Congenital Disability Effects on Parents' Labor Supply and Family Composition: Evidence from the Zika Virus Outbreak

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Abstract

Severe child disability is among the most consequential events to parent's labor market outcomes, but there is still a small literature studying its effects. We study this question in the context of the Zika Virus epidemic in Brazil, which caused thousands of children to be born with microcephaly. We argue that several characteristics of the epidemic make it suitable as a natural experiment. Infection was sudden and the link between Zika and microcephaly was unknown at the time. Using data on the universe of births and formal employment links in the country, we show that affected mothers had similar labor market trajectories to other mothers before childbirth. However, starting 9 months after childbirth, they are 20% (10 p.p.) less likely to have a formal job. These effects persist over time. We do not observe any effects for fathers' labor market outcomes. We also find that affected families have lower subsequent fertility and fathers are more likely to divorce or leave the family.

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1 Introduction

Mothers' labor market decisions are influenced by their children's characteristics, and severe, permanent disability may be one of the most profoundly impactful. The additional demands are traditionally met by women, so the dip in labor market participation after childbirth may be larger for mothers of disabled children. This dip is especially problematic because disabled children also need more financial resources for medical treatment, adaptation in addition to time and attention. Therefore, estimating the effect of child disability on maternal employment is crucial for the design of policies that help these families.

The small existing literature on child disability and maternal employment faces a challenge in dealing with unobserved co-founders. For instance, mothers who follow preventive recommendations such as folate supplementation or abstaining from smoking are likely different in other relevant dimensions than those who do not. This concern is identified and dealt with in various ways in the broader literature on child health and mother's work (e.g. Frijters, Johnston, Shah, and Shields (2009) uses instrumental variables, Breivik and Costa-Ramón (2022) uses panel-data to obtain a valid comparison group). Existing work on child disability, however, has not dealt explicitly with it (Salkever 1982; Powers 2001; Powers 2003; Wasi, Berg, and Buchmueller 2012).

In this paper we provide evidence on the causal effects of child disability on parental labor force participation, household composition, fertility, and income by exploiting a large shock to the incidence of child disability: the 2015 Zika virus outbreak in Brazil. The outbreak caused several thousands of children to be born with a severe disability, microcephaly. We argue that the sudden onset of this event, together with characteristics of the infection, rules out endogeneity of maternal health behaviors.

Using detailed data on the universe of births and formal employment links in the country, we show that affected mothers had similar labor market trajectories to other mothers before childbirth. However, starting 9 months after birth maternity leave, they are 20% (10 percentage points) less likely to have a formal job. For fathers, we do not find any effect in the formal labor market participation, but find that they are less likely to be cohabiting with the mother and child. We also document that, for households where the first child was born during the Zika outbreak, families with a child with microcephaly are less likely to have other children. Interestingly, we find spillover effects on fertility. In municipalities where the incidence of microcephaly was higher, families without a child with microcephaly are less likely to have more children in the next three years.

The Zika virus outbreak in Brazil in 2015 provides a useful case study because its particular characteristics rule out several threats to identification. Since it is transmitted by a common mosquito, anyone in affected areas could be exposed. The sudden introduction of the virus, along with the fact that the link to microcephaly was not known, means that differences in preventive behavior are unlikely: no one could know to be concerned. Even after public health authorities identified the outbreak and raised awareness, prevention had only a long delayed effect, because infection is more likely to cause microcephaly when it happens in the first trimester. Another potential threat to identification, selective abortion, is unlikely for two reasons: infection is asymptomatic in most cases, so women were unaware, and diagnosis of microcephaly is difficult before birth. Finally, Zika has no lasting effects on adults, ruling out direct effects on labor supply.

Children affected by the Zika outbreak developed microcephaly, a severe, life-long disability that puts significant strain on parental resources. The condition is characterized by underdevelopment of the brain, resulting in cognitive and developmental disabilities. Children often suffer from seizures and must have access to therapy to develop speech and movement. Brazil's public health care system offers free treatment, but families may have difficulty accessing it, particularly in remote areas. Furthermore, even with free medical treatment families still need to spend significant time caring for affected children at home.

To study the impact of the outbreak on maternal labor outcomes, we use three administrative datasets. The first is SINASC/SUS, which logs all births in the country and details the municipality of the delivery, the municipality of the mother's residence, date, the mother's date of birth, and whether the newborn has microcephaly. Microcephaly occurs very rarely due to causes unrelated to Zika, so we can confidently link cases during 2015-2016 to the outbreak. The second is the Annual Account of Social Information (Relação Anual de Informações Sociais, RAIS), a dataset that allows us to follow an individual's employment history throughout the entire period and observe monthly earnings, hours and dates of maternity leave. We link these two datasets using the Single Registry, a federal registry of all recipients of social programs. Recipients undergo interviews with local government agents, and answer a standardized questionnaire on the socioeconomic characteristics of all household members. This information must be updated every couple years to ensure to eligibility to social programs.

To isolate the causal effect of child disability, we compare the labor market trajectory of mothers of children with microcephaly to a matched comparison group. The matched comparison group is composed of all mothers in the same municipalities that gave birth during the same months as mothers of children with microcephaly. We compare the average labor force participation between these two groups each month following maternity leave. We argue this method yields causal estimates for two reasons. First, the unexpected nature of the epidemic and characteristics of the infection make selection bias unlikely. Second, the groups are similar in observable characteristics, including previous trajectory in the labor force.

We find that mothers of children with microcephaly are about 20% (10 percentage points) less likely to have a job in the formal sector than matched mothers. This difference starts about 9 months after the start of maternity leave and persists for as long as we can estimate, 36 months. Conditional on working, we do not find significant differences in hours worked or hourly wages, although standard errors are large.

2 Background

The 2015 outbreak of Zika in Brazil provides an exogenous shock to the rate of child disability, with other characteristics that also help to isolate its effect on mother's employment. Selection driven by differences in preventive behavior is addressed by the sudden and widespread nature of the outbreak in the regions it affected. Selective abortion is unlikely because diagnosis is difficult in utero and adults have no symptoms. The lack of symptoms also rules out direct effects of the virus on labor outcomes.

The Zika virus was introduced to Brazil around 2014, where it had never been observed before. The virus spreads through a common mosquito, the Aedes Aegypti, that also transmits dengue, yellow fever and chikungunya, affecting around 2 million Brazilians per year. The outbreak was first identified in mid-2015, following a spike in cases of microcephaly. The Northeast of Brazil was particularly affected, but infection was widespread within the region and anyone could be exposed.

Exposure to the Zika virus in pregnant mothers, especially in the first trimester, can cause microcephaly in the newborn, a severe, lifelong disability. Microcephaly is characterized by underdevelopment of the brain, resulting in smaller head circumference than normal. Children with microcephaly need frequent medical and parental attention. They often suffer from seizures, vision and hearing problems, have intellectual disabilities and difficulty with motor and speech development. Brazil's public health care system offers free treatment, including continuing therapy, but families may have difficulty accessing it, particularly in remote areas.

In contrast with the dramatic effects on newborns, Zika infection has no lasting effects in adults, so it should not directly impact labor supply. About 80% of cases in adults result in no symptoms (Haby, Pinart, Elias, and Reveiz 2018). In the other cases, typical symptoms are fever and rashes, lasting for up to a week. One exception is that there have been reports of an increased chance of developing Guillan-Barré syndrome, a very serious, potentially lethal condition. However, even this increased risk is extremely rare and would not have any relevant impact to our results.

The outbreak was focused on the Northeast, started suddenly and ended fast. Figure 2 shows the number of microcephaly cases per 1000 births over time, in each of the 5 regions of Brazil. The Northeast region was clearly hit the hardest by the epidemic, with a peak over 7 times larger than any other region. The very steep increase in the second half of 2015 shows how abruptly cases increased, from basically zero to the peak in a few months. The subsequent fall in cases was almost as fast, with a much more modest second wave in the latter half of 2016.

Differential exposure to the virus based on differences in mothers' preventive behavior is unlikely to be a cause for bias for two main reasons. First, Zika had never been observed in Brazil, and second, the link to microcephaly in newborns was unknown. The first signs of a new disease were observed in March of 2015, and the increase in microcephaly was first identified in October. Researchers were only able to identify the causal link between these facts in 2016, so mothers would only know to take any precaution afterwards. Even then, preventive measures would probably only be reflected in a reduction of disabled children with a significant delay. Since the virus is more likely to cause microcephaly during the first trimester of pregnancy, its effects can be undetected for several months.

Another potential threat to identification, differential rates of abortions, is unlikely for several reasons. First, microcephaly is difficult to identify in utero, and mothers would have to decide to terminate pregnancy without confirmation that their baby is affected. Second, Zika infection is often asymptomatic, and otherwise can be similar to dengue, making it difficult for mothers to know if they have been infected. Third, even in infected mothers, the chance of the baby developing microcephaly is relatively low. Finally, abortion is illegal in Brazil except in cases of rape, or risk to the mothers' life.

Although differential child mortality could impact the interpretation of our results, the magnitudes are small. Infant mortality among children with Zika-induced microcephaly is roughly three times higher than the average in Brazil at the time (45 deaths per thousand births compared to 15 in the overall population). Although this could bias our estimates in theory, in practice the absolute rate is small enough to not have a significant impact in our estimates. We obtain bounds on our estimated effects accounting for differential mortality using Lee bounds (Lee 2009), and find only a tiny impact in our conclusions. Furthermore, there is no evidence that Zika causes higher rates of miscarriages.

3 Data

We use three administrative datasets that cover all births in the country and all formal employment links. The first is the SINASC (*Sistema de Informações de Nascidos Vivos*, or Information System on Live Births), a dataset collected by the Ministry of Health detailing every live birth within a health facility. Second, RAIS (*Relação Anual de Informação Social*, Annual Report of Social Information), is an administrative dataset used and made available by the Ministry of Labor, containing detailed information on employment links. Finally, we use the Single Registry (*Cadastro Único)*, an administrative dataset used to manage and coordinate a variety of social programs, covering essentially all of Brazil's poor population. We link these datasets using location, time of birth and mother's age.

3.1 Data on Births

To identify the children affected by the Zika epidemic who were born with microcephaly, we rely on a publicly available administrative record of all births in Brazil, SINASC. We observe the municipality the birth took place, the municipality of the mother's residence, the date, the mother's age, and whether the newborn has microcephaly, or any other birth anomaly.

This dataset contains detailed information on all live births in Brazil. It provides the location of the birth, the mother's municipality of residence, date of birth, and several variables, such as birth-weight, APGAR score, and the ICD-10 codes for congenital malformations. We are able to identify whether a child born with microcephaly[1] in each municipality-month. These data are high quality and coverage is believed to be close to 100% (Oliveira et al. 2015).

The map on the left of Figure 1 shows the number of microcephaly cases per thousand births during the zika outbreak for each municipality. The map also shows the five Brazilian regions. The Northeast region was the hardest hit, while the South was mostly unaffected. The map on the right zooms in on the Northeast region, in which we focus our analysis. There is considerable spatial variation in exposure among counties. While most municipalities had zero or very few cases, there are many with over 1.2 per thousand births.

[1]The ICD-10 code for microcephaly is Q02.

Figure 2 shows the number of microcephaly cases by month and region. The Northeast concentrated the vast majority of cases, reaching 500 cases in a single month in the peak of the outbreak. Although less severe, the Southeast also saw an significant increase in the number of cases. The other regions saw only a few tens of cases. The number of cases in the country returned to low levels after 2017, although still higher than the pre-outbreak levels.

3.2 Data on the Labor Market

To observe mothers' and fathers' labor market outcomes, we use administrative data covering all formal employment links in Brazil. We are able to follow an individual's employment history and observe monthly earnings, hours and the dates of any maternity leave.

The RAIS is a longitudinal dataset of social security records for employees and employers. It is collected by the Ministry of Labor in a compulsory survey of all firms and their registered workers, covering around 230,000 formally registered firms and over 3.5 million workers annually. RAIS provides information on workers' demographics (age, gender, schooling, race), job characteristics (occupation, wage, hours worked), hiring and termination dates, and the personal tax id (CPF). It also includes information on many firm-level characteristics, notably the number of employees, municipality, firm tax id (CNPJ), and industry code. We built a panel of formal workers from 2015 to 2018, amounting to XX million worker-year-month observations in Brazil.

Figure 5 shows the share of women who remains employed in the formal labor market after the start of maternity leave. Since maternity leave usually lasts four months, there is no separation in this period. After that, there is a steep drop in the share of women working in the formal sector, and this number stabilizes around the eighteenth month with half of the women remaining employed in the formal labor market.

3.3 Single Registry

In order to link the household members, we use data from the Single Registry (*Cadastro Único*) to observe families' characteristics and link different family members to formal employment data. The Single Registry is a federal registry used for several social programs to verify eligibility and track recipients over time. It started exclusively as Bolsa Família's administrative database but evolved through the years to be the primary federal dataset on poverty. Currently, more than 20 social programs use it, covering virtually all of Brazil's poor (Campello and Neri 2013). Single Registry aims to include all households with income per capita below one-half of the minimum wage (R$255 in 2010), which is much higher than the official poverty threshold (R$140 in 2010).

To be eligible for any government benefit that uses Single Registry, families must have a valid registration (complete and up-to-date), updated at least every two years. They must undergo interviews with local government agents, including a standardized questionnaire on their earnings, living conditions, demographic and occupational characteristics, and personal tax ID (CPF). They have to inform authorities of relevant changes to family size or income.

3.4 Linking the Datasets

Because the public dataset on births does not include personal identifiers, we cannot directly link it to RAIS or Single Registry. We deal with this challenge using the mothers' date of birth, municipality of residence, and date of childbirth, available on Single Registry. Those variables uniquely identify XX% of the births in this period. Once we selected the control and treated mothers in the Single Registry, we use their tax ID to find them in RAIS.

If we find a woman at least once in RAIS, we can re-construct her formal employment history. If we do not see her any year, then we know she has never worked in the formal sector. Our measure of employment is a dummy indicating if the woman appears in the RAIS dataset in that year with at least one job reporting a non-zero amount of hours per week. We also obtain average yearly wages and hours worked from RAIS.

3.5 Balance and Summary

Table 1 shows summary stats for affected mothers and for controls. Overall, our control group seem to be similar to the treatment group along observable characteristics. We do not reject the hypothesis of equality between the samples for all variables at the usual significance levels, and no difference is economically significant.

In our sample, the mean mother's age at first birth is 28.3 for controls and 27.8 for treated mothers. This is very similar to estimates of age at first birth for the country in general, suggesting no strong selection along this margin. For monthly earnings, we find the largest t statistic of the test of equality. Mothers of children with microcephaly have about 7% greater monthly earnings than control mothers, but the difference is not statistically significant. Note that the sign of the difference is the opposite of what could be expected, under the theory that poorer mothers are more exposed to disease. The level of earnings is lower than the average income per capita in Brazil (780 BRL in 2015), but not much lower than the average in the Northeast. Again, this suggests selection by income does not play a large role.

In terms of its racial composition, our sample is considerably less white than average Brazilians, reflecting the regions most affected. We have about 15.5% of undeclared race in the sample, at identical rates between treatment and control. Around 70% of the sample has finished high school, with most of the others having at least middle school. The p-value of the test of joint significance of all race variables is 0.23, of all educational variables is 0.14 and the overall joint test of all variables presented is 0.36.

4 Empirical Strategy

We are conducting a comparison between two groups of families within the same municipality. The first group consists of families who have a child with microcephaly, while the second group comprises families who have a child without any disability. For a fair comparison, we specifically select families from both groups who had their children in the same month and year. Furthermore, we ensure that the mothers in both groups have the same age and level of education. We estimate the following model:

$$y_{ft} = \sum_{k \in (-18,\ldots,36), k \neq -9} \beta_k \cdot T_f \times \mathbb{1}(t - \tau(f) = k) + \alpha_{p(f)} + \delta_t + \varepsilon_{ft} \tag{1}$$

where y is the outcome of interest for family f at year-month t. T_f is a dummy indicating families with a child with microcephaly. $\tau(f)$ is the date of birth of the child of family f, such that k is the time relative to birth. Thus β_k, captures the difference between the outcomes of families with microcephaly and the other families. We control for pair fixed effects, $\alpha_p(f)$, to ensure we are comparing each treated family with the most similar control families. We also add for year-month fixed effects, δ_t, to capture to any time-trend common to all families. We normalize the coefficients relatively to nine months before the childbirth. ε_{ft} is the random error, clustered at the municipality level.

Our identification assumption is that, conditional on having a child around the same time, in the same municipality, and mothers's age and educational level, the incidence of microcephaly is uncorrelated with unobserved characteristics that affect the outcomes of interest. As discussed in details in Section 2, the characteristics of the outbreak rules out several threats to identification, making it plausible that unobserved characteristics, such as mothers' behaviors, are not correlated to the chance of having a child with microcephaly.

Selective fertility as a response to the outbreak could have important implications for our estimates. However, the delay with which the zika virus infection causes microcephaly means that, in practice, this channel is unlikely to affect our results. Because the infection is most dangerous in the first months of pregnancy, and has mild symptoms otherwise, it went practically undetected until after the first babies were diagnosed with microcephaly. Furthermore, any selective fertility response that followed the widespread recognition of the seriousness of the outbreak would only impact births with 9 months of delay, resulting in births in a period when cases were already far past the peak.[2] Figure 3 shows fertility rate in the Northeast by month of conception. We plot separately the averages for municipalities that saw no cases versus those above and below the median cases per capita among the municipalities with positive cases during the outbreak. In all groups we see a dip in fertility corresponding to conceptions in early 2016. Therefore, there could be some selection effects on births in the second semester of 2016, outside our main period of interest. Junior and Rasul 2019 provide a more thorough investigation of the fertility response.

Infant mortality rates for children with microcephaly are also relevant for the in-

[2]One exception is late-stage abortion, which could have a faster effect on births. Abortion is illegal in Brazil, except in case of risk to the mother's life, pregnancy resulting from rape, or fetal anencephaly.

terpretation of our results. If the higher rates of microcephaly caused by the zika virus were also translated into increased mortality, that could be driving our results. Figure 4 shows mortality rates by year for children with and without microcephaly in the Northeast. While the average infant mortality in the Northeast was 18.4 per thousand births, the mortality among children with microcephaly was 454.8 per thousand births in the pre-zika period. Other causes of microcephaly include malnourishment, heavy smoking and drinking during pregnancy, genetic syndromes, or other vertically-transmitted infections. During 2015, however, the mortality rate for children with microcephaly was 55.5 per thousand, much closer to the overall mortality rate, indicating that these children were considerably less negatively selected. Although high, these rates are unlikely to have a quantitatively relevant effect on our estimates.

5 Results

5.1 Employment and Earnings

We find that mothers of children with microcephaly are about 10 percentage points (50%) less likely to have a job in the formal sector than matched mothers. This difference starts about 9 months after the start of maternity leave and persists for as long as we can estimate, 36 months. The impact on earnings follows a similar path. We do not find any impact on fathers' employment or earnings.

Figure 6 shows average labor force participation of mothers' around the time of childbirth for the treated and control groups, evidencing the parallel trends before childbirth and the stark differences after the end of maternity leave. In this figure, we include controls of mothers' year of birth and municipality of residence. First, we observe that treated mothers are very similar to controls in their previous trajectory in the labor market. At the time of childbirth, treated mothers are about 5 p.p. more likely to be formally employed than controls. For the previous 2 years, the groups are even closer, following similar trends.

Starting 6 months after childbirth, corresponding to the period of maternity leave, both groups see a sharp fall in employment, with mothers of children with microcephaly stabilizing at 10% participation, compared to about 20% for controls. This result is conditional on the sample of women that were in the formal sector for at least one month in the year preceding the childbirth. The effects persist and increase in magnitude over the following three years, the longest length we can estimate.

Figure 7 shows the results of estimating Equation 1 for employment. This figure differs from Figure 6, first by plotting the regression coefficient corresponding to the difference between the groups, (β_k), along with point-wise confidence intervals. Second, it includes pair and month fixed effects, instead of only municipality and mother's year of birth. We fail to reject the hypothesis of parallel trends before childbirth, and confirm that the results are highly statistically significant at the usual confidence levels.

We analyze the effect on earning, also conditional on the sample of women that were in the formal sector for at least one month in the year preceding childbirth. Results show a decrease of R$ 100 or a 13 p.p. decrease relatively to the minimum wage in 2015.[3]

We repeat the same analyze for fathers, finding no effects for formal employment or earnings. Figures 9 and 10 show that fathers' formal employment and earnings are not affected by the birth of a child with microcephaly. Labor market trends for treated and control groups fathers were identical.

[3] Minimum wage in Brazil in 2015 was R$ 788,00.

5.2 Fertility

One potential response to the demands of caring for a disabled child is that families may choose to avoid having more children, depressing subsequent fertility. Not only is this an important effect on its own right, it also informs the interpretation of the effects we found on the labor market. Since fertility tends to depress labor market participation, this causal channel will tend to make differences in participation smaller. In this section we show that child microcephaly does decrease future fertility compared to paired controls. We also find evidence of negative spillover effects to mothers without a child with microcephaly.

First, we estimate the effect on the probability of having at least one other child after the birth of the child with microcephaly, compared to paired controls. We measure that using data from Single Registry at the last wave we have access to, estimate the following equation:

$$fertility_i = \beta \cdot T_i + \alpha_{p(f)} + u_i \tag{2}$$

where $fertility_i$ is a dummy indicating whether mother i had an additional child within the following three years. T_i is a dummy indicating whether mother i had a child microcephaly. We control for pair fixed-effect, $\alpha_{p(f)}$ to ensure we are comparing each treated family with the most comparable control families. u_i is the random error, clustered at the municipality level.

Table 2 shows that mothers with a child with microcephaly are 1.7 p.p. less likely to have another up to three years after the birth of the child with microcephaly than mothers in the control group. This effect is driven by mothers whose first child was born with microcephaly. If we restrict the sample to families with only one child at the initial period, the chance of having a second child fall by 4.2 p.p. as shown in Column (2).

There is no effect on fertility for families that already had more than one child, (column (4)). This is to be expected, since fertility above 2 children is relatively uncommon, so there is not the possibility of further reducing it much more.

To estimate the spillover effects, we exclude mothers with a child with microcephaly, and compare control mothers in municipalities with a higher incidence of microcephaly to control mothers in municipalities with a lower incidence. We identify the spillover effects estimating the following equation:

$$fertility_{im} = \gamma \cdot T_i + \delta_{state(i)} + X_i + \epsilon_i$$

where $fertility_{im}$ is a dummy indicating whether mother i had an additional child in the following three years. *share microcephaly*$_m$ is the share of birth of children with microcephaly during the Zika virus outbreak period. We control for the state fixed effect, $\delta_{state(i)}$, and mothers' characteristics, X_i. ϵ_i is the random error, clustered at the municipality level.

We find that mothers of healthy children in municipalities with a higher share of children born with microcephaly are also less likely to have another child in the future. Column (5) of Table 2 shows that for each additional case of microcephaly per thousand births, the chance of a mother without a child with microcephaly falls by 0.017.

5.3 Family structure

Child disability creates severe stress in the household, and one of the possible medium-term effects is divorce or separation of the parents. Following the zika epidemic, there were several news stories about divorce in households where in families with a child with microcephaly, providing anedotical evidence that this may be an important dimension. We test for higher rates of separation in our sample.

We estimate the Equation 2, with the outcome variable being an indicator of the presence of the father in the household in 2019, the last year in the sample. We find that in families with a child with disability, fathers are less likely to live in the same house. Table 3 shows the results.

Column 1 shows the results with no controls. Families of children with microcephaly are 1.4 p.p. less likely to have a cohabiting father. The average for the control group is very small, only 35% of households have a cohabiting father. Column 2 shows that the inclusion of pair fixed-effects increases the coefficient to 6.6 p.p., a statistically significant difference. To ensure that these differences are not pre-existing, in Column 3 we control for whether the father was present in 2015. We find that the coefficient is slightly reduced to 5.6 p.p. Column 4 presents the results of a similar test; instead of controlling for the fathers' presence in 2015, we include the 2015 data in the sample and conduct a DID, finding similar results.

6 Conclusion

In this paper, we analyse how congenital microcephaly in a child affects the labor outcomes of the parents, subsequent fertility and family structure. We show that mothers' labor market participation falls by close to one half, an effect that does not seem to fade over time. On the other hand, fathers' labor outcomes are not affected. We also find that affected families have lower subsequent fertility and fathers are more likely to divorce or leave the family.

We conduct our analysis in the context of the Zika virus epidemic. Unique features of the outbreak allow us to rule out or substantially reduce several concerns, such as endogeneity of maternal care and health behaviors and selective abortion or mortality. Our paper contributes to the literature studying the effects of this outbreak by highlighting the effects on families' labor market outcomes.

Overall, our results help quantify the enormous human costs associated with disease and disability, and highlight the disproportionate effect on women. A better understanding of the ways individuals and families deal with persistent health shocks and disabilities can be an important input in the design of public policy to address these issues.

References

Breivik, Anne-Lise and Ana Costa-Ramón (2022). "The career costs of children's health shocks". In: *University of Zurich, Department of Economics, Working Paper* 399.

Campello, Tereza and Marcelo Côrtes Neri (2013). "Programa Bolsa Família: uma década de inclusão e cidadania". In.

Frijters, Paul, David W Johnston, Manisha Shah, and Michael A Shields (2009). "To work or not to work? child development and maternal labor supply". In: *American Economic Journal: Applied Economics* 1.3, pp. 97–110.

Haby, Michelle M, Mariona Pinart, Vanessa Elias, and Ludovic Reveiz (2018). "Prevalence of asymptomatic Zika virus infection: a systematic review". In: *Bulletin of the World Health Organization* 96.6, p. 402.

Junior, Ildo Lautharte and Imran Rasul (2019). "The Anatomy of a Public Health Crisis: Household and Health Sector Responses to the Zika Epidemic in Brazil".

Lee, David S (2009). "Training, wages, and sample selection: Estimating sharp bounds on treatment effects". In: *Review of Economic Studies* 76.3, pp. 1071–1102.

Oliveira, Max Moura de et al. (2015). "Evaluation of the national information system on live births in Brazil, 2006-2010". In: *Epidemiologia e Servicos de Saúde* 24, pp. 629–640.

Powers, Elizabeth T (2001). "New estimates of the impact of child disability on maternal employment". In: *American Economic Review* 91.2, pp. 135–139.

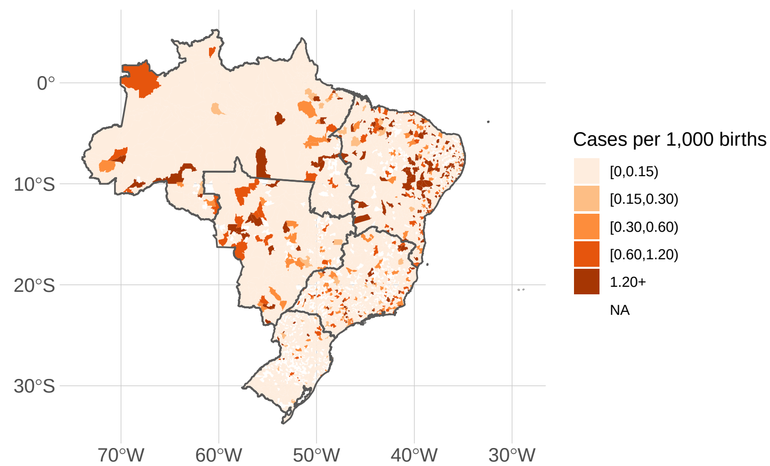
— (2003). "Children's health and maternal work activity estimates under alternative disability definitions". In: *Journal of human resources* 38.3, pp. 522–556.

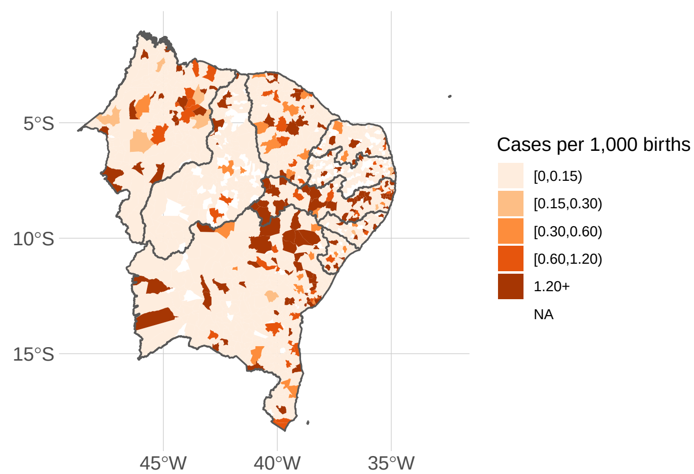
Salkever, David S (1982). "Children's health problems: Implications for parental labor supply and earnings". In: *Economic aspects of health*. University of Chicago Press, pp. 221–252.

Wasi, Nada, Bernard van den Berg, and Thomas C Buchmueller (2012). “Heterogeneous effects of child disability on maternal labor supply: Evidence from the 2000 US Census”. In: *Labour Economics* 19.1, pp. 139–154.

Figures

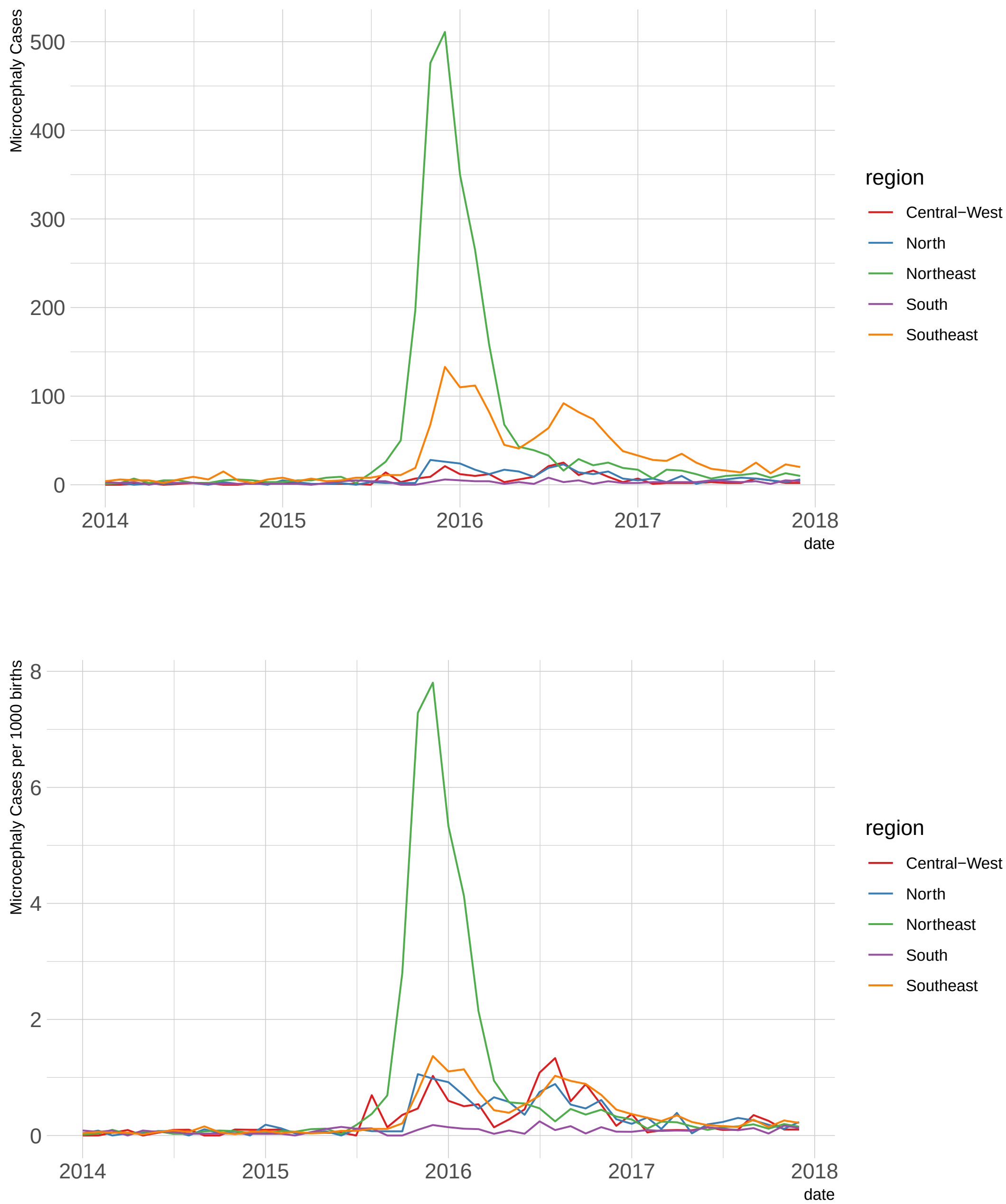
Figure 1: Geographic Variation on the Number of Microcephaly cases per 1000 Births





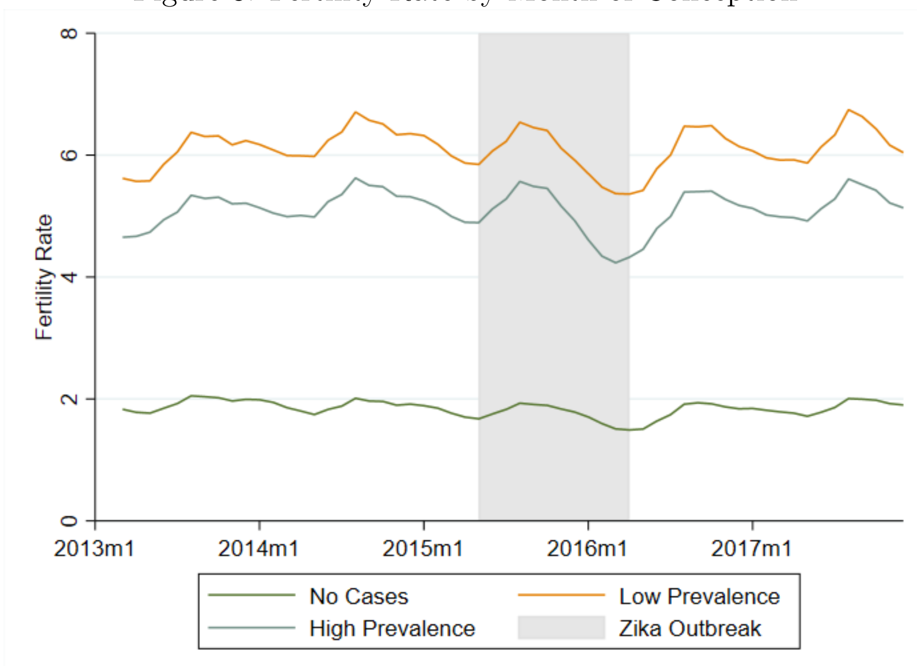
Notes: This figure illustrates the geographic variation on the number of microcephaly cases per thousand births in 2015 and 2016 for all Brazilian municipalities (left) and for the Northeast region only (right). The total number of births and cases of microcephaly are made available by SINASC/SUS. Microcephaly is identified by the ICD-10 code Q02.

Figure 2: Microcephaly Cases by Month and Region



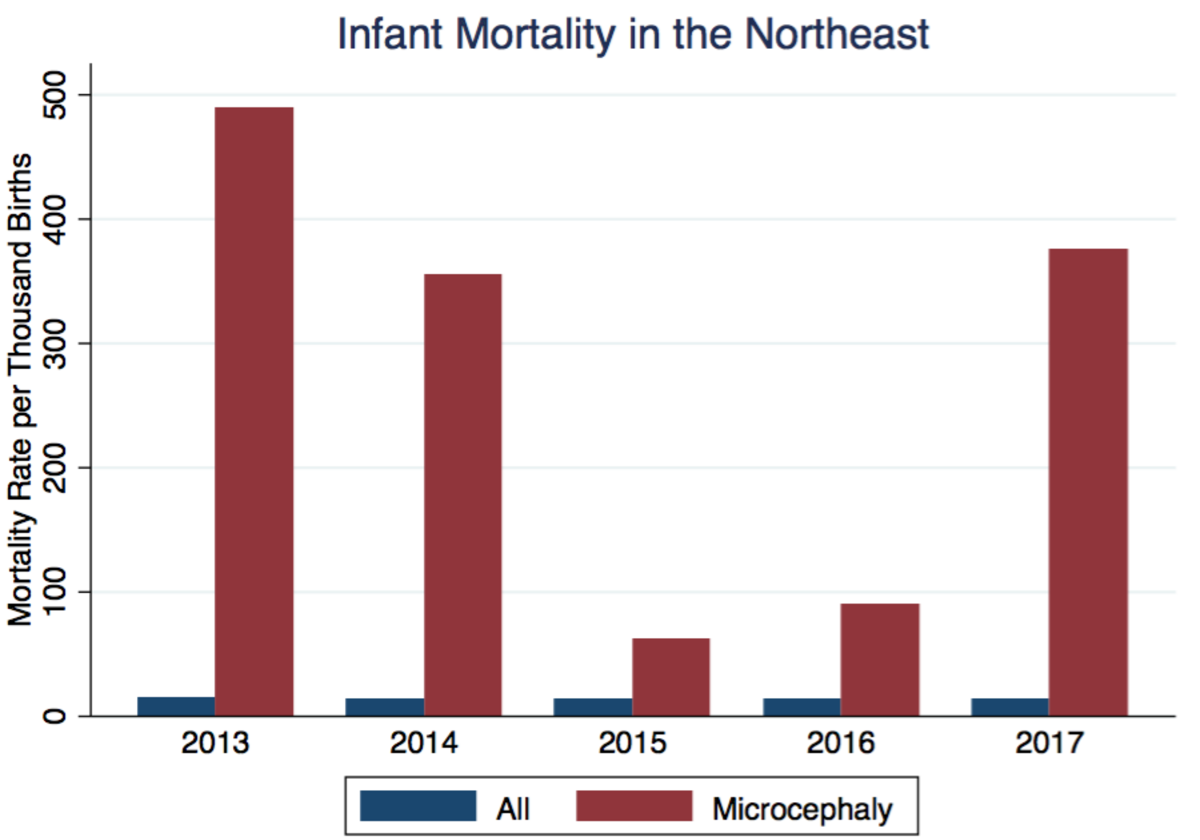
Notes: These figures show the evolution in the total number (upper) and per thousand births (lower) cases of microcephaly by month for each region. The total number of cases of microcephaly is made available by SINASC/SUS, under the the ICD-10 code Q02.

Figure 3: Fertility Rate by Month of Conception



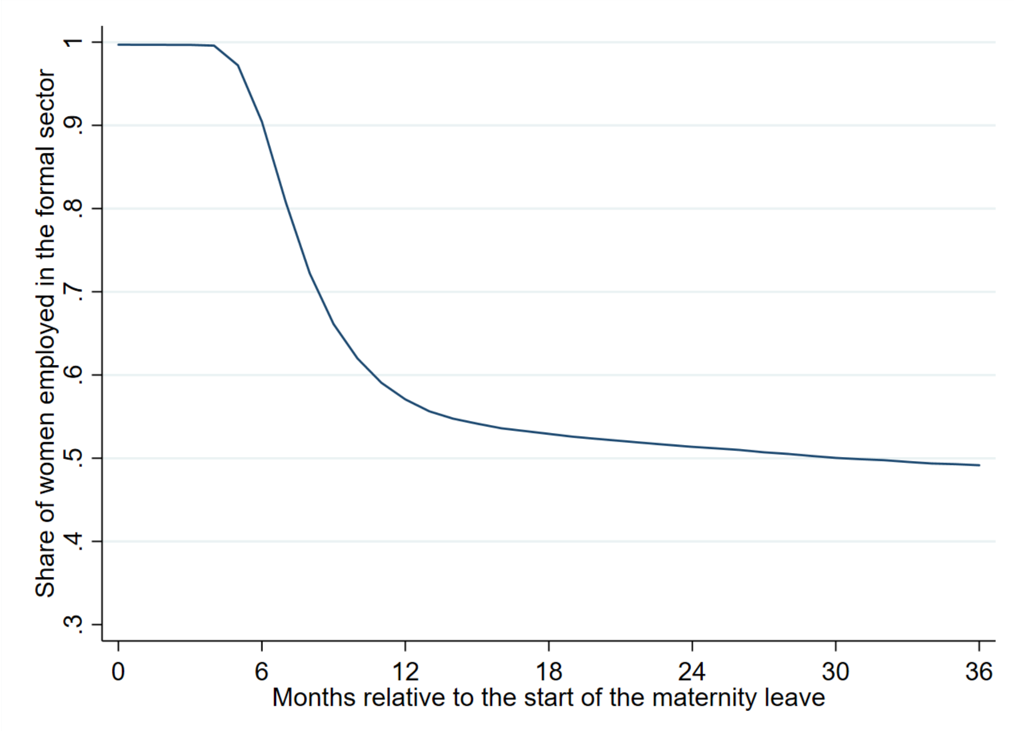
Notes: This figure shows the fertility rate in the Northeast by month of conception. We plot separately the averages for municipalities that saw no cases (No cases) versus those above (High Prevalence) and below (Low Prevalence) the median cases per capita among the municipalities with positive cases during the outbreak. The total number of births and cases of microcephaly are made available by SINASC/SUS. Microcephaly is identified by the ICD-10 code Q02.

Figure 4:



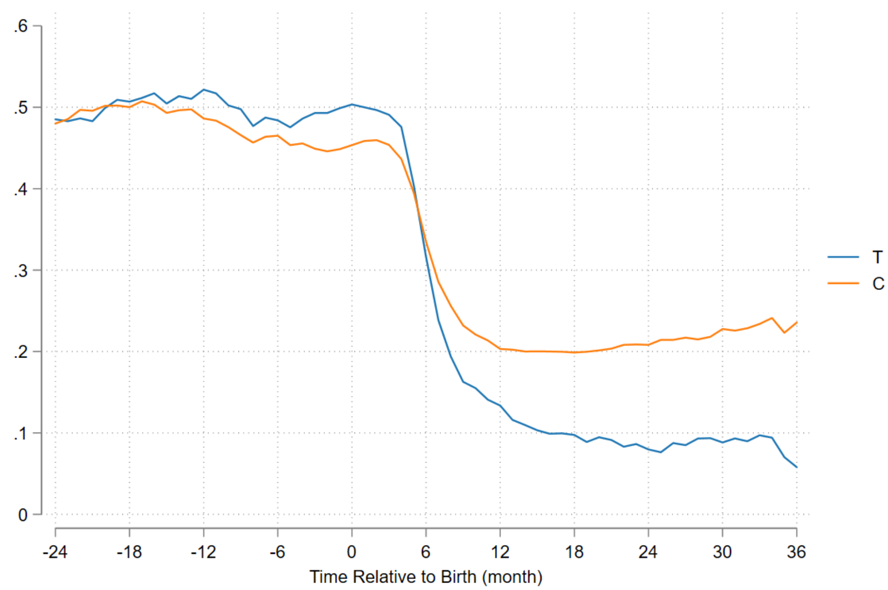
Notes: This figure shows the number of infant mortality per thousand births for all births and restricting only to children born with microcephaly. The total number of births and cases of microcephaly are made available by SINASC/SUS. Microcephaly is identified by the ICD-10 code Q02. Infant mortality is made available by SIM/SUS. We define infant mortality as deaths of one-year-old children or younger, and do not include fetal deaths.

Figure 5: Share of mothers employed after taking maternity leave



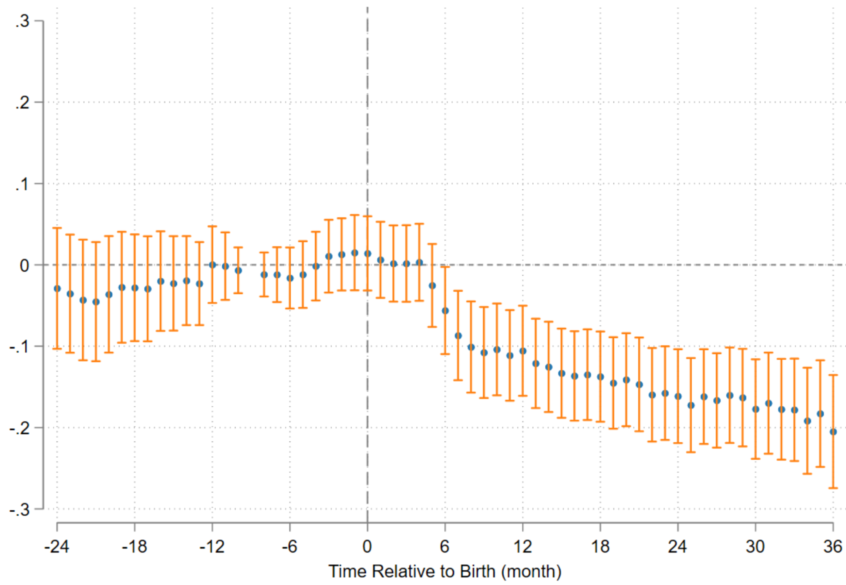
Notes:

Figure 6: Labor Force Participation of Treated and Matched Control Mothers



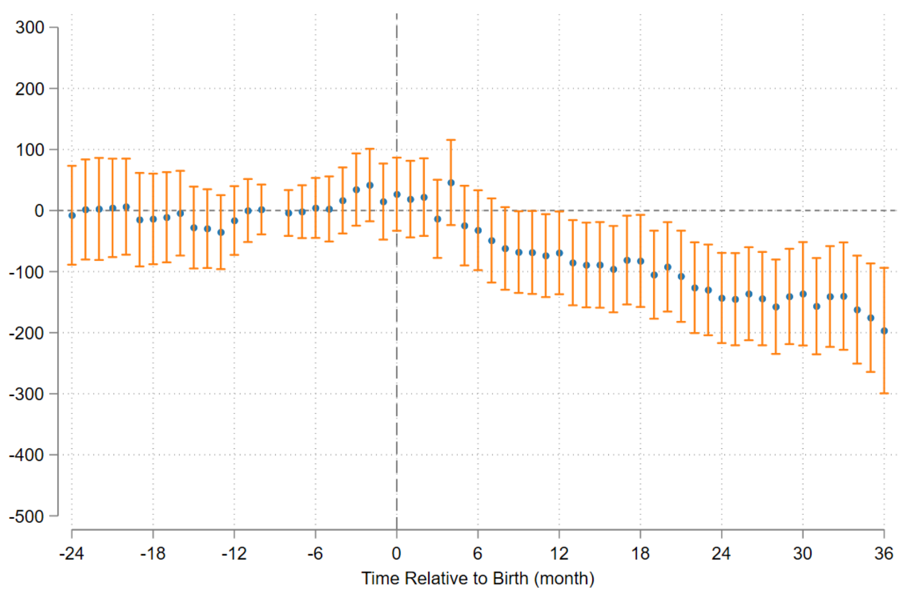
Notes: This figure shows the average share of mothers with a child with microcephaly (T) and other mothers (C) working relatively to childbirth.

Figure 7: Effect on Mothers' Formal Employment



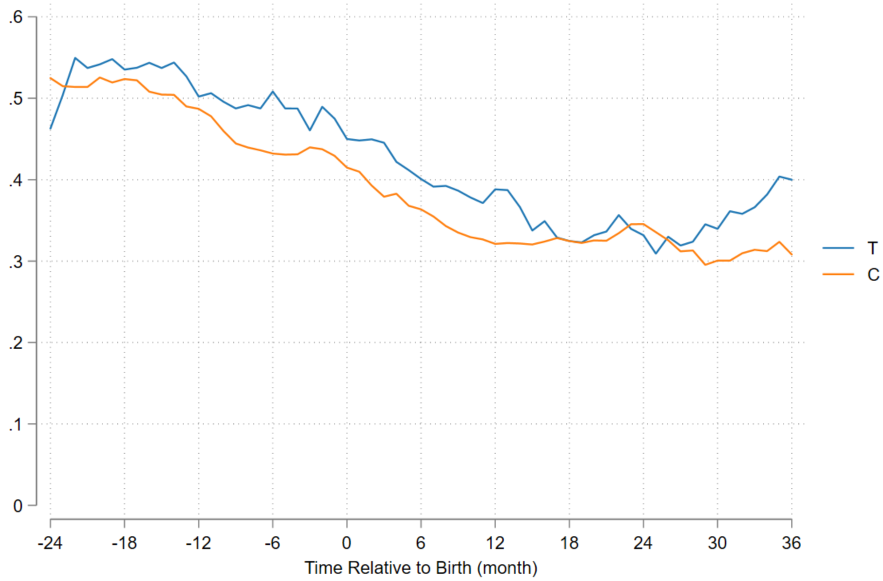
Notes: This figure shows the effect of having a child with microcephaly on mothers' monthly formal employment relatively to the childbirth.

Figure 8: Effect on Mothers' Earnings



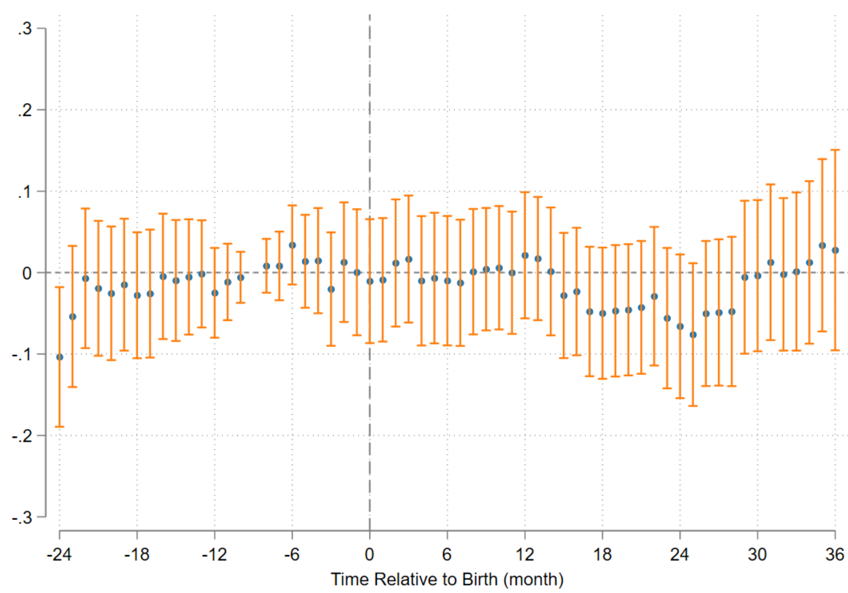
Notes: This figure shows the effect of having a child with microcephaly on mothers' monthly earnings relatively to the childbirth.

Figure 9: Labor Force Participation of Treated and Matched Control Fathers



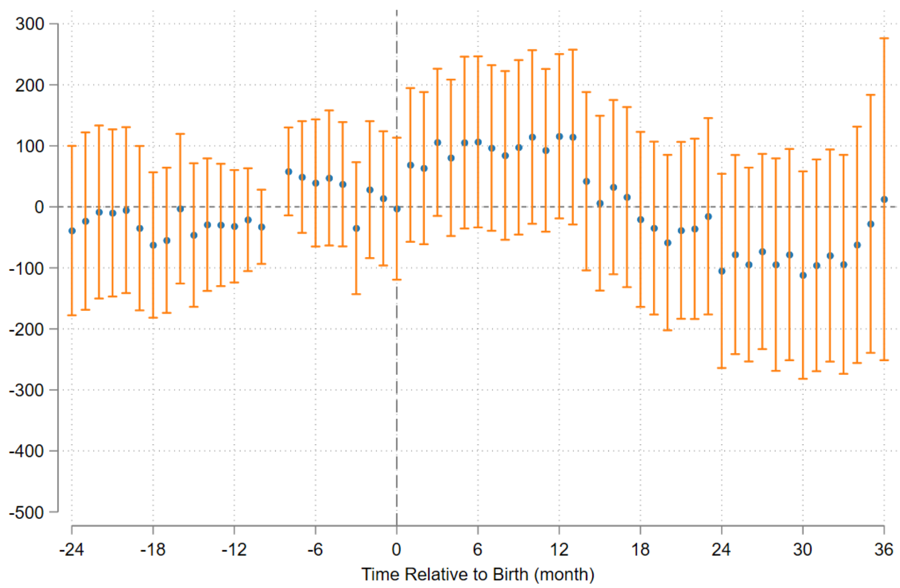
Notes: This figure shows the effect of having a child with microcephaly on fathers' monthly formal employment relatively to the childbirth.

Figure 10: Effect on Fathers' Formal Employment



Notes: This figure shows the average share of fathers with a child with microcephaly (T) and other fathers (C) working relatively to childbirth.

Figure 11: Effect on Fathers' Earnings



Notes: This figure shows the effect of having a child with microcephaly on fathers' monthly earnings relatively to the childbirth.

Tables

Table 1: Summary Statistics

	Treated	Control	p-value
Age	27.79	28.27	.432
SD	5.98	5.56	
Monthly Earnings	543.95	507.44	.192
SD	613.62	602.51	
Weekly Hours	20.69	19.45	.928
SD	21.41	21.27	
Race			
Indigenous	.004	.004	.141
White	.342	.347	.388
Black	.035	.061	.799
Asian	.013	.01	.657
Pardo	.456	.422	.747
Education			
Less than Middle School	.083	.091	.651
Finished Middle School	.171	.193	.337
Finished High School	.711	.658	.276
Finished College	.035	.057	.868
N	382	2045	

Notes: This table shows means and standard deviations for the treated and control samples along demographic and labor variables. The treated sample consists of mothers of children with microcephaly, and the control sample consists of matched mothers in the same municipalities, who gave birth at the same month. Both samples are conditional on having worked at least one month in the formal sector during the year before childbirth. Monthly earnings measured in 2014 BRL. Earnings and hours are unconditional on working, with 0 imputed for non-workers.

Table 2: Effect on Fertility

	Dep. Var.: Had another child				
	(1)	(2)	(3)	(4)	(5)
Sample:	All	All	One child	Two or more children	Without a child with microcephaly
Treated	-.013	$-.017^{*}$	$-.042^{***}$	.00007	
	(.0088)	(.0088)	(.013)	(.014)	
Microcephaly per birth					$-.00065^{**}$
					(.00027)
Pair FE	No	Yes	Yes	Yes	-

Notes: This table shows the chance of having another child up to three years after the birth of the child with microcephaly. Columns (1) and (2) include all families. We split the sample among families with only one child (column (3)) and more than one child (column (4)). In conlumn (5), we exclude mothers with a child with microcephaly, and compare control mothers in municipalities with a higher incidence of microcephaly to control mothers in municipalities with a lower incidence.

Table 3: Family Structure

	Fathers Presence after birth			
	(1)	(2)	(3)	(4)
Treated	-.014	-.066***	-.056***	
	(.022)	(.022)	(.017)	
Present 2015			.64***	
			(.012)	
Treated × Year=2019				-.051***
				(.019)
Constant	.35***	.37***	.14***	.36***
	(.0021)	(.0021)	(.0047)	(.00092)
Pair FE	No	Yes	Yes	Yes

Notes: This table shows the effect of having a child with microcephaly on the likelihood if fathers live in the same house.