in 2017, Singapore identified its first confirmed positive case of COVID-19 in January 2020, with the government implementing a mandatory 14-day quarantine for all individuals entering the country in March 2020—only citizens, permanent residents, and long-term pass holders were allowed entry. In April, as detected cases continued to rise, the government implemented a lockdown, locally known as a 'circuit breaker' (CB) which required the closures of schools and non-essential businesses by law (Singapore Ministry of Health 2020). During CB, businesses and services that could not continue operations through telework were suspended and only essential services such as supermarkets, delivery services, food suppliers, energy manufacturers, and medical services remained open, although these essential services were suspended if any staff member becomes infected with COVID-19 (Singapore Ministry of Health 2020). In addition to school closures, parents were not allowed to drop their children off at relatives' homes while only essential workers were allowed to drop off their children at childcare facilities (Jalelah Abu Baker 2020). The general population was advised to exit the home only to procure essential goods and services or to exercise, which also had to be done alone in open spaces. Formal sanctions were also introduced where any violations of CB guidelines resulted in individuals being fined an amount not exceeding $10,000, and/or jailed for not more than six months. In June 2020, CB formally drew to a close and movement restrictions were relaxed in incremental phases (Government of Singapore 2020).

Survey Setup

Our longitudinal dataset consists of three survey waves. The first wave of data was collected between April and July 2018. A total of 660 female participants were recruited using street intercept at the five main geographical regions of Singapore (Central, East, North, Northeast and West). Of the 660 participants, 500 consented to be re-contacted for follow-up surveys. 416 (83.2%) completed a follow-up online survey in May 2020 in the midst of the CB, and 378 (75.6%) completed a third wave in November 2020 after the easing of restrictions. The key dependent variables are married women's self-reported fertility responses in all survey waves. In 2018, respondents were asked: "How has it [the Zika

virus] affected your decision to have children?" whereby they could respond yes or no to "delayed childbearing" and "decided to have fewer children". In May 2020, respondents were asked how much the pandemic had affected their childbearing intentions, whereby they could respond yes or no to "brought forward childbearing", "decided to have more children", "delayed childbearing" and "decided to have fewer children". In November 2020, respondents were asked how much their childbearing intentions had changed compared to before CB, whereby they could respond yes or no to "brought forward childbearing", "decided to have more children", "delayed childbearing" and "decided to have fewer children".

Early Findings

Table 1 presents stated fertility responses to COVID-19 in May and November 2020 by whether or not they delayed childbearing in response to Zika in 2018. The proportion that stated that they delayed childbearing during CB was 32.5%, significantly higher than 14.8% among those who did not delay childbearing due to Zika ($p < 0.1$). The difference is no longer significant after CB. Intuitively, the higher proportion of respondents who delayed childbearing during both the Zika and COVID-19 crises might be attributable to selection for an innate higher level of caution exercised during the height of a public health crisis. Conversely, the proportions of respondents who stated that they decided to have fewer children in response to COVID-19 were not significantly different during CB, but was significantly lower after CB among those who had delayed childbearing in 2018 ($p < 0.05$). This reversal is interesting and suggests a catch-up motive where women who had previously delayed childbearing due to Zika might feel more urgency to catch up to their desired fertility levels once they perceive that the worst of the COVID19 pandemic had passed when CB ended. This catch-up motive is further supported by our finding that 9.34% of women who said they had delayed childbearing during Zika subsequently chose to bring forward childbearing during CB, significantly higher than 1.77% among women who did not delay childbearing during Zika. This difference is even more pronounced after CB.

In Table 2, we present logistic regression results showing the associations between stated delay or reduced childbearing and a set of explanatory variables: whether or not the respondent had previously delayed childbearing due to Zika (for COVID-19 only); the respondent's perceived probability that a local would be infected by the virus, and self-reported anxiety about the virus; self-reported stress and fatigue levels; and a range of sociodemographic controls, including whether or not the couple's ideal fertility levels had been met, years married, marital satisfaction, age, education and income levels of wife and husband, whether either had experienced income loss during COVID19, and wife's race. Our key finding is that whereas higher anxiety about getting infected was significantly associated with self-reported delayed childbearing during the Zika epidemic ($p < 0.01$), this explanatory variable was not significant for COVID19. Instead, higher stress predicted the decision to have fewer children during CB ($p < 0.01$), suggesting that COVID19's influence on desired fertility levels operated through more general disruptions and uncertainty related to daily life. We also found that sociodemographic characteristics were associated with changing fertility intentions: if a respondent had achieved her ideal fertility level, was married for longer, or had above-median income, she was less likely to delay childbearing during CB, while respondents with a bachelor's degree were more likely to do so. Respondents who had achieved their ideal fertility level and were older than 30 were less likely to state that they delayed childbearing after CB, likely due to the higher risk of infertility with age. Respondents who were Chinese or whose husbands had a bachelor's degree more likely to reduce childbearing during CB, while respondents whose husbands earned above-median income or lost income due to COVID-19 were less likely to reduce childbearing.

Preliminary discussion

In this paper, we provide evidence of heterogenous self-reported fertility responses to COVID-19, with non-trivial proportions stating that they had delayed or accelerated childbearing. We find evidence that fertility response to the previous Zika episode predicted response s during COVID-19, which may be due to selection for risk aversion or the 'scarring' hypothesis (Marteleto et al. 2021). We also see meaningful differences between the explanatory variables for the two disease outbreaks, with infection risks being more salient for Zika, and subjective wellbeing playing a more important role during COVID-19.

Table 1: Self-reported changes in fertility due to COVID-19, by self-reported delayed fertility due to Zika						
	Intentions in May 2020			**Intentions in Nov 2020**		
Response to Zika	No delay	Delay	Difference	No delay	Delay	Difference
Delayed (%)	14.77	32.45	*	16.62	29.34	
Reduced (%)	6.20	6.78		9.07	1.44	**
Brought forward (%)	1.77	9.34	**	5.83	17.28	*
More (%)	7.07	0.00		7.97	1.88	
N	381	30		321	24	

* Estimates adjusted using sample weights. Difference calculated using Pearson's chi-square *** p<0.01, ** p<0.05, * p<0.1.

Table 2: Logit regressions predicting self-reported delayed/reduced fertility					
DV:	Delay			Reduce	
Time:	Apr-Jul 2018	May 2020	Nov 2020	May 2020	Nov 2020
	(1)	(2)	(3)	(4)	(5)
Delayed due to Zika		1.278**	1.032	-0.538	-1.929*
		(0.558)	(0.652)	(0.768)	(1.085)
Probability of getting virus (0-100)	0.012	0.005	0.005	0.008	0.009
	(0.010)	(0.007)	(0.007)	(0.007)	(0.008)
Virus anxiety (1-5)	0.566***	0.196	0.079	0.121	-0.043
	(0.206)	(0.165)	(0.169)	(0.174)	(0.175)
Stress (1-5)	-0.557	0.275	0.370	1.103***	-0.106
	(0.372)	(0.237)	(0.319)	(0.348)	(0.292)
Fatigue (1-5)	-0.350	-0.276	0.085	-0.116	0.424
	(0.319)	(0.272)	(0.303)	(0.404)	(0.281)
Fertility ideals met (C)	-0.824	-1.937***	-0.990*	-0.745	-0.506
	(0.548)	(0.522)	(0.510)	(0.570)	(0.527)
Years married	0.612	-1.114***	-0.770	-0.230	-0.392
	(0.571)	(0.416)	(0.498)	(0.495)	(0.469)
High marital satisfaction (W)	-0.389	-0.392	0.035	-0.869	-1.124
	(0.581)	(0.497)	(0.496)	(0.754)	(0.705)
Age>30 (W)	-0.136	-0.217	-0.810*	0.021	0.030
	(0.569)	(0.404)	(0.475)	(0.655)	(0.522)
Age>30 (H)	-0.166	0.514	0.009	-0.237	0.480
	(0.622)	(0.455)	(0.478)	(0.611)	(0.563)
Degree (W)	-0.233	1.535***	0.124	0.084	0.177
	(0.528)	(0.542)	(0.568)	(0.593)	(0.529)
Degree (H)	-0.329	-0.133	-0.012	1.474**	0.661
	(0.534)	(0.435)	(0.544)	(0.723)	(0.478)
Income>=4k (W)	-0.167	-1.363***	-0.488	-0.603	-0.274
	(0.497)	(0.452)	(0.495)	(0.502)	(0.462)
Income>=4k (H)	0.117	-0.194	0.236	0.166	1.049*
	(0.708)	(0.462)	(0.560)	(0.480)	(0.553)
Income loss (W)		0.181	0.233	0.698	-0.018
		(0.468)	(0.506)	(0.636)	(0.526)
Income loss (H)		-0.149	0.066	-1.230*	0.944*
		(0.470)	(0.586)	(0.693)	(0.483)
Chinese (W)	0.018	-0.091	-0.408	2.643**	
	(0.754)	(0.470)	(0.551)	(1.147)	
Constant	-1.361	-2.170	-2.720**	-9.561***	-5.032***
	(1.812)	(1.354)	(1.384)	(1.755)	(1.567)
N:	405	394	323	394	323
Pseudo-R^2:	.13	.19	.13	.26	.11

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Estimates adjusted using sample weights. W=Wife, H=Husband, C=Couple. High marital satisfaction coded as 1 if the wife self-reported the maximum score of 5 on a scale of 1 to 5, and 0 otherwise. Age>30 coded as 1 if the individual was older than 30 at baseline. Income loss coded as 1 if the individual reported a decrease in income bracket. Race omitted for (5) as it perfectly predicts the outcome.

References

Aassve, A., N. Cavalli, L. Mencarini, S. Plach, and M. Livi Bacci. 2020. 'The COVID-19 Pandemic and Human Fertility'. *Science (New York, N.Y.)* 369(6502):370–71. doi: 10.1126/science.abc9520.

Berrington, Ann, Joanne Ellison, Bernice Kuang, Sindhu Vasireddy, and Hill Kulu. 2021. 'Recent Trends in UK Fertility and Potential Impacts of COVID-19'. Retrieved 22 April 2021 (https://eprints.soton.ac.uk/448062/).

Borges, Ana Luiza Vilela, Caroline Moreau, Anne Burke, Osmara Alves Dos Santos, and Christiane Borges Chofakian. 2018. 'Women's Reproductive Health Knowledge, Attitudes and Practices in Relation to the Zika Virus Outbreak in Northeast Brazil'. *PloS One* 13(1):e0190024. doi: 10.1371/journal.pone.0190024.

Castro, Marcia C. de, Qiuyi Han, Lucas R. Carvalho, Cesar Gomes Victora, and Giovanny V. A. França. 2018. 'Implications of Zika Virus and Congenital Zika Syndrome for the Number of Live Births in Brazil'. *Proceedings of the National Academy of Sciences*. doi: 10.1073/pnas.1718476115.

CDC. 2014. 'Zika Virus'. *CDC*. Retrieved 29 April 2021 (https://www.cdc.gov/zika/hc-providers/clinical-guidance/sexualtransmission.html).

Coelho, Flávio Codeço, Margaret Armstrong, Valeria Saraceni, and Cristina Lemos. 2017. 'Can Zika Account for the Missing Babies?' *Frontiers in Public Health* 5. doi: 10.3389/fpubh.2017.00317.

Diaz-Quijano, Fredi Alexander, Daniele Maria Pelissari, and Alexandre Dias Porto Chiavegatto Filho. 2018. 'Zika-Associated Microcephaly Epidemic and Birth Rate Reduction in Brazilian Cities'. *American Journal of Public Health* 108(4):514–16. doi: 10.2105/AJPH.2017.304260.

Gómez, Eduardo J., Fernanda Aguilar Perez, and Deisy Ventura. 2018. 'What Explains the Lacklustre Response to Zika in Brazil? Exploring Institutional, Economic and Health System Context'. *BMJ Global Health* 3(5). doi: 10.1136/bmjgh-2018-000862.

gov.sg. 2020. 'Ending Circuit Breaker: Phased Approach to Resuming Activities Safely'.

Hegarty, Stephanie. 2021. 'Covid: From Boom to Bust - Why Lockdown Hasn't Led to More Babies'. *BBC News*, March 18.

Jalelah Abu Baker. 2020. 'COVID-19: Parents Not Allowed to Drop Children off Daily at Grandparents' Place, Open-Air Stadiums to Close'. *Channel News Asia*, April 10.

Johnson-Hanks, Jennifer. 2011. *Understanding Family Change and Variation: Toward a Theory of Conjunctural Action*. Springer.

Lebel, Catherine, Anna MacKinnon, Mercedes Bagshawe, Lianne Tomfohr-Madsen, and Gerald Giesbrecht. 2020. 'Elevated Depression and Anxiety Symptoms among Pregnant Individuals during the COVID-19 Pandemic'. *Journal of Affective Disorders* 277:5–13. doi: 10.1016/j.jad.2020.07.126.

Lee, Ping-Ing, Ya-Li Hu, Po-Yen Chen, Yhu-Chering Huang, and Po-Ren Hsueh. 2020. 'Are Children Less Susceptible to COVID-19?' *Journal of Microbiology, Immunology, and Infection* 53(3):371–72. doi: 10.1016/j.jmii.2020.02.011.

Levine, Melissa S. Kearney and Phillip B. 2020. 'The Coming COVID-19 Baby Bust: Update'. *Brookings*. Retrieved 22 April 2021 (https://www.brookings.edu/blog/up-front/2020/12/17/the-coming-covid-19-baby-bust-update/).

Luppi, Francesca, Bruno Arpino, and Alessandro Rosina. 2020. 'The Impact of COVID-19 on Fertility Plans in Italy, Germany, France, Spain, and the United Kingdom'. *Demographic Research* 43(47):1399–1412. doi: 10.4054/DemRes.2020.43.47.

Marteleto, Letícia J., Gilvan Guedes, Raquel Z. Coutinho, and Abigail Weitzman. 2020. 'Live Births and Fertility Amid the Zika Epidemic in Brazil'. *Demography* 57(3):843–72. doi: 10.1007/s13524-020-00871-x.

Marteleto, Letícia J., Molly Dondero, Andrew Koepp. 2021. " Double Exposure to Novel Infectious Diseases: ZIKV, Covid-19 and the Context of Fertility." Presented at PAA 2021.

Parker, Kim, Rachel Minkin, and Jesse Bennett. 2020. 'Economic Fallout From COVID-19 Continues To Hit Lower-Income Americans the Hardest'. *Pew Research Center's Social & Demographic Trends Project*. Retrieved 29 April 2021 (https://www.pewresearch.org/social-trends/2020/09/24/economic-fallout-from-covid-19-continues-to-hit-lower-income-americans-the-hardest/).

Rangel, Marcos A., Jenna Nobles, and Amar Hamoudi. 2020. 'Brazil's Missing Infants: Zika Risk Changes Reproductive Behavior'. *Demography* 57(5):1647–80. doi: 10.1007/s13524-020-00900-9.

Ryu, Hanbyul. 2020. 'The Effect of the Zika Virus Outbreak on Fertility and Female Labour Market Outcomes'. *Applied Economics Letters* 27(5):432–35. doi: 10.1080/13504851.2019.1624913.

Singapore Ministry of Health. 2020. 'MOH | News Highlights'.

Taitson, Paulo F., Vanessa GM de Souza, and Mariana L. Santos. 2017. ‘Zika Virus Outbreak: Reproductive Effects and Decreases in the Number of Births in Brazil’. *JBRA Assisted Reproduction* 21(4):293–94. doi: 10.5935/1518-0557.20170064.

The World Bank. 2020. ‘COVID-19 to Plunge Global Economy into Worst Recession since World War II’.

Trinitapoli, Jenny, and Sara Yeatman. 2011. ‘Uncertainty and Fertility in a Generalized AIDS Epidemic’. *American Sociological Review* 76(6):935–54. doi: 10.1177/0003122411427672.

Trinitapoli, Jenny, and Sara Yeatman. 2018. ‘The Flexibility of Fertility Preferences in a Context of Uncertainty: Flexibility of Fertility Preferences in a Context of Uncertainty’. *Population and Development Review* 44(1):87–116. doi: 10.1111/padr.12114.

Vignoli, Daniele, Giacomo Bazzani, Raffaele Guetto, Alessandra Minello, and Elena Pirani. 2020. ‘Uncertainty and Narratives of the Future: A Theoretical Framework for Contemporary Fertility’. Pp. 25–47 in *Analyzing Contemporary Fertility, The Springer Series on Demographic Methods and Population Analysis*, edited by R. Schoen. Cham: Springer International Publishing.

Voicu, Malina, and Delia Bădoi. 2021. ‘Fertility and the COVID-19 Crisis: Do Gender Roles Really Matter?’ *European Societies* 23(sup1):S199–214. doi: 10.1080/14616696.2020.1822537.

WHO. 2018. ‘Zika Virus’.

Wilde, Joshua, Wei Chen, and Sophie Lohmann. 2020. *COVID-19 and the Future of US Fertility: What Can We Learn from Google? Working Paper*. 13776. IZA Discussion Papers.