COMMUNITY-BASED HEALTH INTERVENTION AND SUICIDE PREVENTION: EVIDENCE FROM BRAZIL

Rafael Parfitt[1]
Antonio Daniel Caluz[2]

[1]Fundação Getulio Vargas (EESP/FGV), São Paulo, SP, Brasil
[2]Insper Instituto de Ensino e Pesquisa (INSPER), São Paulo, SP, Brasil

This paper evaluates the impact of a community-based intervention on suicide prevention. To do so, we exploit heterogeneity in the program's implementation across time, allowing us to investigate the program's effect using an event study. We focused on the Family Health Program, which aims to provide primary health care to the population. We perform our analysis using municipality panel data. We employ a Difference-in-Differences strategy to assess the causal effect of the program. Our results indicate that FHP has a strong negative impact on suicide mortality rates and this effect is monotonic with the exposition time, especially in middle-aged individuals. Also, we found that more prolonged exposure to the program reduces suicide among women at younger ages. However, results indicate that the program is associated with increased hospitalization self-inflicted injuries rate in elderlies. We discuss different potential mechanisms for differential impacts by age and sex.

Keywords: community-based interventions; suicide prevention; Family Health Program.

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INTERVENÇÃO EM SAÚDE BASEADA NA COMUNIDADE E PREVENÇÃO DE SUICÍDIO: EVIDÊNCIAS DO BRASIL

Este artigo avalia o impacto de uma intervenção comunitária na prevenção do suicídio. Para isso, explorou-se a heterogeneidade na implementação do programa ao longo do tempo, permitindo investigar o efeito do programa por meio de um estudo de eventos. Focou-se no Programa de Saúde da Família, que visa prestar atenção primária à saúde da população. A análise foi realizada usando dados de painel municipais. Empregou-se uma estratégia de Diferença em Diferenças para avaliar o efeito causal do programa. Os resultados indicam que o PSF tem forte impacto negativo nas taxas de mortalidade por suicídio e esse efeito é monotônico com o tempo de exposição, principalmente em indivíduos de meia-idade. Além disso, descobriu-se que a exposição mais prolongada ao programa reduz o suicídio entre as mulheres em idades mais jovens. No entanto, os resultados indicam que o programa está associado ao aumento da taxa de internações autoprovocadas em idosos. Discutiu-se diferentes mecanismos potenciais para impactos diferenciais por idade e sexo.

Palavras-chave: intervenções comunitárias; prevenção ao suicídio; Programa Saúde da Família.

INTERVENCIÓN COMUNITARIA DE SALUD Y PREVENCIÓN DEL SUICIDIO: EVIDENCIA DE BRASIL

Este artículo evalúa el impacto de una intervención comunitaria en la prevención del suicidio. Para ello, se exploró la heterogeneidad en la implementación del programa a lo largo del tiempo, lo que permitió investigar el efecto del programa a través de un estudio de eventos. Se centró en el Programa de Salud de la Familia, que tiene como objetivo brindar atención primaria a la salud de la población. El análisis se realizó utilizando datos de panel municipales. Se utilizó una estrategia de diferencias en diferencias para evaluar el efecto causal del programa. Los resultados indican que el PSF tiene un fuerte impacto negativo en las tasas de mortalidad por suicidio y este efecto es monótono con el tiempo de exposición, especialmente en individuos de mediana edad. Además, se encontró que una exposición más prolongada al programa redujo el suicidio entre las mujeres a edades más tempranas. Sin embargo, los resultados indican que el programa está asociado con un aumento en la tasa de hospitalizaciones auto infligidas en los ancianos. Se discutieron diferentes mecanismos potenciales para impactos diferenciales por edad y sexo.

Palabras clave: intervenciones comunitarias; prevención del suicidio; Programa de Salud de la Familia.

1. INTRODUCTION

The mental health issues have increased worldwide, becoming the number one cause of mortality from self-inflicted injury (Bangs *et al.*, 2007; Hegerl *et al.*, 2013; Turecki & Brent, 2016; Gräfe *et al.*, 2019). Low-income countries are the most impacted ones (Funk *et al.*, 2012), however mental health is also a major problem in developed countries, verified by the high suicide rates in the USA and Japan (Rockett & Caine, 2015).

It is possible to highlight sevweral developed countries that have mitigated the problem through suicide prevention programs, primary and secondary care for depression and mental health promotion, such as Finland, Japan, USA, Canada, United Kingdom and France (Oyama *et al.*, 2008; Lebenbaum *et al.*, 2020).

Therefore, even with the growth of mental illness and suicide rates, it is possible that basic community interventions, even when not specifically focused on mental health, can be an important ally of mental health and suicide prevention, especially in low- income countries, where poorer areas have limited access to health.

This present study aimed to investigate the effect of the wide expansion of the PSF and basic community intervention, during the past decades, regarding mental health, suicide rates and self- inflicted injuries.

In relation to specific mental health interventions, De Macedo *et al.* (2021) discuss the association between CAPS municipal coverage and low rates of hospitalizations for attempted suicide, psychiatric problems, and alcoholism. In another study, by Dias and Fontes (2020), it was revealed that CAPS increased patients' access to mental health care and decreased hospitalizations for mental and behavioral disorders.

However, the literature about the impact of non-specific interventions, such as the PSF, on mental health is still scarce. Previous studies of community-based intervention do not focus on causal assessments, but on descriptive analysis.

Thus, this paper contributes to the study of a non-specific community-based intervention on mental health and suicide. In addition, the chosen methodology for this paper it is barely used in this subject.

This study turns out to be very important to Brazil, since mental health and self-inflicted injuries are being presented as a growing problem in the country. In 2016, 11,433 suicides were registered, which represents an increase of 2 % when compared to 2015, becoming one of the highest suicide rates in Latin America (Funk *et al.*, 2012). The PSF program is key to facing this problem, as it is a wide and embracing program of primary health care and health promotion.

The next sections are: section 2, which presents the models of primary health care and mental health; section 3, where the paper provides a review of the literature in relation to suicide and health interventions; section 4 provides a description of the data and the empirical strategy used; section 5 presents and discuss the results; and finally, in section 6, the paper is concluded.

2. BACKGROUND OF COMMUNITY-BASED HEALTH PROGRAMS IN BRAZIL

Mental health is one of the subjects that are part of the Family Health Care Program (PSF). The PSF's goal is to extend and qualify the health care, targeting gradual the and planned reduction of psychiatric hospitalizations, through psychosocial care (Brasil, 2010).

Mental health is one area that is part of the Family Health Care Program (PSF). The PSF goal is to extend and qualify mental health care, targeting a gradual and planned reduction of psychiatric hospitalizations through psychosocial care (Brasil, 2010)

The professionals working for the PSF are responsible for a recommended average of 3,000 inhabitants and a maximum of 4,000 inhabitants. As part of the program, there are family doctors or general doctors or community doctors, nurses, health family specialists, nurse technicians and community workers. Their work schedule is composed of 40 weekly hours and by a minimum team (DATASUS). Their main activities are: (i) To keep an updated families and individuals database and use the data to analyze the health situation, considering the social, economic, cultural, demographic and epidemiologic characteristics; (ii) Accurate definition of the working area, mapping and recognition of the area that will cover a determined population, with continuous update; (iii) Diagnosis, planning and execution of activities according to health risk criteria, prioritizing the solution of the most frequent health problems (Rocha & Soares, 2010).

In addition, another vital support initiative for the Primary Health Care is the Psychosocial Care Center (CAPS), acting as a strategic spot for the Psychosocial Care Network and is part of the community health network services that give priority care to people with mental disorders.

Brazil went through a psychiatric reform in 1978, which increased the primary intervention on mental health and decreased the hospitalization, followed by the CAPS program implementation to fulfil the psychiatric reform demand (Brasil, 2005). The first CAPS unity was created in 1987, broadly spread throughout the country nowadays. The CAPS program is composed by CAPS I, II or III, according to the total population that it will cover, besides having special unities for children and teenagers (CAPSi) and for drug and alcohol disorders (CAPSad).

CAPS is responsible for severe cases and those who need intensive care, having the duty to support the community-basic intervention. It is crucial the integration between the PSF and the CAPS to discuss cases, design projects, join interventions, support and share the knowledge. In addition to this integration, there must be complementarities between all the health networks and projects, such as the PSE (School Health Program), PRONASCI and Community Culture Centers, built on an intersectoral basis (Brasil, 2009)

To better understand the situation and the duty of the PSF teams in supporting mental health, Ribeiro *et al.* (2008) compared the assistance to mental health provided by a UBS (Unity

of Basic Health, from the Portuguese Unidade Básica de Saúde) with and without a PSF team, not sharing consistent results with the hypothetical expectation of a healthier system. The revision was done by Gryscheck Pinto (2015), showing that not always the best PSF teams are ready to deal with mental health issues, highlighting the need for training and integration between the teams and the health chain. In addition, Amarante *et al.* (2011) revealed that the PSF professionals have difficulties identifying mental health care as part of the family health team's responsibility. Another study also presented some issues related to the difficulty of understanding and matrix supporting the groups and a lack of communication between them, preventing interdisciplinarity (Alvarez; Vieira; Almeida, 2019).

The main strategies used to approach the mental health, accordingly to a revision study in the NASF were home visits; bond and hosting; guidance; integration; matrix support (Correia; Barros; Colvero, 2011).

The home visits are essential to identify, track and guide mental disorders patient's treatment and medication, as well as being important to establish family bonding and allowing the reception of the patients, which is vital to human assistance. The guidance and integration are about when it is necessary to provide more specialized attention, such as a CAPS transfer or a public psychiatrist appointment. The matrix support is the team endorsement for the primary health action development (Correia; Barros; Colvero, 2011).

Another study performed in some PSF units in Teresina-PI, aimed to identify the mental health nurse's graduation and actions. The main identified actions were home visits; medical appointments; guidance; medication delivery; outpatient care; community therapy. It was confirmed that mental health disorders are reported. However, just a few actions are taken due to the professional's low qualification to work in this area, reinforcing the need to increase their skills and the health chain integration (Souza *et al.*, 2007)

Since the PSF union with other institutions and initiatives such as the CAPS, mental health care has received more attention. The PSF expansion in the last decades may directly have an impact on mental disorders and suicide prevention.

3. LITERATURE ON SUICIDE AND SUICIDE PREVENTION

In a seminal study, Gary Becker started the Human Capital Theory in Economic that had many indirect implications for health economics (Becker, 1965). Grossman (1972) contributed with the literature on health eco nomics using a human capital model to study the demand for health. In this path, Hamermesh and Soss (1974) brought the health economics literature to study causes and consequences of suicide. More specifically, in line with Fedden (1938), they identify, theoretically and confirm empirically, that economic activity can be an important cause of suicide, although they recognize that most of the cases can be explained by non-economic issues. They find that negative shocks in economic activity may increase suicide. Moreover,

they show that older people are more sensitive to unemployment and that, in general, suicide rates are relatively lower in higher-income people. More recently, Anderson and Genicot (2015) investigated the impact of women property rights on male and female suicide rates in India. Using individual level data on domestic violence, they found an evidence that the increase of the property rights for women also increased the violence against them and it was associated with a decrease in the difference between female and male suicide rates. However, they found a growth on both male and female suicide rates.

This literature helps the design of public policy to target people more inclined to suicide. There are many interventions addressing the suicide problem in developed countries. The suicide prevention programs were applied worldwide and still are part of the public health of many countries around the world. For instance, a community-based suicide prevention intervention was designed in a rural area in Japan, the Yuri Town (Oyama *et al.*, 2008). The targeted population were the elderly, and the intervention was effective in reduce the high suicide rate of women, although it was not effective on men.

One issue in the public-policy design is its cost effectiveness. Beyond a statistically significant effect, the aggregate cost and social benefits should be an important dimension in the policy evaluation. Taking this cost-effectiveness into account Lebenbaum *et al.* (2020) evaluated a nationwide suicide prevention intervention in Canada, taken into account this cost-effectiveness of the intervention. Their analysis found that the suicide prevention was cost-effective, and this is likely to be the case for other similar countries.

For USA, there were targeted populations other than the elderly. In 1997, the US Air Force implemented the Air Force Suicide Prevention Program to reduce the high suicide rates in the institution. We use data available from 1981 to 2008. Knox *et al.* (2010) show that after the implementation of the program the suicide rate lower significantly except in 2004, when the program started to be less rigorously implemented.

As previously explained, the mental health care issue is a global issue. However, it increases on least developed countries due to the weak social and economic situation and less access to general health care. Becker and Kleinman (2013) shows that in low-income countries, more than 75% of the population diagnosed with mental disorders have neither an adequate treatment nor any medical care. Regarding the small population portion that has access to medical care, there are just a few available data that measure the quality or the effectiveness of medical assistance.

Wang *et al.* (2007) also highlights that the mental health care challenges are globally presented and stronger on least developed countries. The data used in his study revealed that the mental health care users in these countries are smaller than those on the developed ones, which is directly proportional to the GDP amount provided to heath care, evidencing its need of expansion and better allocation.

Santos and Siqueira (2010) investigated the occurrence of the mental disorders in the adult population from Brazil. They found in the literature that the occurrence varies among 20 % and 56 % in the adults. The most affected age group was the one between 25 and 54 years old, more probably on women, informal employment, social economic matters (unemployment, poor education attainment, underprivileged house conditions) and marital status (divorced or widowed). The most affected workers group were: teachers, farm workers, health professionals, drivers and bus collectors.

Williams, Latta and Conversano (2007) articulates that the sooner the mental disorder is treated, the better patients will accept and respond to its treatment, and psychiatric hospitalizations will be reduced. The public service is often impaired by high demand and low service capacity, affecting the mental disorders diagnoses and delaying the treatment.

Andrade *et al.* (2012) shared in their analysis of São Paulo that high anxiety and mood disorders rates, impulse control, substances usage as well as their mixture with the high urbanity, social de- prival ion and crime exposure indicates that women and migrant men who lives in poor areas are the most susceptible group.

Mosciki (1994) found differences on suicide attempts between the genders, showing that the suicides attempts are more frequent among women, while consummated suicides mostly happen with men, taking into consideration that the risks for both genders are inherited from unstructured family atmosphere and mental disorders. In another study, Moscicki *et al.* (1988) also demonstrated that a higher suicide rate is linked with individuals with previous mental disorder diagnoses, women, divorced couples, white people and those on lower social condition.

The literature considers that the main risks for suicidal behavior in younger people are the social and educational disadvantage, mental illness, exposure to stressful circumstances during life and substances abuse (Beatrais, 2000).

Additional studies have demonstrated the relation among access to primary health care service with health care or suicide risk. Johannessen *et al.* (2001) identified strong associations between mental disorders and suicide. However, a well-succeeded treatment can prevent suicide, therefore, the bigger is the access to treatment, the better will be the impact on suicide rates. Even though suicide can be prevented by the treatment, the increase in the health care programs in Norway did not presents substantial impact on the suicide rates.

In contradiction of de Johannessen et al (2001) study, Tondo *et al.* (2006) demonstrated that the mental health care access indicators are strongly linked with decreasing suicide rates. For Pirkola *et al.*, the analyses reveal that the mental health communitarian services are more related to lower suicide rates than the hospital service.

De Macedo *et al.* (2021) discloses that the CAPS opening was associated with lower hospitalization rates and lower rates of psychiatric disorders and alcoholism, becoming a potential cost and hospitalizations reducer in low/medium income countries. Dias and

Fontes (2020) also shared that CAPS accessibility has the potential to reduce mental disorders hospitalizations, especially those who need long and intensive care, besides the decrease of liver-alcoholic diseases due to the substances abuse center addition.

The literature articulates that the suicide and other metal disorders are related with many social, physiological and economic factors, and determine that treatment accessibility can provide impacts in the mental health indicators. Furthermore, it states that an early treatment can prevent suicide and be beneficial for the patients while less expensive for the government. Consequently, the relationship between the expansion of primary health care services (especially the PSF) and suicide rates will be studied in the next sections.

4. DATA DESCRIPTION AND EMPIRICAL STRATEGY

4.1 Data

In this section we describe our data and empirical strategy. We take advantage of the public availability of a Brazilian municipality-level data allowing us to build a municipality-year panel data. For each municipality, the year of the implementation of the Family Health Program is obtained from the Health Ministry in the Department of Basic Attention, which provides the year of implementation at municipality level starting from 1996 to 2004. We also collect some educational characteristics of the municipalities such as number of professors, number of schools, rural schools and number of professors with at least superior education, which are available on Ministry of Education National Institute for Educational Studies and Research (INEP)[1]. Data on mortality by self-injury (suicide) and hospitalization by self-inflicted injury for different age and gender at the municipality level are available from the Integrated System of Information (DATASUS)[2]. Lastly, we have information between 1996 to 2004 forming a Brazilian municipality panel data of 8 years. Specifically, the availability of hospitalization data is not reliable before 1998, so we only use it from 1998 onward.

Table 1 summarizes the information of Brazilian suicide rate by age and year. As well, information of the coverage by year of FHP beneficiaries. We can see that in 1996 FHP exposition was in 3.89% of municipalities and in 2004 it was in around of 88%. Note also that most of the suicides come from men in middle age, being approximately 5 times higher than the suicide rate of women. Table 2 provide information of the summary statistics of the municipalities panel. Control variables are shown *per capita*, and we use educational characteristics as controls. Moreover, dependent variables are in logarithm of the rate by the population of interest (in ten-thousand terms), more details of descriptive statistics in Table 2.

[1] The National Institute of Educational Studies and Research *Anísio Teixeira* (INEP) is a federal agency linked to the Brazilian Ministry of Education (MEC).
[2] Integrated System of Information (DATASUS) is a Brazilian organization who provides information of health and programs aimed at the Brazilian population.

Table 1 – Characterization of in Brazilian Municipality Sample

Panel A: Sample by year			
	In 1996	In 2000	In 2004
No. of obs. (total)	5, 572	27, 820	44, 767
No. of obs. (yearly)	5, 572	5, 572	5, 572
No. of suicides (total)	5, 667	28, 218	53, 311
No. of suicides (yearly)	5, 667	5, 546	6, 453
FHP beneficiaries mun. (%)	3.89	55.07	88.51
Panel B: Sample by Age and Sex			
	Aged to (15 to 29)	Aged to (30 to 49)	Aged to (50 to 74)
No. of suicide (total)	47, 298	61, 422	38, 822
No. of suicide from (mun. mean)	8.84	11.02	6.96
No. of suicide total from (by men)	39, 112	50, 605	31, 393
No. of suicide total from (by women)	8, 179	10, 809	7, 424

Note: Panel A and B represent the sample municipality-yearly data from 1996 to 2004. Panel A provide information of sample by year and panel B provide information of the sample by age groups.

Table 2 – Descriptive Statistics - Brazilian Municipality-Level Data in Baseline (1996)

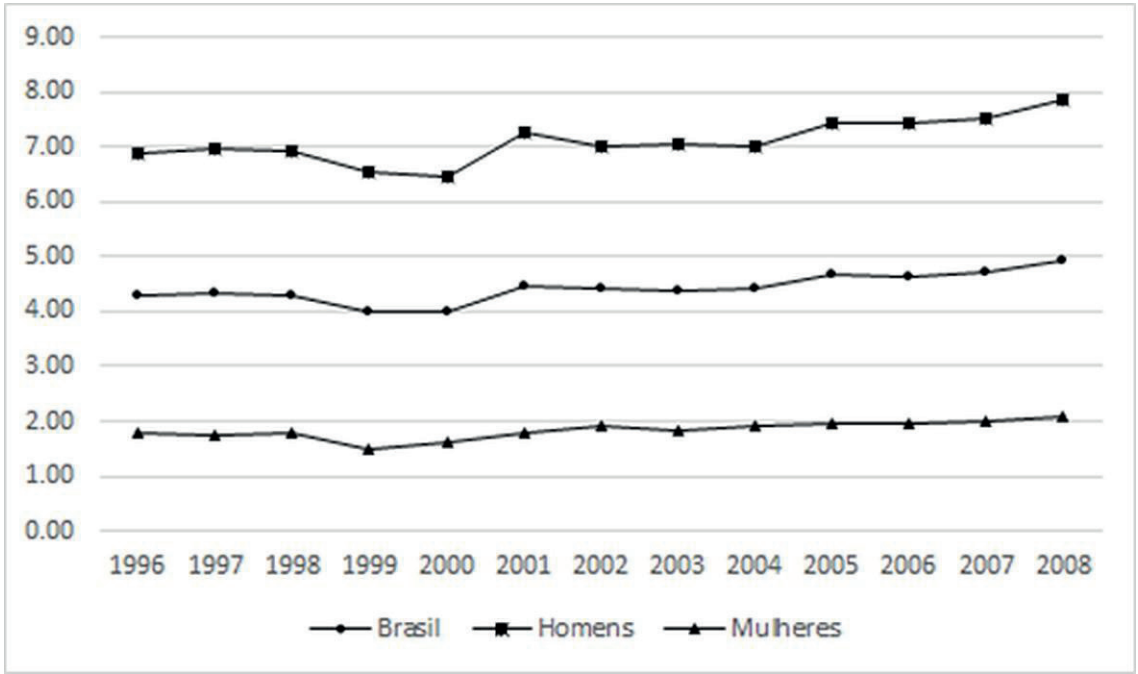
	Mean	SD	Min	Max	Source of Data
Total Suicide Mortality rate	0.6221	1.3683	0.000	30.549	SIM/datasus
Suicide Mortality rate (15-29 years)	0.4380	1.7036	0.000	49.261	SIM/datasus
Suicide Mortality rate (30-49 years)	0.6731	2.1914	0.000	55.658	SIM/datasus
Suicide Mortality rate (50-74 years)	0.8017	3.0617	0.000	79.365	SIM/datasus
Total Suicide Mortality rate (Men)	1.0062	2.3659	0.000	45.180	SIM/datasus
Suicide Mortality rate (Men 15-29 year)	0.6922	2.9094	0.000	85.106	SIM/datasus
Suicide Mortality rate (Men 30-49 years)	1.1036	3.8767	0.000	106.383	SIM/datasus
Suicide Mortality rate (Men 50-74 years)	1.3262	5.3997	0.000	126.582	SIM/datasus
Total Suicide Mortality rate (Women)	0.2236	1.1104	0.000	39.447	SIM/datasus
Suicide Mortality rate (Women 15-29 years)	0.1705	1.5186	0.000	59.880	SIM/datasus
Suicide Mortality rate (Women 30-49 years)	0.2262	1.7584	0.000	50.000	SIM/datasus
Suicide Mortality rate (Women 50-74 years)	0.2701	2.5903	0.000	178.571	SIM/datasus
Hosp. rate (SI) Total	0.0403	0.2892	0.000	21.8613	SIM/datasus
Hosp. rate (SI) Total (15-29 year)	0.5691	1.4115	0.000	47.3272	SIM/datasus
Hosp. rate (SI) Total (30-49 year)	0.0053	0.1136	0.000	15.3846	SIM/datasus
Hosp. rate (SI) Total (50-74 year)	0.9850	2.6417	0.000	62.7666	SIM/datasus
Hosp. rate (SI) Men Total	1.8263	4.8258	0.000	105.3152	SIM/datasus

	Mean	SD	Min	Max	Source of Data
Hosp. rate (SI) Men (15-29 year)	0.0223	0.3196	0.000	31.7460	SIM/datasus
Hosp. rate (SI) Men (30-49 year)	1.6096	3.8653	0.000	78.0488	SIM/datasus
Hosp. rate (SI) Men (50-74 year)	1.0971	2.6679	0.000	44.9942	SIM/datasus
Hosp. rate (SI) Women Total	1.2065	2.7983	0.000	76.4636	SIM/datasus
Hosp. rate (SI) Women (15-29 year)	1.2950	3.1230	0.000	70.4688	SIM/datasus
Hosp. rate (SI) Women (30-49 year)	0.0228	0.1570	0.000	16.0957	SIM/datasus
Hosp. rate (SI) Women (50-74 year)	0.0458	0.3428	0.000	22.5839	SIM/datasus
FHP at Municipality	0.4927	0.5000	0.000	1.000	SIM/datasus
Number of schools (perc.)	0.0033	0.0023	0.0001	0.0343	INEP
Number of professors (perc.)	0.0141	0.0042	0.0014	0.0780	INEP
Proportion of rural school	0.6546	0.2784	0.000	1.000	INEP

Note: This table contains the values of the descriptive statistics for the municipality panel variables. This database is created by collecting data from Brazilian from 1996. The meaning of hosp. (SI), is hospitalization by self-inflicted injury. The baseline of hospitalization data is from 1998. Suicide rate are in per 10,000 people and hospitalization are in per 1,000 people.

Figure 1 shows how the suicide trend evolved over time from 1996 to 2008. Particularly, it confirms that men's suicide mortality is higher than in women. We can also notice that there is an increase in all trends recently. Moreover, the rates are increasing most of the years for both genders being one of the main issues in health policy. We also highlight that middle-aged Brazilians are the main affected by suicide (Wong *et al.*, 2008).

Figure 1 – Suicide rate per 100,000 population



Data from Datasus, 1996-2008.

5. EMPIRICAL STRATEGY

Since the adoption of FHP on municipalities varies over time and we have data previously to treatment implementation, we employed a Difference-in-Differences approach exploring the impact of program over municipalities. Our methodology is particularly well suited as it eliminates the self- selection bias for the program for the program due to fixed non-observed characteristics (Bertrand *et al.*, 2004). This paper performs a Difference-in-Differences specifications with heterogeneity in the time of adoption, having an effect that is allowed to vary with the time of implementation.

We follow Rocha and Soares (2010); Bhalotra *et al.* (2019); Parfitt *et al.* (2019) employing this specification to capture the pre and post timing of adoption and different time of program exposure. More details of this empirical specification can be found in the cited paper.

Hence, our equation for the Difference-in-Differences Model that captures the exposition time variation of FHP is the following:

$$Y_{Suicide_{m,t}} = \mu_m + \sum_{j=-6}^{8} \beta_j \times FHP_{m,t-j} + \delta X_{m,t} + \mu_{s,t} + \nu_{m,t} \qquad (1)$$

where $Y_{Suicide^{m,t}}$ denotes suicide rate outcome for municipality *m* in year *t*, $FHP_{m,t-j}$ indicates a dummy variable assuming value 1 if municipality *m* had already received at least one team of the FHP in year $t-j$. $X_{m,t}$ denotes a set of controls for municipality level, μ_m is a municipality fixed effect, $\mu_{s,t}$ is state-year fixed effect, $\nu_{m,t}$ is the random error term, α, β_j and δ are parameters.

Also, notice that the comparison group in equation (1) is composed by municipalities where FHP was not implemented yet and 1 year before its arrives. Moreover, we follow the recommendations of Abadie *et al.* (2017) to include cluster standard errors at municipality level for the possibility of heteroskedastic errors problem.

We also opt to explore the period where the program has a higher variation between treatment and control using the panel data from 1996 to 2004. After 2004, the Family Health Program implementation has a low level of variation. This has been done by previous evaluations of the FHP program on other health outcomes, as we can see in Rocha and Soares (2010); Bhalotra *et al.* (2019).

Furthermore, one concern about this econometric specification is the bias that arises with by the possibility of confounding omitted factors correlated with both FHP and suicide rate outcomes. We highlight that we use fixed effect over municipality, state and year and their iteration to control any possibility of endogeneity. Another concern is that the adoption of the program may be correlated with unobserved municipality characteristics. One example is if the intervention is correlated to poor municipalities, this would cause endogeneity in all our estimates. However, we are not concerned about this possibility, since Rocha and Soares

(2010) perform a hazard estimation over FHP on municipalities to investigate the correlation of adoption, and they found that the program follows political adoption.

This empirical specification allow us to examine the effect of the time exposition to the program on the Tables comparing the $\beta_j^j s$ with the control group. Additionally, we conduct a placebo-like study with $FHP_{m,t-j}$ dummies to test the plausibility of the Difference-in-Differences pre-existing trends that threat our identification strategy. We present the results in the next section.

6. RESULTS AND DISCUSSION

In this section, we present the estimation results of the Family Health Program's effect on suicide mortality and hospitalization rates. First, in Table 3, we present the results for suicide rate splitting the effects by age, following the idea from Fedden (1938) that people from different ages can be more vulnerable to suicide. Then, we move to Tables 4 and 5 where we split the results by gender. Therefore, Tables 6 to 8 report the effects of FHP on hospitalization for self-inflicted injury rate also splitting the effects by sex and age. Finally, we discuss the mechanism we believe that are driving the results and we report some placebo tests varying the year in which the FHP was implemented in the econometric specification.

In our tables, each column represents a different age range for the impact of the FHP on an outcome variable. Following an event study, we present the coefficients for each year. One should notice that our specification uses a log-linear form, then, the percentage variation in suicide rate when receiving the FHP intervention is obtained computing $e^{\beta} - 1$, , where β is the estimated coefficient.

Table 3 reports the effect of the intervention on the logarithm of suicide for all individuals. First, note that, in general, all the impact coefficients of the program year 0 to 8 are negative and have a tendency to fall. Following the first column, the effects over the total suicide rate, there is a small significant drop around 2% on the second year of FHP penetration. This increases in magnitude in the fifth year of the program (around 5%), and monotonically decreases until the eighth year of the program penetration with an effect of 11.8%. Still, in Table 3, we notice that when we split the suicide rate by age, there is a significant drop in the suicide rate over the middle age people (30-49 years old). Note that also impact starting in the 2nd year of the program implementation with a magnitude around 5% of the decrease in the suicide rate of 30-49 years old, and this effect declines monotonically until FHP year 8 to about 21%. We find no significant effects over other ages. Since Community-based interventions are policies mainly devoted to primary health care, the FHP teams may identify and provide information to patients about the appropriate treatment of depression and anxiety. It also provides some other information for the most important group of people with the most serious mental illness,

as reported in Hegerl *et al.* (2013), especially in developing countries, where there is a huge inequality in the health system, and then there seems to be important to reduce the suicide rates Funk *et al.* (2012). Hence, family health programs can provide and improve an appropriate treatment for individuals with depression and individuals who see no longer reason to live. So far, our results are in line with this well-established idea in the literature. Now, we explore heterogeneity in the estimation of the effect to show what are the sub-populations driven the results and provide some mechanisms.

Table 3 – Effects of FHP on Logarithm of Suicide Mortality Rate Outcomes for All

	Suicide Total	Suicide rate 15-29	Suicide rate 30-49	Suicide rate 50-74
DID Model: FHP Exposition time				
FHP Year -6	0.0299	0.0245	0.0818	-0.0292
	(0.222)	(0.438)	(0.012)	(0.476)
FHP Year -5	0.0359*	0.0193	0.0714***	-0.0082
	(0.071)	(0.446)	(0.005)	(0.792)
FHP Year -4	0.0232	0.0165	0.0574***	-0.0260
	(0.119)	(0.405)	(0.003)	(0.275)
FHP Year -3	0.0006	-0.0127	0.0317*	-0.0287
	(0.962)	(0.377)	(0.051)	(0.131)
FHP Year -2	0.0053	0.0035	0.0184	0.0150
	(0.527)	(0.733)	(0.115)	(0.316)
FHP Year 0	0.0033	0.0129	-0.0015	-0.0095
	(0.679)	(0.196)	(0.894)	(0.523)
FHP Year 1	-0.0068	0.0086	-0.0239	-0.0133
	(0.526)	(0.507)	(0.107)	(0.464)
FHP Year 2	-0.0229*	-0.0080	-0.0497***	0.0004
	(0.090)	(0.623)	(0.009)	(0.985)
FHP Year 3	-0.0202	-0.0061	-0.0412*	-0.0196
	(0.236)	(0.763)	(0.070)	(0.509)
FHP Year 4	-0.0334	-0.0123	-0.0681**	-0.0296
	(0.110)	(0.616)	(0.015)	(0.439)
FHP Year 5	-0.0510*	-0.0309	-0.1018***	-0.0218
	(0.058)	(0.304)	(0.003)	(0.637)
FHP Year 6	-0.0722**	-0.0465	-0.1248***	-0.0428

	Suicide Total	Suicide rate 15-29	Suicide rate 30-49	Suicide rate 50-74
DID Model: FHP Exposition time				
FHP Year 7	-0.0673*	-0.0360	-0.1413***	-0.0298
	(0.083)	(0.386)	(0.003)	(0.652)
FHP Year 8	-0.1129***	-0.0932**	-0.1943***	-0.0393
	(0.004)	(0.045)	(0.000)	(0.543)
N	43,767	43,767	43,767	43,767

Note: This table present the results of FHP on logarithm of suicide mortality rate at municipality-level. The interval is between 1996 to 2004. The estimation is a Heterogeneous Difference-in-Differences in time. All specifications include cluster standard errors at municipality-level. As well municipality, state-year fixed-effects. All regressions are weighted by the baseline respective population. Control variables were omitted due to space considerations. Values in parentheses are the robust p-values of the coefficients. *, ** and *** represent statistical significance of 10%, 5% and 1%, respectively.

Table 4 provides the effects of the program on men by age. We find negative significant coefficients on two columns, for men on the total suicide rate and suicide mortality rate of 30-49 years old. For the first column, the magnitude of effects goes around 7% in year 5 to about 15.5% in year 8 of FHP penetration. Following this, the effects of the program on men aged 30 to 49 years, the intervention has a significant impact of the program in year 2, and in year 5 to year 8. Its magnitude decreases monotonically until about 25% in 8 years of program penetration. A possible mechanism that may explain this decline is the relation of community-based programs on primary care, FHP may be providing adequate treatment for individuals with suicidal tendencies. Moreover, as mention earlier, a low perspective of future and low socioeconomic factors are main factors of suicide in men in middle life Wong *et al.* (2008) and the program achieves this dissemination of information on appropriate psychological treatment, and this leads to a decline concerning suicide.

Table 4 – Effects of FHP on Logarithm of Suicide Mortality Rate Outcomes for Men by age

	Suicide Total Men	Suicide Men 15-29	Suicide Men 30-49	Suicide Men 50-74
DID Model: FHP Exposition time				
FHP Year -6	0.0482	0.0412	0.1060**	-0.0271
	(0.159)	(0.344)	(0.025)	(0.628)
FHP Year -5	0.0456	0.0257	0.0869**	-0.0116
	(0.103)	(0.466)	(0.015)	(0.779)
FHP Year -4	0.0347*	0.0219	0.0788***	-0.0247

	Suicide Total Men	Suicide Men 15-29	Suicide Men 30-49	Suicide Men 50-74
DID Model: FHP Exposition time				
	(0.099)	(0.418)	(0.005)	(0.448)
FHP Year -3	0.0041	-0.0118	0.0431*	-0.0358
	(0.807)	(0.554)	(0.066)	(0.166)
FHP Year -2	0.0029	-0.0028	0.0281*	-0.0274
	(0.807)	(0.843)	(0.097)	(0.189)
FHP Year 0	0.0046	0.0203	0.0079	-0.0215
	(0.691)	(0.159)	(0.633)	(0.312)
FHP Year 1	-0.0044	0.0180	-0.0180	-0.0247
	(0.775)	(0.336)	(0.398)	(0.355)
FHP Year 2	-0.0228	-0.0009	-0.0461*	-0.0040
	(0.243)	(0.969)	(0.095)	(0.899)
FHP Year 3	-0.0205	-0.0002	-0.0341	-0.0367
	(0.397)	(0.994)	(0.300)	(0.375)
FHP Year 4	-0.0377	-0.0119	-0.0647	-0.0523
	(0.205)	(0.733)	(0.112)	(0.322)
FHP Year 5	-0.0662*	-0.0393	-0.1094**	-0.0485
	(0.081)	(0.350)	(0.027)	(0.458)
FHP Year 6	-0.0858*	-0.0511	-0.1362**	-0.0588
	(0.065)	(0.334)	(0.021)	(0.417)
FHP Year 7	-0.0770	-0.0359	-0.1594**	-0.0439
	(0.154)	(0.532)	(0.019)	(0.621)
FHP Year 8	-0.1440***	-0.1042	-0.2252***	-0.0745
	(0.008)	(0.114)	(0.002)	(0.425)
N	43,767	43,767	43,767	43,767

Note: This table present the results of FHP on logarithm of suicide mortality rate at municipality-level. The interval is between 1996 to 2004. The estimation is a Heterogeneous Difference-in-Differences in time. All specifications include cluster standard errors at municipality-level. As well municipality, state-year fixed-effects. All regressions are weighted by the baseline respective population. Control variables were omitted due to space considerations. Values in parentheses are the robust p-values of the coefficients. *, ** and *** represent statistical significance of 10%, 5% and 1%, respectively.

We also consider the impacts of the FHP on women in Table 5. The results are similar to the previously presented Tables. There is a monotonic decrease with FHP implementation. For middle-aged women (30-49 years) this drop in the suicide rate starts in year 1 with a magnitude of 2% dropping to 6% in year 5 until reaches a drop around 12%. Moreover, we found an interesting result in younger women with 15-29 years old, exceptionally for then we find a significant effect when splitting by age. That is a drop in the suicide rate of women aged between 15 and 29 years. This drop is between year 6 to year 8 of the program, with a drop around 9% in FHP year 8. Since adolescent older women are more likely to attempt suicide than men of the same age (Andrews; Lewinsohn, 1992), this is a potential sub-population in which the intervention is necessary, and as shown, effective. We find no significant effect of the intervention on the suicide rate of women with higher age (50-74 years).

Table 5 – Effects of FHP on Logarithm of Suicide Mortality Rate Outcomes for Women by age

	Suicide Women Total	Suicide Women 15-29	Suicide Women 30-49	Suicide Women 50-74
DID Model: FHP Exposition time				
FHP Year -6	0.0080	0.0073	0.0246	-0.0135
	(0.670)	(0.754)	(0.349)	(0.661)
FHP Year -5	0.0207	0.0187	0.0288	0.0086
	(0.158)	(0.280)	(0.141)	(0.737)
FHP Year -4	0.0071	0.0138	0.0137	-0.0154
	(0.534)	(0.329)	(0.369)	(0.416)
FHP Year -3	-0.0027	-0.0088	0.0083	-0.0061
	(0.776)	(0.428)	(0.518)	(0.697)
FHP Year -2	0.0089	0.0129	0.0011	0.0074
	(0.257)	(0.165)	(0.911)	(0.562)
FHP Year 0	0.0017	0.0020	-0.0112	0.0073
	(0.810)	(0.819)	(0.274)	(0.594)
FHP Year 1	-0.0127	-0.0104	-0.0261**	0.0005
	(0.149)	(0.312)	(0.031)	(0.970)
FHP Year 2	-0.0222**	-0.0190	-0.0404***	0.0059
	(0.034)	(0.130)	(0.007)	(0.752)
FHP Year 3	-0.0207	-0.0227	-0.0349*	0.0027
	(0.109)	(0.141)	(0.055)	(0.905)
FHP Year 4	-0.0289*	-0.0228	-0.0553***	-0.0098
	(0.063)	(0.224)	(0.009)	(0.730)

	Suicide Total	Women	Suicide 15-29	Women	Suicide 30-49	Women	Suicide 50-74	Women
DID Model: FHP Exposition time								
	(0.109)		(0.223)		(0.014)		(0.919)	
FHP Year 6	-0.0544**		-0.0468*		-0.0817***		-0.0381	
	(0.019)		(0.099)		(0.006)		(0.338)	
FHP Year 7	-0.0563**		-0.0527*		-0.0824**		-0.0357	
	(0.036)		(0.098)		(0.021)		(0.457)	
FHP Year 8	-0.0767***		-0.0895***		-0.1199***		-0.0158	
	(0.007)		(0.005)		(0.003)		(0.751)	
N	43,767		43,767		43,767		43,767	

Note: This table present the results of FHP on Logarithm of Suicide Mortality rate at municipality-level. The interval is between 1996 to 2004. The estimation is a Heterogeneous Difference-in-differences in time. All specifications include cluster standard errors at municipality-level. As well municipality, state-year fixed-effects. All regressions are weighted by baseline the respective population. Control variables were omitted due to space considerations. Values in parentheses are the robust p-values of the coefficients. *, ** and *** represent statistical significance of 10%, 5% and 1%, respectively.

The results showing an increase in the hospitalization in older people is interesting since Bhalotra *et al.* (2019) shows that community-based health programs increase the provision of hospital beds.

This, combined with the visitations from the FRP teams, that helps to identify better who needs to go to the hospital, drives this effect. The literature reports that the treatment of suicide prevention of older people is more complicated and that they have more likelihood of attempts suicide Kim *et al.* (2001). Also, elderly people may be in difficult-to-reach places, such as agriculture or more displaced cities, given that Brazil has a large territorial extension, which would lead them to benefit only from the increase in hospital beds. Thus, the Brazilian FHP also has some positive implications for the elderly.

Tables 6 to 8 show the effect of the FHP on hospitalization by self-injury rates. Table 6 provides the effects on the self-injury hospitalization rate by age. Following column 4 in this Table, the program has a monotonically significant increasing effect in the hospitalization in the older age group; this effect starts in program year 4 and going until year 8 of program exposition. This can be due several factors, one of which is that FHP increases the number of hospital beds as showed in Bhalotra *et al.* (2019). Another factor that may explain this effect is that men are less likely to accept health care treatment in comparison to women (Murphy, 1998), so the FHP teams are identifying men who should be hospitalized, and taking them to

the hospitals. This indicates that one channel in which the program works is through identifying and referring people to adequate treatment, where women are more likely to receive primary care, and then they go more often to the hospital when needed.

Table 6 – Effects of FHP on Logarithm of Hospitalization for Self-inflicted Injury rate by age

	Hosp. rate Total	Hosp. rate 15-29	Hosp. rate 30-49	Hosp. rate 50-74
DID Model: FHP Exposition time				
FHP Year -6	0.0080	0.0096	-0.0248	-0.0734
	(0.599)	(0.886)	(0.709)	(0.249)
FHP Year -5	0.0127	0.0256	0.0088	-0.0399
	(0.255)	(0.609)	(0.859)	(0.412)
FHP Year -4	0.0121	0.0223	0.0070	-0.0406
	(0.205)	(0.567)	(0.856)	(0.288)
FHP Year -3	0.0018	0.0284	0.0232	-0.0120
	(0.774)	(0.298)	(0.375)	(0.639)
FHP Year -2	0.0009	0.0096	0.0106	-0.0062
	(0.814)	(0.518)	(0.470)	(0.673)
FHP Year 0	-0.0055	0.0034	0.0041	0.0113
	(0.131)	(0.829)	(0.793)	(0.465)
FHP Year 1	-0.0060	0.0077	0.0139	0.0302
	(0.323)	(0.775)	(0.598)	(0.234)
FHP Year 2	-0.0115	0.0137	0.0307	0.0522
	(0.189)	(0.718)	(0.410)	(0.144)
FHP Year 3	-0.0117	0.0165	0.0395	0.0625
	(0.297)	(0.731)	(0.398)	(0.166)
FHP Year 4	-0.0127	0.0374	0.0627	0.1057**
	(0.343)	(0.516)	(0.264)	(0.048)
FHP Year 5	-0.0121	0.0466	0.0780	0.1327**
	(0.461)	(0.494)	(0.244)	(0.039)
FHP Year 6	-0.0078	0.0737	0.1162	0.1973***
	(0.653)	(0.346)	(0.129)	(0.008)
FHP Year 7	-0.0056	0.0870	0.1257	0.2180**
	(0.802)	(0.330)	(0.158)	(0.014)
FHP Year 8	0.0034	0.0636	0.1466	0.2712***
	(0.897)	(0.525)	(0.144)	(0.007)
N	34,811	34,811	34,811	34,811

Note: This table present the results of FHP on logarithm of hospitalization for self-inflicted injury rate at municipality-level. The interval is between 1998 to 2004. The estimation is a Heterogeneous Difference-in-differences in time. All specifi- cations include cluster standard errors at municipality-level. As well municipality, state-year fixed-effects. All regressions are weighted by the baseline respective population. Control variables were omitted due to space considerations. Values in parentheses are the robust p-values of the coefficients. *, ** and *** represent statistical significance of 10%, 5% and 1%, respectively.

In Table 7 we note that there is a significant drop in hospitalization on men 30 to 49 years old. This drop starts in FHP year 1 with a monotonic drop until program year 8 with a negative magnitude of around 5.7%. In addition, we can observe that for the hospitalization rate older men it has a positive effect and increase until program year 8, with a magnitude of about 30%. As discussed earlier, this may occur since the program increases the number of hospital beds with greater attention to these people of these age groups.

Table 7 – Effects of FHP on Logarithm of Hospitalization for Self-Inflicted Injury Rate of Men by Age

	Hosp. Men Total	Hosp. Men 15-29	Hosp. Men 30-49	Hosp. Men 50-74
DID Model: FHP Exposition time				
FHP Year -6	0.0016	0.0028	0.0399*	-0.0899
	(0.922)	(0.971)	(0.062)	(0.202)
FHP Year -5	0.0089	0.0230	0.0397**	-0.0402
	(0.497)	(0.689)	(0.035)	(0.452)
FHP Year -4	0.0050	0.0269	0.0228*	-0.0302
	(0.630)	(0.547)	(0.075)	(0.468)
FHP Year -3	-0.0013	0.0326	0.0189*	-0.0168
	(0.872)	(0.299)	(0.058)	(0.551)
FHP Year -2	-0.0011	0.0098	0.0113**	0.0036
	(0.803)	(0.572)	(0.041)	(0.825)
FHP Year 0	-0.0063	0.0096	-0.0061	0.0158
	(0.152)	(0.605)	(0.185)	(0.354)
FHP Year 1	-0.0054	0.0150	-0.0154**	0.0348
	(0.471)	(0.631)	(0.044)	(0.220)
FHP Year 2	-0.0118	0.0192	-0.0255***	0.0575
	(0.272)	(0.662)	(0.006)	(0.148)
FHP Year 3	-0.0139	0.0200	-0.0343***	0.0661
	(0.299)	(0.719)	(0.004)	(0.186)
FHP Year 4	-0.0138	0.0474	-0.0367***	0.1163*
	(0.381)	(0.474)	(0.008)	(0.052)
FHP Year 5	-0.0119	0.0594	-0.0461***	0.1379*
	(0.543)	(0.448)	(0.006)	(0.054)

	Hosp. Men Total	Hosp. Men 15-29	Hosp. Men 30-49	Hosp. Men 50-74
DID Model: FHP Exposition time				
	(0.828)	(0.324)	(0.010)	(0.014)
FHP Year 7	0.0008	0.0969	-0.0550**	0.2374**
	(0.975)	(0.343)	(0.020)	(0.019)
FHP Year 8	0.0094	0.0723	-0.0571**	0.2994**
	(0.754)	(0.527)	(0.032)	(0.011)
N	34,811	34,811	34,811	34,811

Note: This table present the results of FHP on logarithm of hospitalization for self-inflicted injury rate at municipality-level. The interval is between 1998 to 2004. The estimation is a Heterogeneous Difference-in-differences in time. All specifications include cluster standard errors at municipality-level. As well municipality, state-year fixed-effects. All regressions are weighted by the baseline respective population. Control variables were omitted due to space considerations. Values in parentheses are the robust p-values of the coefficients. *, ** and *** represent statistical significance of 10%, 5% and 1%, respectively.

Finally, Table 8 provides the effect of the FHP on hospitalization for women by age. We can observe that there is a monotonic positive impact in the program implementation on older women (50-74 years old). This effect goes from 10% in FHP year 5 to around 24% in 8 years of the program penetration.

We can observe on the upper part of Tables 3 to 8, the placebos tests of each regression that might reflect pre-existing trends. The coefficients of before program arrival (FHP Year < 0) pre-intervention dummy's[3]. In general, we find that placebos treatment has no significant effect on the suicide rate in almost all regressions. There are few placebos on the estimates of men on middle age that are significant. This may point out that the program effects for men is sensitive to some previous trend, but when we look at the effects for women, placebos do not reach any significance in any estimation. But notice, since we have six years of pre-trends and the probability of type 1 error increases with this large number of dummies. Finally, we provide robustness of the results on the online appendix by adding and excluding some controls and fixed effects.

[3] The FHP year -2 is dummy that contains the municipalities over time 2 years before FHP arrives, and interpretation goes so on.

Table 8 – Effects of FHP on Logarithm of Hospitalization for Self-Inflicted Injury Rate of Women by Age

	Hosp. Total Women	Hosp. Women 15-29	Hosp. Women 30-49	Hosp. Women 50-74
DID Model: FHP Exposition time				
FHP Year -6	0.0095	-0.0019	-0.0002	-0.0512
	(0.458)	(0.972)	(0.934)	(0.413)
FHP Year -5	0.0131	0.0106	0.0044	-0.0443
	(0.157)	(0.797)	(0.120)	(0.361)
FHP Year -4	0.0112	0.0116	0.0036	-0.0500
	(0.165)	(0.727)	(0.139)	(0.194)
FHP Year -3	0.0041	0.0228	0.0033	-0.0046
	(0.412)	(0.339)	(0.105)	(0.864)
FHP Year -2	0.0004	0.0083	0.0018	-0.0160
	(0.907)	(0.541)	(0.179)	(0.327)
FHP Year 0	-0.0031	0.0021	0.0002	0.0096
	(0.308)	(0.870)	(0.832)	(0.568)
FHP Year 1	-0.0037	0.0110	-0.0022*	0.0301
	(0.458)	(0.613)	(0.096)	(0.231)
FHP Year 2	-0.0059	0.0227	-0.0028*	0.0497
	(0.382)	(0.463)	(0.065)	(0.154)
FHP Year 3	-0.0043	0.0300	-0.0032	0.0656
	(0.615)	(0.436)	(0.127)	(0.142)
FHP Year 4	-0.0053	0.0441	-0.0041	0.0998*
	(0.613)	(0.346)	(0.129)	(0.056)
FHP Year 5	-0.0059	0.0475	-0.0051	0.1333**
	(0.637)	(0.392)	(0.114)	(0.035)
FHP Year 6	-0.0046	0.0748	-0.0050	0.1972***
	(0.746)	(0.244)	(0.177)	(0.006)
FHP Year 7	-0.0053	0.0943	-0.0064	0.2035**
	(0.752)	(0.197)	(0.204)	(0.015)
FHP Year 8	0.0018	0.0851	-0.0074	0.2433***
	(0.930)	(0.303)	(0.197)	(0.009)
N	34,811	34,811	34,811	34,811

Note: This table present the results of FHP on logarithm of hospitalization for self-inflicted injury rate at municipality-level. The interval is between 1998 to 2004. The estimation is a Heterogeneous Difference-in-differences in time. All specifications include cluster standard errors at municipality-level. As well municipality, state-year fixed-effects. All regressions are weighted by the baseline respective population. Control variables were omitted due to space considerations. Values in parentheses are the robust p-values of the coefficients. *, ** and *** represent statistical significance of 10%, 5% and 1%, respectively.

7. CONCLUSION

The present study explores the impacts of a community-based intervention on suicide prevention. We evaluated the intervention on reported self-inflicted injury deaths and suicide rates in municipalities. The marginal effects were presented by groups for better reliability, splitting the municipality's suicide rates by age and gender. It is important to notice that the suicide rate used in this work may be underestimated. Consequently, our estimated effects regarding the community-based intervention might be even higher.

Our results provide evidence that Family Health Program implementation affects the suicide rate, dropping as it is implemented and follows a monotonic decrease, that is, lowering, even more, the suicide with the time exposition to the program. We suggest that FHP provides appropriate treatment to the needed population, referring them to a hospital, especially women with mental illness, which leads to a slight decline in suicide rates. To the best of our knowledge, no preview study evaluates the effects of the Brazilian community-based health intervention on the treatment of mental illness.

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Rafael Parfitt[4]
https://orcid.org/0000-0001-7475-1681
Ph.D. Candidate in Economics at EESP-FGV. His research interest is in applied microeconomics, especially health economics.
rafael.parfitt@hotmail.com

Antonio Daniel Caluz
https://orcid.org/0000-0003-0937-4589
Ph.D. candidate in Business Economics at INSPER and Data Scientist at FGV-Projetos. His research interest is in Stochastic Choice (decision theory and econometrics), structural econometrics and applied microeconomics.
adrecaluz@gmail.com

[4] Correspondent author.