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The Brazilian Family Health Strategy and adult health: evidence from individual and local data for metropolitan areas

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Abstract

Previous studies have found that the expansion of primary healthcare in Brazil under the country-wide family health strategy (ESF), one of the largest primary care programs in the world, has improved health outcomes. However, these studies have relied either on aggregate data or limited individual data, with no fine-grained information about household participation in the ESF or local supply of ESF services - which represent crucial aspects for analytical and policy purposes. This study analyzes the relationship between the ESF and health outcomes for the adult population in Brazilian metropolitan areas. We investigate this relationship through two linked dimensions of the ESF - the program's local supply of health teams and ESF household registration - using fixed-effects models. By contrast with previous studies that focus on comparisons between some definition of "treated" versus "non-treated" populations, our results indicate that the local density of health teams is important for the observed effects of the ESF on adult health. We also find evidence that is consistent with the presence of positive primary healthcare spillovers to people not registered with the ESF. However, current ESF coverage levels in metropolitan areas seem inadequate to address prevailing health inequalities. Our analysis suggests that the local intensity of ESF coverage should be a key consideration for evaluations and policy efforts related to future ESF expansions.

JEL classification: I18, C23

Keywords: Family health strategy, Self-assessed health, Fixed effects, Pooled cross-section, Health surveys

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1. Introduction

The Brazilian primary care model seems to be a success. The country's experience with "family-based" programs is noted in the literature (Couttolenc, Dmytraczenko (2013)), its primary background being the family health program (PSF), nowadays called the family health strategy (ESF). The model has become the backbone of Brazil"s public health scheme, prioritizing preventive health within the Brazilian Unified Health System (SUS) '(Paim et al. (2011), Gragnolati et al. (2013)). The ESF is the work of multi-professional health teams of four to six community health workers, one nurse, two nurse assistants, and one general practitioner. They are responsible for following-up on an assigned population within a delimited area through health promotion, prevention, recovery, and rehabilitation of diseases and frequent injuries[1].

The expansion of the ESF and its reflection on access to primary care services has led to sizable health effects, most of which have been measured. Thus, studies found reductions in infant and adult mortality (Macinko et al. (2006), Macinko et al. (2007), Aquino et al. (2009), Serra, Rodrigues (2010), Guanais (2015), Rasella et al. (2014), Diaz et al. (2020), Hone et al. (2020)), improvement in maternal and child health outcomes (Bhalotra et al. (2019)), and a decline in hospitalization (Macinko et al. (2010)). However, despite the vast literature on ESF effects, the relevant studies employ the program's treatment variable at one of two levels: municipality (panel data) or individual (cross-section). This study bridges this gap by combing both strategies.

This study analyzes the relationship between ESF and health outcomes for the adult population in Brazil's metropolitan areas. It uniquely employs two variables to link the ESF program to health outcomes: the local supply, given by the number of ESF health teams per 10,000 inhabitants, and individual ESF registration. The study employs self-assessed and objective health measures per a national health survey conducted every five years by the Brazilian Institute for Geography and Statistics.

The motivation for the study stems from the great heterogeneity of the ESF expansion within the country. Until currently, the program's local coverage differed substantially. The population covered by ESF country-wide jumped from 1.96% in 1998 and to 33.32% five years later. Big cities saw a 0.98% to 17.22% jump in the same period (Bousquat et al.

[1] Households under the ESF receive monthly visits to have their health conditions monitored, including hypertension, diabetes, and communicable diseases, such as dengue, tuberculosis, and leprosy. Pregnant women are encouraged to follow prenatal appointments. Once they give birth, they receive home visits within the first few days (Morosini, Corbo (2007)).

(2006)). Further, this study ascertains whether the local supply of health teams affects individual health outcomes apart from their status of treated or non-treated. Thus, even non-treated individuals could benefit from the increase in health teams within their location (indirect effect). Even though indirect effects are common on health intervention, measuring it is challenging. Prior studies note that much of the health program benefits to non-treated individuals come from physical or social proximity with the treated population (VanderWeele, Christakis (2019), Benjamin-Chung et al. (2017))[2].

This study introduces an important feature to analyze the ESF program: it employs individual data from the adult population (25 to 64 years) in large metropolitan regions of Brazil. Few studies employ individual data to analyze the effect of ESF on the adult population, such as Moreno-Serra (2008) and Rocha, Soares (2010). However, none employ program registration information. Moreno-Serra (2008) concludes that positive levels of regional ESF coverage improve individual health outcomes, with relatively small effects for adults but larger estimated impacts for children. This study also explores the ESF intensity, measured by the percentage of people in metropolitan areas that are registered in the ESF program between 1998 to 2003. Rocha, Soares (2010) finds that the ESF program increased adult labor supply and child school enrollment and reduced fertility in small municipalities.

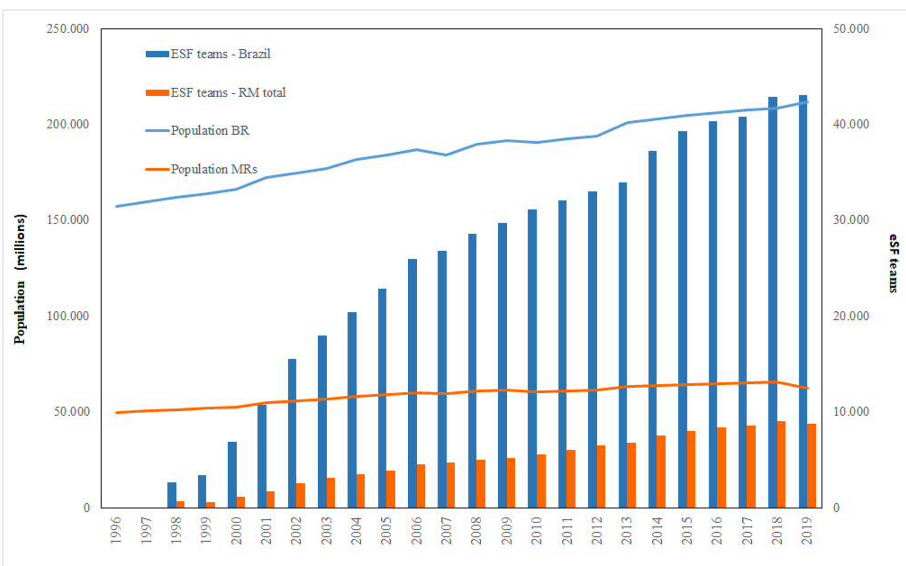


Figure 1: Evolution population and ESF health teams: Brazil and MRs

[2]Studies that analyze the effects of cash transfer programs on health outcomes explores the variation within household members (target members against others) to ascertain the existence of spillovers (e.g., Guerrero et al. (2020), Avitabile (2012) Banerjee et al. (2010)).

The metropolitan regions (MRs)[3] are crucial to the ESF development. Since MRs comprised a major proportion of the Brazilian population (30%)[4], the program in those areas is vital in the effective transformation of the country's health model (Dain (2002)). Figure 1 shows that these regions have a slower expansion of ESF health teams than the rest of the country. Thus, to estimate the population covered by the program, the government commonly employs a *"rule of thumb"*. The rule is a technical standard that each ESF health team should be assigned to a geographical area to enroll and monitor the health of about 3,500 people. Therefore, given the population of the MRs in 2019, a gap of about 9,400 health teams emerged[5].

Ultimately, this study focuses on issues about ESF implementation ignored in the literature. More specifically, it investigates four health outcomes: self-assessed health (SAH), limitations of routine activities for health reasons, being bedridden, and hospitalizations. The remainder of the paper is structured as follows. Section 2 presents the datasets employed, the variable definitions, and descriptive statistics. Section 3 explains the empirical strategy. Section 4 presents the results and checks their robustness. Section 5 concludes.

2. Data definitions and description

The study employs data from two Brazilian cross-sectional household surveys: the Special Health Supplement of National Household Sample Surveys (PNAD) and the National Health Survey (PNS). The PNS replaced the PNAD health supplement in 2013 and has since maintained the same investigation aspects[6], which allowed for getting parallel data in different survey years. Thus, our estimates used the PNAD health supplement for 1998, 2003, and 2008; and the PNS for 2013 and 2019. Apart from the entire country, the two surveys are representative at the MR level, 27 Brazilian states, and five major geographic areas. The PNS sample covers 21 MRs[7], while PNAD supplement is limited to nine MRs. Therefore, the common MRs are: Belém, Fortaleza, Recife, Salvador, Belo Horizonte, Rio

[3]We analyze the largest and oldest regions: Belém, Fortaleza, Recife, Salvador, Belo Horizonte, Rio de Janeiro, São Paulo, Curitiba, and Porto Alegre

[4]See Table Appendix A.

[5]According to this *"rule of thumb"*, in 2009, the MRs should have 17.8 thousand ESF health teams; however, it obtained 8.4 thousand. In the same year, 43 out of 205 MR municipalities accomplished this standard, unlike 3,696 of 5,365 for the rest of the country (Brazil has 5,570 municipalities).

[6]The Brazilian households surveys on health are published every five years.

[7]One in each state, except six: Acre (AC), Rondônia (RO), Roraima (RR), Piauí (PI), Mato Grosso do Sul (MS), and Tocantins (TO).

de Janeiro, São Paulo, Curitiba, and Porto Alegre[8]. The samples allow for evaluating how 20 years of ESF expansion in MRs relates to adults' health outcomes.

Further, to employ pooled cross-section data from the five datasets (1998, 2003, 2008, 2013, and 2019), we harmonized them over time and addressed changes among different survey years. The most important change occurred when the PNAD health supplement became the PNS, which introduced a new module in its questionnaire via a third stage restricted to selected residents[9]. Thus, some variables are not fully comparable for all years in our sample, thus requiring estimates with distinct sets of control for different periods[10].

The full pooled data (1998–2019)[11] encompasses 2,034,385 individual observations for the whole country, of which the MRs analyzed here are 31.73%. This study focuses on the adult population aged 25 to 64 years old within the MRs. Thus, the remaining sample is 310,479 observations[12]. Further, to analyze individual health outcomes, subject to the ESF program effect, this study employed four questions common to the PNAD health supplement and the PNS as follows:

a. *Overall, how would you rate your health?*: the usual SAH, commonly referred to as ““the five-point scale,” is a categorical variable ranging from very bad, through average, to very good. From this rank, we generate a dummy that aggregates the *bad* and *very bad* categories into a value of one and sets it against the others as zero.
b. *In the last two weeks, have you failed to perform any of your usual activities (e.g., work, school, play, and tasks) for health reasons?*: The dummy variable for the limitation of routine activities assumes a value of one to an affirmative answer and zero otherwise.
c. *In the last two weeks, have you been bedridden?*: The dummy variable assumes a value of one when the answer to the question is positive and zero otherwise.
d. *In the past 12 months, have you been hospitalized?*: The dummy variable assumes a value of one if the person was an inpatient in the last 12 months and zero otherwise.

[8]This set covers the country's five major geographic regions

[9]Those aged 18 years or older, who are already on the sample up to the (2^{nd}) stage. In the last stage, exclusive to the PNS questionnaire, selected persons answer questions on specific health aspects, such as lifestyle (weight, food or alcohol consumption, physical activity, and smoking), chronic diseases, women's health, prenatal care, accidents, and violence.

[10]Hence, to use all five years, our estimates must be restricted to available information up to the (2^{nd}) stage of the PNS questionnaire. Regarding the PNAD health supplement, all questions encompass information for the full sample.

[11]"1998–2019 " includes 1998, 2003, 2008, 2013, and 2019

[12]The latest information from the population count (IBGE/2016) shows that those aged 25 to 64 years old corresponds to 55.9% of the MR population, with a share of 30.8% in the national population.

Regarding SAH, this study follows the literature that employs it as a multidimensional indicator to synthesize physical, mental, and functional aspects as health behaviors (e.g., Cullati et al. (2018), Bombak (2013)). Apart from SAH, other health outcomes emerge from objective questions[13], or enhance a health-specific context (hospitalizations). Section Appendix B shows the behavior of the health outcomes over the years. The general picture is a low and constant percentage of individuals who over the years rate their health as “very bad” or “bad” (4.2%), relate limitations due to health reasons (5.4%) or were bedridden (3.5%), and had been hospitalized in the last 12 months (6.1%).

Regarding the ESF enrollment, we have information for the last three years of the sample (2008, 2013, and 2019). Once the 'ESF health team must assist the whole family, registration occurs at a household level. Once the household is enrolled in the program, all residents are considered as the population served by it. Moreover, the surveys also show how long ago the household is assisted by ESF[14]. We created a dummy for people registered in ESF for at least one year.

[13]Two of them are based on a broad context: “limitation to perform usual activities” and “bedridden”

[14]The options are as follows: less than two months, from two to less than six months, from six months to less than 12 months, or, at least, one year

Table 1: Descriptive Statistics pooled sample 1998, 2003, 2008, 2013 and 2019

Group	Variable	Obs	Mean	Std. Dev.	Min	Max
Health Outcomes	SAH "bad" health	310,479	0.0424	0.1897	0	1
	Routine limitation (last 2 weeks)	310,479	0.0537	0.2255	0	1
	Bedridden (last 2 weeks)	310,479	0.0344	0.1822	0	1
	Hospitalization (last 12 months)	310,479	0.0609	0.2391	0	1
Individual Covariates	Age	310,479	41.60	10.87	25	64
	Male	310,479	0.4626	0.4986	0	1
	Black	310,479	0.5016	0.4999	0	1
	Health plan	310,479	0.3394	0.4735	0	1
	Work	310,479	0.7104	0.4535	0	1
	Elementary school	310,479	0.4676	0.4823	0	1
	High school	310,479	0.3667	0.4803	0	1
	College or higher	310,479	0.1656	0.3745	0	1
	Disease	234,449	0.3705	0.7001	0	6
	Smoking	109,233	0.3572	0.4791	0	1
Household Covariates	Child up to 5 years old	310,479	0.3903	0.4878	0	1
	Adult over 54 years old	310,479	0.1558	0.3626	0	1
	PCA - household welfare	310,479	0.3589	11.799	- 6.32	1
	Household income per capita (log)	310,479	62.355	11.281	0	11.9
	Urban	310,479	0.9557	0.2055	0	1
	Registered in ESF	191,575	0.4416	0.4965	0	1
	Registered in ESF (12 mo. or more)	191,575	0.3913	0.4880	0	1
Metropolitan Region Covariates	ESF coverage (at level t_0)	310,479	0.8802	0.5730	0	2
	ESF coverage (t - 1)	310,479	0.8371	0.6187	0	2
	Time of ESF in MR	310,479	7.6202	5.9917	0	20.2
	Population (log)	310,479	15.5206	0.7302	14.3	16.9
	Taxes per capita (log)	310,479	17.3640	0.9296	15.4	19.2
	GDP per capita (log)	310,479	9.7992	0.6667	8.3	10.9
	Public hospital beds (1,000 inh.)	310,479	2.0673	0.7605	1.0	3.9
Metropolitan Region Fixed Effects	Belém MR	310,479	0.0765	0.2658	0	1
	Fortaleza MR	310,479	0.0999	0.2998	0	1
	Recife MR	310,479	0.1046	0.3061	0	1
	Salvador MR	310,479	0.0987	0.2983	0	1
	Belo Horizonte MR	310,479	0.1116	0.3148	0	1
	Rio de Janeiro MR	310,479	0.1428	0.3499	0	1
	São Paulo MR	310,479	0.1672	0.3731	0	1
	Curitiba MR	310,479	0.0803	0.2718	0	1
	Porto Alegre MR	310,479	0.1180	0.3227	0	1
Years Fixed Effects	1998	310,479	0.1813	0.3853	0	1
	2003	310,479	0.2015	0.4011	0	1
	2008	310,479	0.2115	0.4084	0	1
	2013	310,479	0.2071	0.4052	0	1
	2019	310,479	0.1983	0.3987	0	1

Table 1 shows that for the pooled sample, on average, 44.2% is registered in ESF independent of how long, while 39.1% were in the program for at least one year. A simple average t-test on health outcomes shows a significant difference between both groups, with the enrolled population exhibiting a greater likelihood of self-rating their health as bad, presenting a limitation on usual tasks (for health reasons), being bedridden, and being hospitalized in the last 12 months. Apart from the dummy for ESF registration, we are also interested in local ESF coverage (or "local ESF supply"). We measure it as the number of ESF health teams per 10,000 inhabitants for each MR[15]. Regarding families that were registered in the ESF for at least 12 months, for the ESF coverage variable, we use its lagged (t-1) level. Figure 2 shows the distribution of ESF coverage in the pooled sample[16].

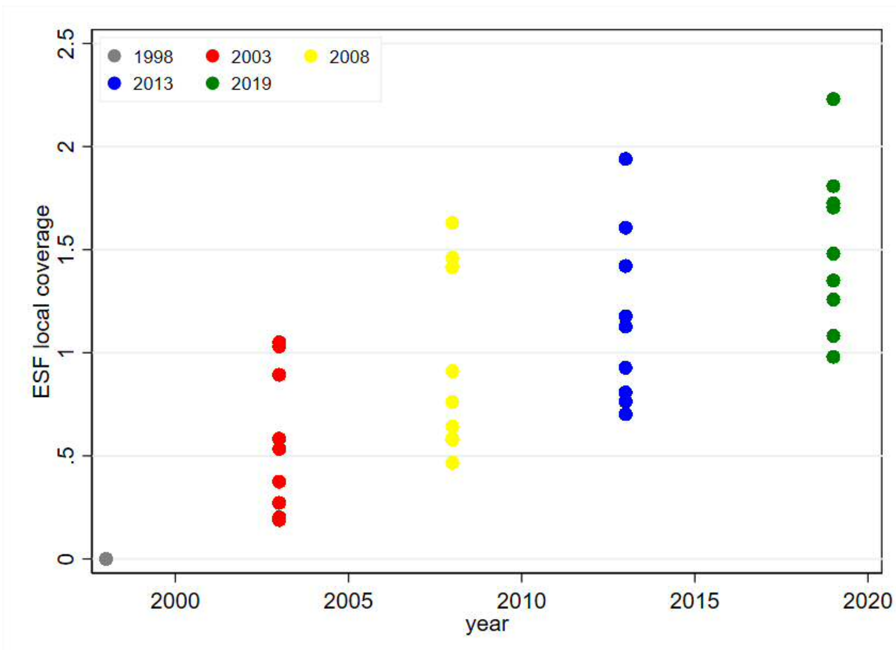


Figure 2: Distribution of ESF health teams per 10,000 inhabitants in metropolitan regions over the sample period

There is heterogeneity among the MR ESF coverage that is stable over the years. We explore this variation to analyze how the play between local coverage *vis-a-vis* individual registration is related to health outcomes. Parallel to the ESF' coverage, following Rocha,

[15]The data is obtained from the Department of Primary Care of the Ministry of Health. The number of eSF teams for each municipality is obtained within the MRs registered in the system. Available at: `https://egestorab.saude.gov.br/paginas/acessoPublico/relatorios/relHistoricoCoberturaAB.xhtml`.

[16]Since we use lagged information, in 1998, the coverage refers to 1997, when the program has yet to be implemented.

Soares (2010), we also included as control the period lag where the program has been implemented in each MR. Thus, this variable starts at zero in 1998 and grows over time at different speeds in each MR. The mean values for the nine regions are 2.8, 6.9, 11.2, and 16.4 years in 2003, 2008, 2013, and 2019, respectively.

Regarding individual characteristics, we controlled for age, sex, color, private health insurance, work, and education[17]. Information restricted by the change in the sample design is the data for chronic diseases and smoking. Thus, these controls will be applied just for the PNS samples (2013 and 2019). The chronic disease covariate refers to a discrete variable that sums the number of individuals' chronic diseases out of six possibilities[18]. The smoking is a dummy for whether a person is or was a smoker. Regarding household controls, apart from income per capita, there are dummies for children aged up to 5 years, adults aged over 54 years, urban area, and a "welfare" component[19]. In addition to individual and household controls, we incorporated variables regarding inpatient beds[20], population, local taxes revenue, and GDP (*per capita*) at MRs.

3. Empirical strategy

Two basic differences between this study and prior studies on the ESF program are: the health outcomes' level of analysis and the measure of coverage. Both characteristics have relevant implications for empirical strategies because the analysis unit reflects the type of link established between the health variable and ESF intervention. Hence, departing from most of the prior literature, this study focuses on individual health outcomes in MRs. Thus, to establish the strategy, we draw the ESF implementation pathway from the municipality to the individual level. Figure 3 shows the direction of the study analysis.

Within this path are two selection moments: municipality level (A) and household or individual level (B). Regarding moment (A), the adoption of the ESF (and the efforts to speed up its coverage) depends on mayors' willingness to join (or expand) it. Thus, there is a potential endogeneity at the municipality level. This issue is a concern that has been

[17]All the variables are dummies, which assumes a value of one when the person in the sample is male, is black, works, and have health insurance. The education dummies are elementary school, high school, college, or higher.

[18]The PNS questionnaire covers cancer, diabetes, hypertension, heart, kidney, and depression.

[19]It was calculated via the Principal Component Analysis (PCA) (see Jackson (2005)) using three sets of household characteristics: wall features, public services access (piped water, sanitary sewer, and trash), and consumption goods (phone, fridge, and washing machine).

[20]It refers exclusively to SUS patients.

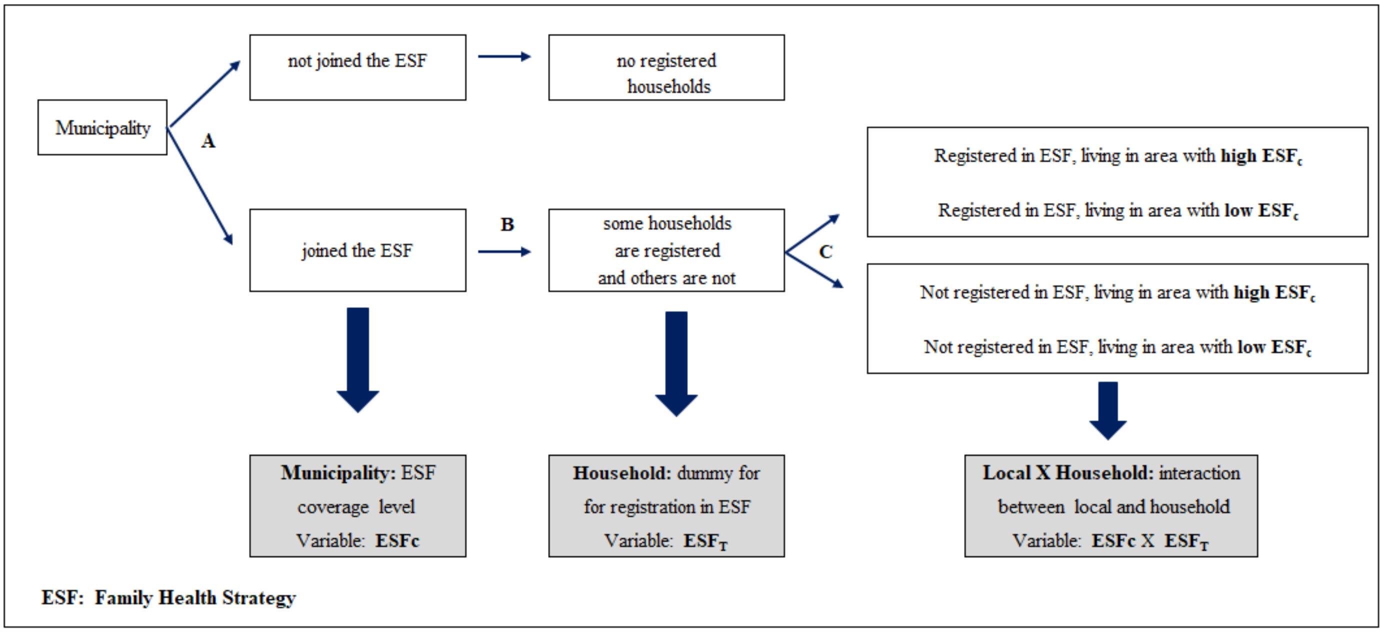


Figure 3: ESF's path from municipality to individual health indicators

debated in studies that analyze the program at the aggregate level[21] (e.g., Rocha, Soares (2010), Macinko et al. (2010), and Bhalotra et al. (2019)). The second moment (B) refers to the decision about the distribution of health-care teams among the population within municipalities that have adopted the program. This allocation is defined exclusively by each local health manager, and evidence shows that they use observable indicators to select the ESF's beneficiaries[22]. Hence the choice to join the ESF is not considered at the individual level[23]. Moreover, the treated population commonly lives in the poorest and unhealthiest neighborhoods (see Bousquat et al. (2006) for data on MRs).

Given the rapid growth of the program, by the beginning of the 2000s, more than 80% of all municipalities in Brazil managed the selection of households that would receive this service[24]. For the MRs, the adherence of 80% of municipalities to the ESF program happened

[21]Municipalities or a combination of municipalities into Minimum Comparable Areas.

[22]Normally, simple indicators, such as income average, Human Development Index, or infant mortality levels are employed; see Brasil. Ministério da Saúde (2005)

[23]At the household level, the ESF works as if it is mandatory; that is, whoever is registered will necessarily receive a visit from health teams. Arguably, individuals could deny access to their homes. However, according to Brasil. Ministério da Saúde (2006), it is far less likely that families will refuse this free service.

[24]The brief evolution in the number of municipalities with the ESF teams shows the following: 21.2% (1,182) in 1998, 53.4% (4,523) in 2000, 81.2% (4,523) in 2003, 94.3% (5,250) in 2008, 95.4% (5,333) in 2012, and 98.4% (5,480) in 2016 (Diaz et al. (2020)).

approximately eight years later (2008). The heterogeneity on the program's coverage within the same local area, given the identification between treated and non-treated populations, allows for analyzing the indirect relations between the program and health outcome for those not registered ("spillovers"). Thus, following the path in figure 3 to the end, we question whether the program can affect non-treated individuals. Moreover, is the intensity of the local supply of health teams by 10,000 inhabitants relevant for their health outcomes?

This study focuses on four adult' health outcomes described early; thus, our findings accord with Moreno-Serra (2008) and Macinko et al. (2010). Hence, to capture the possible relationship between the ESF' expansion and the outcomes, we estimate the fixed-effects model with pooled cross-section data (1998, 2003, 2008, 2013, and 2019). Thus, this analysis starts at the moment when the program remains incipient and advances over time. Ultimately, it covers 20 years of the ESF, encompassing its implementation and expansion of health teams. Our unit of observation is the individual within a metropolitan region [25].

The results are based on logit fixed-effect models, where the time and local fixed terms allow for the control for differences on health supply factors, such as hospital's infrastructure, change in the health insurance market, or regulation (e.g., new competitors and prices), and differences in epidemiological characteristics among distinct areas over time. The baseline specification, given by Equation (1), employs the local supply of ESF health teams exclusively (($\mathrm{ESF_c}$)) without controlling for household registration in the program ($\mathrm{ESF_T}$). The subscript m indicates the MR, t is the sample year, y_{imt} is each of the four health outcomes of interest, and $_{imt}$ is the vector of our control variables (table 1).

$$y_{imt} = \alpha + X_{imt}\beta + ESF_{\mathrm{c}mt}\delta + M_m + T_t + e_{imt}. \tag{1}$$

The fixed-effects M_m control for time-invariant metropolitan region characteristics, while T_t accounts for time effects for the sample years. That is, the metropolitan region fixed-effects control for a given pattern specific to an area, and time fixed-effects control for possible shocks that could change the adult population habits and impact their health or new national health regulations in a given year for all MRs.

Once the 2008, 2013, and 2019 surveys bring the information regarding the household ESF registration, our second specification includes the ESF treatment at the household level

[25] Each MR encompasses a set of municipalities that has remained stable over time. Unlike other areas of the country, we did not notice the creation of new municipalities among the nine regions over the sample period.

(ESF_T) and the interaction between both ESF interventions. It is specified as follows:

$$y_{imt} = \alpha + X_{imt}\beta_0 + ESF_{\text{T}imt}\beta_1 + ESF_{\text{c}mt}\delta + ESF_{\text{c}mt} * ESF_{\text{T}imt}\gamma + M_m + T_t + v_{imt}. \quad (2)$$

The inclusion of the interaction between ESF_c and ESF_T allows for the assessment of heterogeneity among both ESF variables. The variation on health outcome given by a change in individual condition from not registered to registered in the ESF program (ESF_T) is measured via ($\beta_1 + \gamma ESF_\text{c}$). Further, the expansion of the local supply (ESF_c) is given by (δ + γ) for the treated and, exclusively, δ for the non-treated. The specification (2) incorporates the view that the individual response to the ESF program may differ according to their status and the program's coverage level in each area (Figure 3). Once the estimated coefficient of ESF_c per individual health outcome is significant, we will check whether there is a difference between treated and non-treated responses. Given the changes on the survey's questionnaire (Section 2), we test three set of periods[26]:

(a) Pooled sample 1998–2019: This sample is our benchmark specification. It does not control for individual chronic disease, smoking, or ESF household registration.
(b) Pooled sample 2008–2019: It incorporates the ESF_T but does not control for chronic disease or smoking.
(c) Pooled sample 2013–2019: The data is exclusively from the PNS, including chronic disease, smoking, and ESF_T, limited to the selected residents[27].

4. Results

Our results are presented in three main sub-sections. First, we show the findings for the association between the ESF program and individual health outcomes. We then analyze whether there is any heterogeneity over observable characteristics like sex, color, and household income per capita. The last subsection checks robustness per differences in the time of ESF registration.

4.1. Relationship between the ESF program and individual health

Table 2 presents the marginal effects of the ESF local supply from specification (1). We used the variability among the local density of the ESF teams (ESF_c) over the years to

[26]For simplicity, we refer to pooled samples of 1998, 2003, 2008, 2013, and 2019 as "1998–2019"; 2008, 2013, and 2019 as "2008–2019 ;" and 2013 and 2019 as "2013–2019"
[27]See footnote 9

test whether individual health outcomes can be associated with the program. The results encompass the three different sample periods. Generally, the relationship between ESF_c and individual health outcomes remains significant for the three periods only for hospitalizations, which decreases when ESF health teams expand. The findings refer to the mean for the adult population, independent of the ESF registration.

Comparing the sample periods, we note that the control for chronic disease in the 1998–2008 sample reinforces the magnitude of marginal effects obtained for the sample of all pooled years (except for SAH "bad"). However, the restricted sample results for the 2013–2019 period show that ESF_c is relevant only for the self-rated outcome and hospitalizations in the last 12 months. The results from periods that include the controls for disease and smoking conditions must be taken seriously because these variables could be tied to the program's participation. It means that portions of the population are diagnosed precisely for participating in the program[28]. In such cases, any conclusion may lead to a misunderstanding.

	Marginal effects for ESF_c*		
Health outcome	1998–2019	1998–2008	2013–2019
Self-rated bad health	-0.0069***	-0.0006	-0.0980***
	(0.0026)	(0.0044)	(0.0222)
Limitation of routine activities	-0.0066**	-0.0176***	-0.0339
	(0.0032)	(0.0057)	(0.0298)
Bedridden (last 2 weeks)	-0.0027	-0.0162***	-0.0321
	(0.0026)	(0.0048)	(0.0206)
Hospitalization (last 12 months)	-0.0143***	-0.0184***	-0.0631*
	(0.0037)	(0.0064)	(0.0329)
control for chronic diseases	no	yes	yes
control for smoking condition	no	no	yes
No. observations	310,474	184,584	49,874

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Weighted by individual's household weights provided in each data set.

Table 2: Margin effects of ESF_c - Fixed Effects

Without any control for ESF registration, the hospitalization result was consistent over different sample periods. Its magnitude shows that an increase in one ESF health team per 10,000 inhabitants reduces the possibility of hospitalization by 1.43pp, 1.84pp, and 6.31pp,

[28]The National Program for Tobacco Control and other Risk Factors for Cancer in Brazil considers several actions to reduce the prevalence of smoking, such as assisting ESF health teams to treat smoking (Silva et al. (2014)).

per the period and control variables. Given the current population of MRs at approximately 62.4 million people in 2019, it would be necessary to hire 6,236 more health workers. This finding accords with studies on the relationship between hospitalization and the ESF program at the municipality level (Macinko et al. (2010) and Mendonça et al. (2011)). Thus, focusing on results from the 1998–2019 sample, the 6,236 health teams could decrease per less than 1pp of the likelihood of self-rating health as "bad" (0.69pp) and presenting limitations on usual routine activities (0.66pp).

Apart from the reduction in hospitalizations for all sample periods, the results from the 1998–2008 sample shows that an increase in health teams reduces the probability of failing to conduct usual activities for health reasons by 1.76pp and the likelihood of being bedridden by 1.62pp. Based on the MR population at the time[29], 5,670 more health teams would be necessary to achieve the small changes. However, without any control for the ESF beneficiaries, we cannot distinguish the direct and indirect association between health outcomes and the program expansion. The analysis of specification 2 gives us a more accurate answer.

Once the estimates from (2) include controls for the ESF local supply ($\mathrm{ESF_c}$), ESF registration ($\mathrm{ESF_T}$), and the interaction between both, the interplay allows for evaluating how the individual health outcome is related to changes on both: their situation of (not) being registered in the program ($\mathrm{ESF_{T=0}}/\mathrm{ESF_{T=1}}$) and the level of local supply of the ESF health teams. Table 3 presents the results for the 2008-2019 period[30].

Table 3 shows that apart from the health outcomes that were already significant on baseline estimates from Equation (1) (1998–2019), "being bedridden" also has a significant relationship with the program's supply. Moreover, since the estimated magnitudes of γ is small, we observe a short difference in intensity response for health outcomes of treated and non-treated individuals regarding changes in the $\mathrm{ESF_c}$. Note that when the interaction among $\mathrm{ESF_c}$ and $\mathrm{ESF_T}$ are not significant, the intensity of marginal effects for the treated population diminishes in explanatory power. It affects the SAH as "bad" and hospitalization outcomes. Thus, the expansion of one ESF health team per 10,000 inhabitants

(a) decreases the probability of self-rating their own health as "bad" for both groups (by 2.30pp and 2.43pp for the treated and non-treated, respectively);

[29] In 2008, the nine MRs comprised 56.7 million people.

[30] Given the restriction and drawbacks from the inclusion of chronic disease and smoking conditions controls (2013–2019), we focus exclusively on the 2008–2019 period for the analysis of specification (2). Section Appendix D provides all the estimation results .

Health outcome	**Sample 2008-2019**				
	ESFc	ESF T	ESFc * ESF T	controls disease/ smoking	Obs
SAH bad health	-0.0243***	0.0023	0.0012	no	191,575
	(0.0066)	(0.0032)	(0.0024)		
Limitation of routine activ.	-0.0251***	0.0157***	-0.0124***	no	191,575
(last 2 weeks)	(0.0077)	(0.0039)	(0.0028)		
Bedridden	-0.0162***	0.0137***	-0.0094***	no	191,575
(last 2 weeks)	(0.0063)	(0.0027)	(0.0020)		
Hospitalization	-0.0253***	0.0056	-0.0023	no	191,575
(last 12 months)	(0.0089)	(0.0044)	(0.0031)		

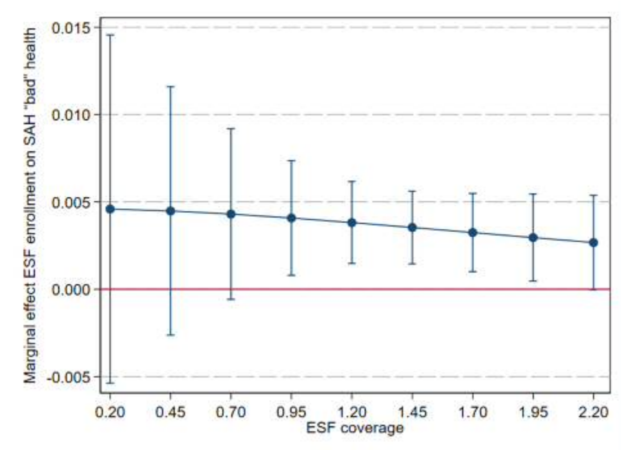
Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Weighted by individual's household weights provided in each data set.

Table 3: Margin effects for ESF_c, ESF_T and interaction - Fixed Effects

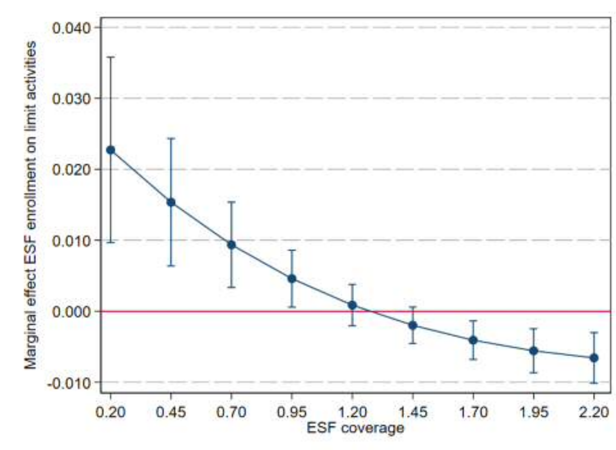
(b) reduces the probability of failing to perform usual activities (for health reasons) by 3.75pp (2.50pp) for those (not) registered on ESF;
(c) diminishes the likelihood of being bedridden by 2.56pp (1.62pp) for the treated (non-treated);
(d) reduces the possibility of inpatient by 2.76pp (2.53pp) for the treated (non-registered).

Apart from the response on ESF_c changes, the estimates also show a positive association among the ESF registration, the presence of limitations for health reasons, and "being bedridden." Thus, the ESF treated population is more likely to present limitations to executing routine activities for health reasons (0.30pp) and being bedridden (0.40pp)[31]. Once the relationship between the treatment and health outcomes is small and positive, we cannot rule out the possibility that the results are a consequence of population selection (as beneficiaries) by municipality health management. The marginal effects of ESF_T in Figure 4 show how it evolves as ESF supply increases.

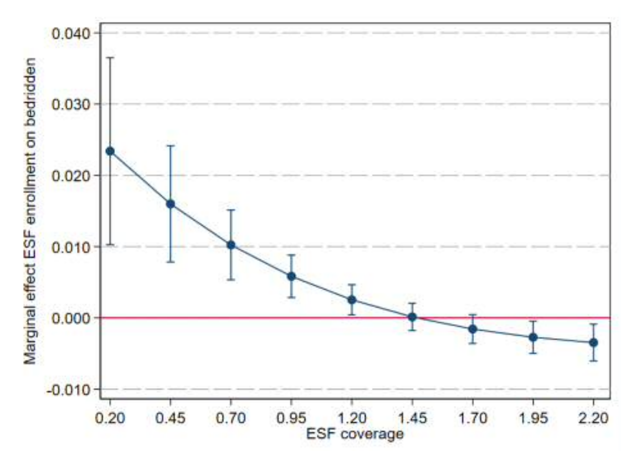
[31] These marginal effects were calculated at a mean of ESF_c; that for the 2008–2019 period is 1.03 health teams per 10,000 inhabitants.



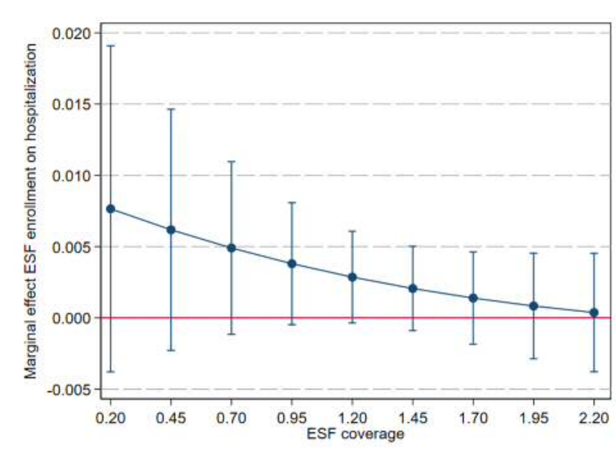
(a) Self-assessed health as “bad”



(b) Limited routine activities (last 2 weeks)



(c) Being bedridden (last 2 weeks)

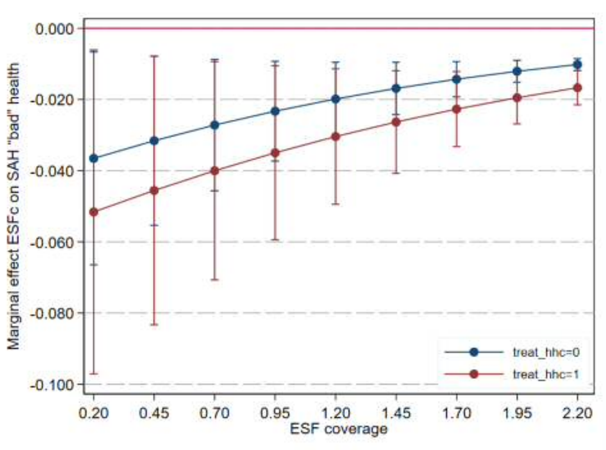


(d) Hospitalization (12 months)

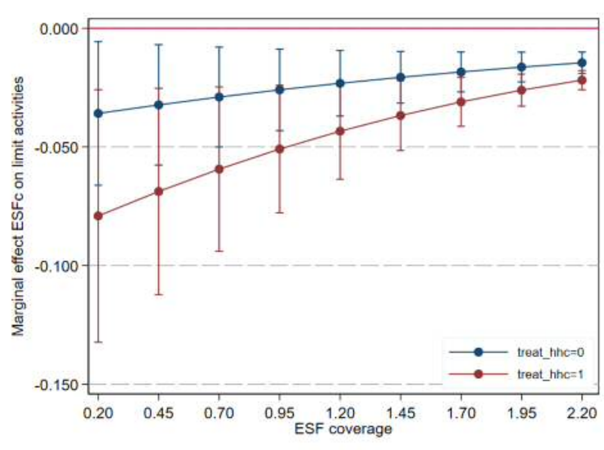
Figure 4: Marginal effects $\mathrm{ESF_T}$ - specification 2

Regarding the $\mathrm{ESF_T}$'s marginal effects, we observe a common path for “limitation on routine activities” and “being bedridden” outcomes: at the low level of the ESF local supply, the ESF registration is linked to a positive likelihood for both, but its positive marginal effect diminishes when the program’s coverage grows until it reaches zero and becomes non-significant. Still, from the moment marginal effect reaches zero, new increases in health teams decrease the likelihood for both outcomes. Nevertheless, for being bedridden, this switch requires more health teams than in the case of limitations on routine. Hospitalization outcome is not related to the ESF participation, perhaps due to few hospitalization observations in the surveys.

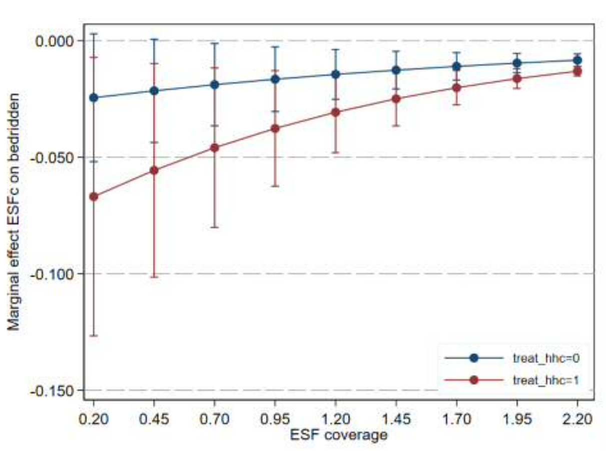
Regarding the pathway in Figure 3, we check how the association between health outcomes and ESF supply of health teams (indirect response) changes as the program expands. The graphs of the ESF_c marginal effects on health outcomes from Figure 5 shows a negative association at all ESF supply levels for both groups[32].



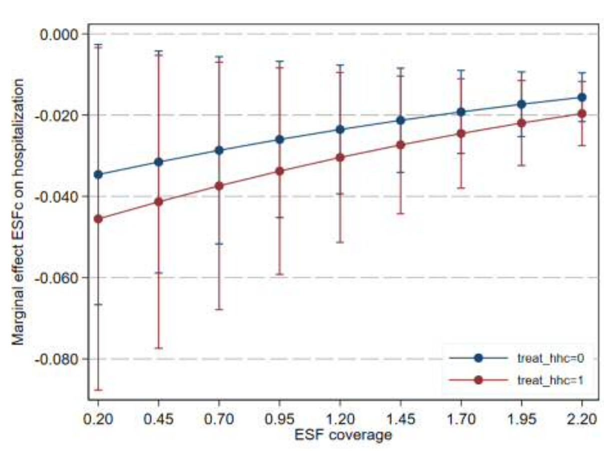
(a) Self-assessed health as "bad"



(b) Limited routine activities (last 2 weeks)



(c) Being bedridden (last 2 weeks)



(d) Hospitalization (12 months)

Figure 5: Marginal effects ESF_c - specification 2

Given that the small magnitude of γ remains for all levels of ESF_c, the behavior of both groups regarding its variation is nearly identical, with the non-treated being lower than

[32]The exception is the outcome for "being bedridden," which is not significant at initials levels of health-team supply.

the treated. Regarding the pooled cross-section, we do not have information on individuals that switched from non-treated to treated positions as the coverage expanded. Thus, a more detailed analysis of the ESF dynamics is required. In any case, the significant and symmetrical response between both groups, even with a percentage of registration below 50%[33], is a sign that the ESF program bears indirect consequences for the adult population. Thus, to complement our analysis, we check if the significance, direct and indirect ($\mathrm{ESF_T}$ and $\mathrm{ESF_c}$), among ESF program and health outcomes is concentrated on specific groups.

4.2. Heterogeneity in response to the ESF program

We selected three groups to check whether there is heterogeneity in response to the ESF program: females, black people, and adults on the first quintile of household income per capita distribution. As the household selection into the ESF program is based upon observable characteristics, we chose the groups with higher participation in the poorest areas within municipalities (black individuals, 1st. quintile). Selecting the female group goes beyond priority for the poorest households. It was included to verify whether there is any gender preference by health staff professionals responsible for the ESF program.

The black population is the majority in Brazil since the Demographic Census of 2010 when they reached 50.7% of the population. In our sample, their participation reaches 50.25%. The worse socioeconomic condition of the black population in Brazil, the inequality regarding their health, is fully documented in the literature (Hone et al. (2017), Azevedo Barros de et al. (2016), Reis (2012)). This inequality is also present in our sample, where 64.07% of the black population's household income per capita is concentrated in the first quintile. Regarding the participation of the three groups, as treated on the ESF program, data from the PNS 2019 shows that females are 48.2%; black adults, 51.2%; and adults in the first quintile, 53.1%. Estimates from specification 3 are employed in the analysis.

$$y_{imt} = \alpha + X_{imt}\beta_0 + ESF_{\mathrm{T}imt}\beta_1 + ESF_{\mathrm{T}imt} * D_{\mathrm{G}imt}\gamma_0 + ESF_{\mathrm{c}mt}\delta + ESF_{\mathrm{c}mt} * D_{\mathrm{G}imt}\gamma_1 + M_m + T_t + v_{imt} \tag{3}$$

were $\mathrm{D_{G_{imt}}}$ is the dummy of each group G= 1,2,3 - female, black and 1^{st} quintile.

The analysis on heterogeneity responses employs the inclusion of interaction between both

[33] The sample shows that for the adult population aged between 25 and 64 years, it was 30.7% in 2003, 39.5% in 2008, and 47.7% in 2019.

the ESF variables (ESF_c and ESF_T) and each group (female/black/1st quintile). Thus, the association between health outcome and the expansion of (ESF_c) over each group is given by γ_1. Moreover, the relationship between health outcome and the move into the ESF's treated set over each group is given by γ_0. Table 4 shows that a potential heterogeneity on the program's response is not generalized for any of the three groups. What exists are specific differences concentrated on some health outcomes, such as bad self-assessed health among black people and population on the 1st quintile and being bedridden on the last [34].

[34] Women and adults on the first quintile respond slightly different to increases in the ESF supply regarding being bedridden and limitations on activities, respectively. In both cases, the negative association with ESF_c is weaker.

Health outcome	$\mathbf{X_i}$	$\mathbf{ESF_c}$	$\mathbf{ESF_c}$ * $\mathbf{X_i}$	$\mathbf{ESF_t}$	$\mathbf{ESF_t}$ * $\mathbf{X_i}$	**Number obs**
SAH bad health	Female	-0.0233***	-0.0008	0.0038**	-0.0000	191,575
		(0.0066)	(0.0023)	(0.0018)	(0.0023)	
	Black	-0.0260***	0.0044*	0.0072***	-0.0059**	191,575
		(0.0066)	(0.0024)	(0.0018)	(0.0023)	
	1^{st} quintile	-0.0222***	-0.0059***	0.0042***	-0.0032	191,575
		(0.0065)	(0.0018)	(0.0013)	(0.0028)	
Limitation of routine activities	Female	-0.0321***	0.0045	0.0001	0.0013	191,575
		(0.0080)	(0.0028)	(0.0025)	(0.0030)	
	Black	-0.0287***	-0.0011	0.0001	0.0016	191,575
		(0.0078)	(0.0028)	(0.0022)	(0.0029)	
	1^{st} quintile	-0.0301***	0.0049**	0.0011	-0.0007	191,575
		(0.0077)	(0.0023)	(0.0016)	(0.0039)	
Bedridden (last 2 weeks)	Female	-0.0221***	0.0038*	0.0031	-0.0002	191,575
		(0.0064)	(0.0022)	(0.0019)	(0.0023)	
	Black	-0.0198***	0.0006	0.0026	0.0006	191,575
		(0.0063)	(0.0021)	(0.0016)	(0.0021)	
	1^{st} quintile	-0.0199***	0.0047***	0.0044***	-0.0093***	191,575
		(0.0063)	(0.0016)	(0.0012)	(0.0028)	
Hospitalization (last 12 months)	Female	-0.0284***	0.0038	0.0035	-0.0009	191,575
		(0.0090)	(0.0030)	(0.0027)	(0.0032)	
	Black	-0.0266***	0.0017	0.0030	-0.0003	191,575
		(0.0089)	(0.0031)	(0.0023)	(0.0031)	
	1^{st} quintile	-0.0267***	0.0029	0.0025	0.0046	191,575
		(0.0089)	(0.0028)	(0.0018)	(0.0049)	

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Weighted by individual's household weights provided in each data set.

Table 4: Marginal effects of ESF_c and ESF_T - Fixed Effects

The behavior of the SAH outcome is different in the black population than in the rest of the adult population. A marginal increase in the ESF health team slightly increases black people's probability of self-rating their health as "bad" (0.44pp) but reduces it by 0.60pp for adults in the 1st. quintile. In turn, the ESF registration diminishes the "bad" self-rating just for black individuals (0.60pp). The same game of opposites between ESF_c/ ESF_T happens with adults at the first quintile regarding being bedridden. That is, adults at the bottom of household income per capita distribution are more likely to be bedridden when the health teams increases (0.47pp). Meanwhile, it decreases once they get registered into the program (0.93 pp). Given that these results do not show a strong movement toward the most disadvantaged groups (black and poor/1^{st} quintile), we cannot strongly attest that ESF has reduced inequality in MRs[35].

4.3. Robustness checks

To confirm our findings, we ran a robustness check[36] regarding the concept of the treated population. We define the treated person as living in a household registered in the program for at least 12 months. Thus, a group of individuals registered in the ESF program, but for less than one year, are in the non-treated group. The choice was made because we believe health outcomes need time to respond to the program. Since we are interested in check the indirect effects from the expansion of the ESF supply over the non-treated, the distinction by the time of participation in ESF can cover-up the results.

We tested the robustness for results presented in Table 3 and redefine treated persons as living in households registered in the ESF regardless of how long. These change moves 10,280 observations into the treated group[37]. Generally, the estimate results for specification (2) with this new arrangement preserve our findings. The exception regards hospitalization, where ESF_T became positively significant. Thus, ESF registration remains associated with an increase in the probability of presenting a limitation to execute routine activities due to health reasons and being bedridden. It also increases in less than 1pp the likelihood of hospitalization. The pattern between ESF_c and health outcomes remains the same for

[35] Hone et al. (2020) analyzed a cohort of low-income adults during seven years in the city of Rio de Janeiro. The authors found greater reductions in the risk of death for ESF users who were black compared to white. Thus at least with respect to mortality in Rio de Janeiro, the inequality between black and whits seems to have decreased.

[36] We simply comment on these in what follows; Table Appendix E summarizes the marginal effects. The results of all estimates are available from the authors on request.

[37] Accounting for 3,000 observations in 2008, 4,212 in 2013, and 3,068 in 2019. These moves equal 5.0% of the pooled sample for three years, representing 8.6 million people.

both the treated and non-treated. Lastly, this check highlights two points: it reaffirms the consistency of municipality selection over the population with worse health outcomes and shows the relevance of identifying the direct and indirect benefits achieved by the program.

5. Conclusions

This study evaluates the relationship between ESF and specific health outcomes. We employ two intervention levels (local supply of health teams and individual ESF registration) to check if their interlinkage reinforces the program's relationship with adult health outcomes. The results provide important insights into the program' dynamics in large urban centers. First, the broad indirect association between health outcomes and the local supply of ESF health teams is stronger than the benefits reached by the treated population.

The second insight regards the expectation of the decrease in hospitalizations via the program. While studies that employ data at municipality levels systematically find that ESF reduces hospitalization, individual-level data does not ascertain that this result is due to the impact on the treated population. Instead, redefining those registered into the ESF for at least 12 months as treated population generates no relationship with being hospitalized. However, a small association (0.59pp) appears when we expand the treated-population concept (including those registered for less than a year). Even so, its correlation with the local supply of the ESF health team is negative and consistent for specifications and sample years. Future work will explore this important result.

The third point regards the ESF as a potential instrument to reduce health inequalities. The absence of a robust connection for black individuals and the poorest population shows that, in MRs, this goal has not been fully reached. Nonetheless, the bad self-assessed health is reverted for those that receive ESF treatment. However, once this gain is separate from the reversion of other poor health outcomes, much remains to be done for inequalities.

One of the limitations of this study is the lack of information on ESF health teams at municipality level. This information would have been important for enabling a better understanding of our hospitalization results, and to conduct a fuller assessment of heterogeneities. A useful next step for this research is therefore to link the individual-level data with ESF data at the municipality level, yet the latter information is currently not publicly available.

This study focused on issues ignored in the broad ESF literature: adult population, MRs, and two intervention levels. Thus, it contributes to the literature and shows that even non-treated adults that live in MRs with low ESF' coverage benefit from it (though small). Accordingly, if these regions find a way to increase the amount of ESF teams, the benefits for the adult population should not be overlooked. The results highlight that after more than 20 years of the ESF program, the task to map channels of action deserves more attention from local health managers, especially regarding the post-COVID-19 period, where all levels of the Brazilian Health system continue to be under pressure. The increase in chronic diseases put aside during the sanitary crisis, given the potential sequelae arising from the COVID-19 pandemic, will hit the adult population strongly. In the near future, the gap in the supply of the ESF teams in MRs will face a more complex picture, showcasing the less successful side of the ESF program.

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Declarations of interest: none

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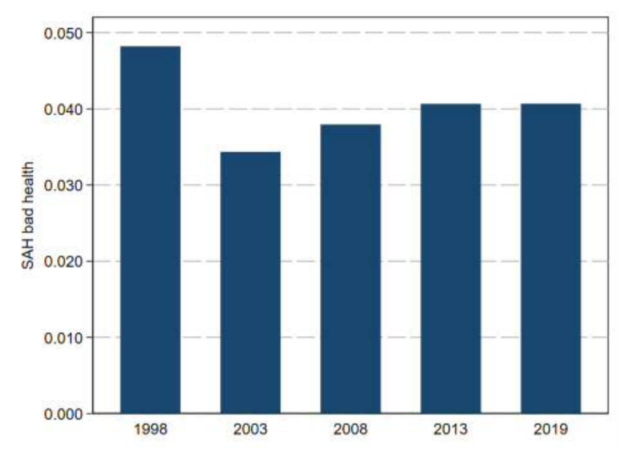
Appendix A. Population of metropolitan areas

Metropolitan Region	State	Year of creation	Population IBGE 2019
São Paulo	SP	1973	21,571,280
Rio de Janeiro	RJ	1974	12,699,743
Belo Horizonte	MG	1973	5,916,189
Porto Alegre	RS	1973	4,255,591
Recife	PE	1973	3,975,411
Fortaleza	CE	1973	3,939,460
Salvador	BA	1973	3,899,533
Curitiba	PR	1973	3,615,027
Belém	PA	1973	2,491,052
Oldest metropolitan areas			**62,363,286**
Brazil			**208,494,896**

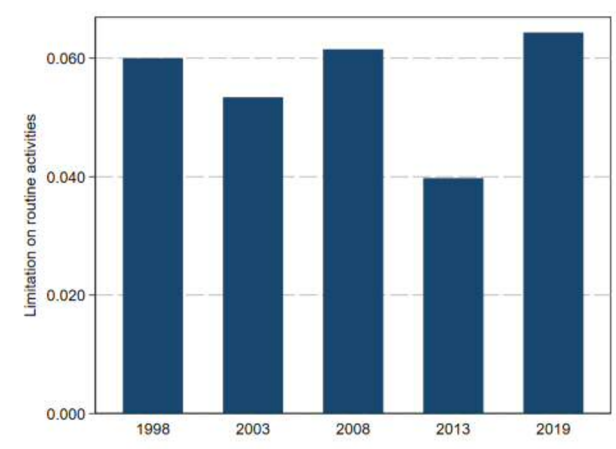
Source: Population estimation from Brazilian Institute of Geography and Statistics (IBGE)

Table A.5: Population of Brazilian Metropolitan Regions - 2019

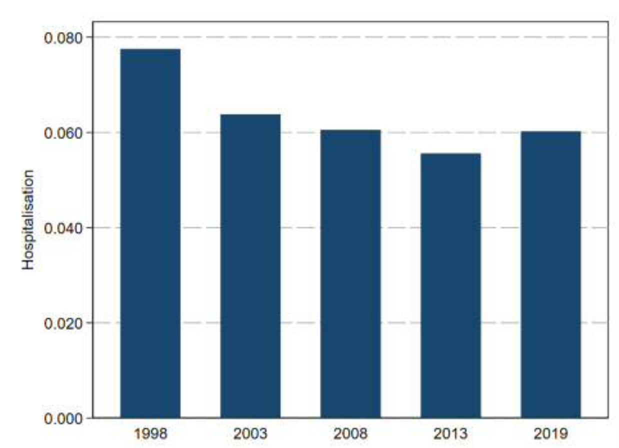
Appendix B. Health outcomes: Behavior over sample years



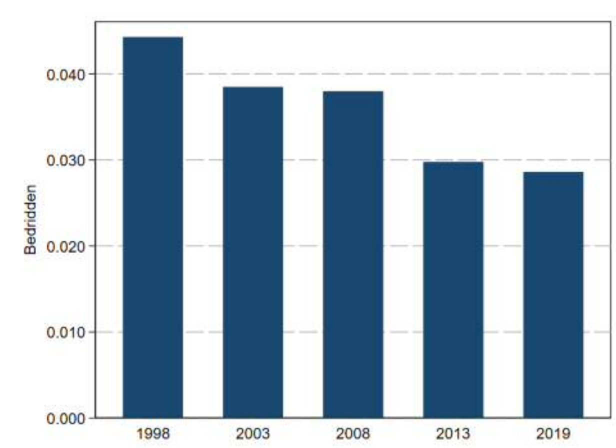
(a) Self-assessed health as "bad"



(b) Limited routine activities (last 2 weeks)



(c) Being bedridden (last 2 weeks)



(d) Hospitalization (12 months)

Figure B.6: Distribution health outcomes: 1998, 2003, 2008, 2013 and 2019

Appendix C. Estimates results: Specification 1

Variables	Health Outcomes - sample 1998–2019			
	Bad health	Routine Limitation	Bedridden (last 2 weeks)	Hospitalization (in 12 months)
ESF_c	-0.0069***	-0.0066**	-0.0027	-0.0143***
	(0.0026)	(0.0032)	(0.0026)	(0.0037)
Num. years of ESF	-0.0000	-0.0015***	-0.0005	-0.0023***
	(0.0004)	(0.0005)	(0.0004)	(0.0006)
Age	0.0019***	0.0012***	0.0006***	0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Men	-0.0013	-0.0208***	-0.0147***	-0.0228***
	(0.0010)	(0.0012)	(0.0009)	(0.0013)
Black	0.0028***	0.0027**	0.0002	0.0001
	(0.0010)	(0.0012)	(0.0009)	(0.0013)
Private	-0.0108***	0.0042***	0.0020**	0.0212***
health plan	(0.0012)	(0.0013)	(0.0010)	(0.0014)
Work	-0.0281***	-0.0153***	-0.0103***	-0.0275***
	(0.0011)	(0.0012)	(0.0009)	(0.0014)
High School	-0.0138***	-0.0105***	-0.0035***	-0.0014
	(0.0010)	(0.0013)	(0.0009)	(0.0014)
College or higher	-0.0233***	-0.0051***	-0.0006	0.0056***
	(0.0020)	(0.0018)	(0.0014)	(0.0019)
Child up to 6 years	-0.0008	-0.0067***	-0.0030***	0.0201***
old in the household	(0.0010)	(0.0012)	(0.0009)	(0.0013)
Adult over 54 years	-0.0081***	-0.0023	-0.0012	0.0095***
old in the household	(0.0014)	(0.0018)	(0.0014)	(0.0022)
Log per capita	-0.0092***	-0.0056***	-0.0047***	0.0008
household income	(0.0005)	(0.0007)	(0.0005)	(0.0008)
PCA	-0.0053***	-0.0041***	-0.0033***	-0.0039***
	(0.0004)	(0.0005)	(0.0004)	(0.0006)
Urban	0.0039**	0.0038	0.0044**	0.0088***
	(0.0018)	(0.0025)	(0.0019)	(0.0028)
Population (log)	0.0820***	0.0085	0.0588***	-0.0531**
	(0.0194)	(0.0233)	(0.0185)	(0.0258)
Taxes per capita (log)	0.0101	0.0014	0.0016	-0.0164*
	(0.0068)	(0.0083)	(0.0064)	(0.0090)
GDP per capita (log)	0.0173**	-0.0018	-0.0019	0.0401***
	(0.0087)	(0.0113)	(0.0089)	(0.0126)
Public hospital	-0.0096***	-0.0077***	-0.0034**	-0.0036
beds (1,00 inh.)	(0.0018)	(0.0022)	(0.0016)	(0.0024)
Years-fixed effects (2008-2019)	yes	yes	yes	yes
Metropolitan areas fixed effects	yes	yes	yes	yes
control for chronic diseases	no	no	no	no
control for smoking condition	no	no	no	no
Observations	**310,479**	**310,479**	**310,479**	**310,479**
Wald chi2	6425.93	2542.14	1777.26	2322.56
Prob >chi2	0.0000	0.0000	0.0000	0.0000
Pseudo R2	0.1158	0.0342	0.0292	0.0256

Standard errors in parentheses. Weighted by individual's household weights provided in each data set.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Variables	Health Outcomes - sample 1998–2008			
	Bad health	Routine Limitation	Bedridden (last 2 weeks)	Hospitalization (in 12 months)
ESF_c	-0.0006	-0.0176***	-0.0162***	-0.0184***
	(0.0044)	(0.0057)	(0.0048)	(0.0064)
Num. years of ESF	0.0006	0.0029***	0.0036***	0.0020
	(0.0009)	(0.0011)	(0.0010)	(0.0013)
Disease indicator	0.0273***	0.0377***	0.0273***	0.0325***
	(0.0005)	(0.0007)	(0.0006)	(0.0008)
Age	0.0012***	0.0002**	0.0000	-0.0009***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Men	0.0075***	-0.0115***	-0.0085***	-0.0239***
	(0.0011)	(0.0013)	(0.0011)	(0.0015)
Black	-0.0003	0.0003	-0.0019	0.0006
	(0.0011)	(0.0014)	(0.0012)	(0.0015)
Private	-0.0108***	0.0039***	0.0026**	0.0280***
health plan	(0.0014)	(0.0015)	(0.0013)	(0.0016)
Work	-0.0200***	-0.0088***	-0.0085***	-0.0266***
	(0.0011)	(0.0014)	(0.0012)	(0.0015)
High School	-0.0110***	-0.0043***	-0.0017	0.0033**
	(0.0012)	(0.0014)	(0.0012)	(0.0016)
College or higher	-0.0118***	0.0005	0.0038*	0.0089***
	(0.0024)	(0.0023)	(0.0020)	(0.0024)
Child up to 6 years	-0.0005	-0.0016	-0.0012	0.0161***
old in the household	(0.0010)	(0.0012)	(0.0010)	(0.0013)
Adult over 54 years	-0.0088***	-0.0038*	-0.0027	0.0071***
old in the household	(0.0016)	(0.0022)	(0.0018)	(0.0026)
Log per capita	-0.0092***	-0.0070***	-0.0054***	0.0020**
household income	(0.0006)	(0.0008)	(0.0007)	(0.0009)
PCA	-0.0039***	-0.0024***	-0.0024***	-0.0047***
	(0.0004)	(0.0005)	(0.0005)	(0.0006)
Urban	0.0000	-0.0046	-0.0006	0.0071*
	(0.0022)	(0.0032)	(0.0026)	(0.0037)
Population (log)	0.0701**	-0.0765*	0.0047	-0.0790
	(0.0346)	(0.0455)	(0.0393)	(0.0523)
Taxes per capita (log)	-0.0250**	-0.0640***	-0.0489***	-0.0571***
	(0.0124)	(0.0161)	(0.0136)	(0.0180)
GDP per capita (log)	-0.0541**	0.0856***	0.0780***	0.0637**
	(0.0218)	(0.0283)	(0.0243)	(0.0315)
Public hospital	0.0024	-0.0049*	-0.0029	-0.0015
beds (1,00 inh.)	(0.0020)	(0.0026)	(0.0021)	(0.0028)
Year-fixed effects	yes	yes	yes	yes
Metropolitan areas fixed effects	yes	yes	yes	yes
control for chronic diseases	yes	yes	yes	yes
control for smoking condition	no	no	no	no
Observations	**184,583**	**184,575**	**184,575**	**184,567**
Wald chi2	7915.81	5456.04	4251.59	3872.96
Prob >chi2	0.0000	0.0000	0.0000	0.0000
Pseudo R2	0.2044	0.0858	0.0851	0.0565

Standard errors in parentheses. Weighted by individual's household weights provided in each data set.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Variables	Health Outcomes - sample 2013–2019			
	Bad health	Routine Limitation	Bedridden (last 2 weeks)	Hospitalization (in 12 months)
ESF_c	-0.0980***	-0.0339	-0.0322	-0.0631*
	(0.0222)	(0.0298)	(0.0206)	(0.0329)
Num. years of ESF	-0.0011	-0.0079*	0.0006	-0.0050
	(0.0034)	(0.0043)	(0.0029)	(0.0048)
Disease indicator	0.0251***	0.0345***	0.0196***	0.0367***
	(0.0012)	(0.0015)	(0.0011)	(0.0018)
Smoking	0.0096***	0.0103***	0.0095***	0.0100***
	(0.0022)	(0.0029)	(0.0020)	(0.0032)
Age	0.0011***	0.0001	-0.0001	-0.0008***
	(0.0002)	(0.0002)	(0.0001)	(0.0002)
Men	-0.0021	-0.0234***	-0.0165***	-0.0194***
	(0.0023)	(0.0031)	(0.0023)	(0.0035)
Black	0.0041*	0.0047	0.0008	-0.0043
	(0.0025)	(0.0032)	(0.0021)	(0.0033)
Private	-0.0060**	0.0076**	0.0008	0.0136***
health plan	(0.0030)	(0.0033)	(0.0022)	(0.0034)
Work	-0.0169***	-0.0083**	-0.0057**	-0.0209***
	(0.0027)	(0.0033)	(0.0024)	(0.0039)
High School	-0.0137***	-0.0127***	-0.0025	0.0000
	(0.0024)	(0.0032)	(0.0022)	(0.0035)
College or higher	-0.0262***	-0.0002	0.0027	0.0055
	(0.0043)	(0.0042)	(0.0029)	(0.0044)
Child up to 6 years	0.0008	-0.0208***	-0.0059**	0.0306***
old in the household	(0.0031)	(0.0040)	(0.0028)	(0.0038)
Adult over 54 years	-0.0114***	-0.0062	-0.0072**	0.0054
old in the household	(0.0033)	(0.0045)	(0.0032)	(0.0054)
Log per capita	-0.0089***	-0.0060***	-0.0032***	0.0007
household income	(0.0013)	(0.0018)	(0.0012)	(0.0019)
PCA	-0.0081***	-0.0053***	-0.0040***	-0.0033
	(0.0013)	(0.0018)	(0.0010)	(0.0021)
Urban	0.0124***	0.0228***	0.0133***	0.0132*
	(0.0045)	(0.0070)	(0.0045)	(0.0070)
Population (log)	-0.3504*	-0.9124***	-0.4344**	-0.6696**
	(0.2055)	(0.2951)	(0.2122)	(0.2903)
Taxes per capita (log)	0.0779	-0.0954	0.0795	0.1075
	(0.0826)	(0.1110)	(0.0750)	(0.1307)
GDP per capita (log)	0.1153**	-0.0394	0.0040	0.0440
	(0.0510)	(0.0678)	(0.0465)	(0.0739)
Public hospital	-0.0919*	0.0923	-0.0273	-0.1462**
beds (1,00 inh.)	(0.0475)	(0.0633)	(0.0443)	(0.0740)
Year-fixed effects	yes	yes	yes	yes
Metropolitan areas fixed effects	yes	yes	yes	yes
control for chronic diseases	yes	yes	yes	yes
control for smoking condition	yes	yes	yes	yes
Observations	**49,874**	**49,874**	**49,874**	**49,874**
Wald chi2	1827.29	1194.30	799.84	913.89
Prob >chi2	0.0000	0.0000	0.0000	0.0000
Pseudo R2	0.1692	0.0772	0.0691	0.0544

Standard errors in parentheses. Weighted by individual's household weights provided in each data set.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix D. Estimates results: Specification 2

Variables	Health Outcomes - sample 2008–2019			
	Bad health	Routine Limitation	Bedridden last 2 weeks	Hospitalization (in 12 months)
ESF_c	-0.0243***	-0.0251***	-0.0162***	-0.0253***
	(0.0066)	(0.0077)	(0.0063)	(0.0089)
ESF_T	0.0023	0.0157***	0.0137***	0.0056
	(0.0032)	(0.0039)	(0.0027)	(0.0044)
ESF_c X ESF_T	0.0012	-0.0124***	-0.0094***	-0.0023
	(0.0024)	(0.0028)	(0.0020)	(0.0031)
Num. years of ESF	-0.0013	-0.0027***	-0.0012	-0.0041***
	(0.0009)	(0.0010)	(0.0008)	(0.0012)
Age	0.0018***	0.0011***	0.0005***	-0.0002*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Men	-0.0019	-0.0216***	-0.0151***	-0.0204***
	(0.0012)	(0.0015)	(0.0011)	(0.0017)
Black	0.0031**	0.0037**	0.0005	-0.0004
	(0.0013)	(0.0015)	(0.0011)	(0.0016)
Private	-0.0108***	0.0044***	0.0020*	0.0184***
health plan	(0.0016)	(0.0016)	(0.0012)	(0.0017)
Work	-0.0291***	-0.0161***	-0.0089***	-0.0253***
	(0.0014)	(0.0016)	(0.0012)	(0.0018)
High School	-0.0146***	-0.0123***	-0.0039***	-0.0023
	(0.0013)	(0.0015)	(0.0011)	(0.0017)
College or higher	-0.0246***	-0.0058***	-0.0010	0.0056***
	(0.0023)	(0.0021)	(0.0016)	(0.0023)
Child up to 6 years	-0.0005	-0.0082***	-0.0031***	0.0207***
old in the household	(0.0013)	(0.0016)	(0.0012)	(0.0017)
Adult over 54 years	-0.0075***	-0.0034	-0.0021	0.0085***
old in the household	(0.0018)	(0.0023)	(0.0017)	(0.0026)
Log per capita	-0.0085***	-0.0048***	-0.0040***	0.0006
household income	(0.0007)	(0.0009)	(0.0007)	(0.0010)
PCA	-0.0065***	-0.0044***	-0.0034***	-0.0030***
	(0.0006)	(0.0006)	(0.0004)	(0.0009)
Urban	0.0068***	0.0087***	0.0074***	0.0082**
	(0.0023)	(0.0032)	(0.0025)	(0.0035)
Population (log)	-0.0309	-0.2095**	-0.1351**	-0.2239**
	(0.0742)	(0.0862)	(0.0669)	(0.1007)
Taxes per capita (log)	0.0143	0.0182	0.0256*	-0.0196
	0.0160)	(0.0187)	(0.0143)	(0.0208)
GDP per capita (log)	0.0271*	-0.0095	-0.0203	0.0167
	(0.0149)	(0.0188)	(0.0140)	(0.0204)
Public hospital	-0.0235***	-0.0194*	-0.0166**	-0.0154
beds (1,00 inh.)	(0.0089)	(0.0104)	(0.0082)	(0.0121)
Year-fixed effects	yes	yes	yes	yes
Metropolitan areas fixed effects	yes	yes	yes	yes
Observations	**191,575**	**191,575**	**191,575**	**191,575**
Wald chi2	4317.09	1696.47	1089.91	1320.47
Prob >chi2	0.0000	0.0000	0.0000	0.0001
Pseudo R2	0.1166	0.0357	0.0289	0.0227

Standard errors in parentheses. Weighted by individual's household weights provided in each data set.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Variables	Health Outcomes - sample 2013–2019			
	Bad health	Routine Limitation	Bedridden last 2 weeks	Hospitalization (in 12 months)
ESF_c	-0.0986***	-0.0326	-0.0269	-0.0611*
	(0.0224)	(0.0298)	(0.0207)	(0.0330)
ESF_T	-0.0018	0.0047	0.0207***	0.0081
	(0.0069)	(0.0091)	(0.0060)	(0.0101)
ESF_c X ESF_T	0.0015	-0.0039	-0.0123***	-0.0058
	(0.0048)	(0.0060)	(0.0042)	(0.0068)
Num. years of ESF	-0.0012	-0.0078*	0.0009	-0.0048
	(0.0033)	(0.0043)	(0.0029)	(0.0049)
Disease indicator	0.0251***	0.0345***	0.0194***	0.0366***
	(0.0012)	(0.0015)	(0.0011)	(0.0018)
Smoking	0.0096***	0.0103***	0.0097***	0.0100***
	(0.0022)	(0.0029)	(0.0020)	(0.0032)
Age	0.0011***	0.0001	-0.0001	-0.0008***
	(0.0002)	(0.0002)	(0.0001)	(0.0002)
Men	-0.0021	-0.0235***	-0.0164***	-0.0194***
	(0.0023)	(0.0031)	(0.0023)	(0.0035)
Black	0.0042*	0.0046	0.0005	-0.0044
	(0.0025)	(0.0031)	(0.0021)	(0.0033)
Private	-0.0060**	0.0076**	0.0011	0.0136***
health plan	(0.0030)	(0.0033)	(0.0022)	(0.0034)
Work	-0.0169***	-0.0082**	-0.0058**	-0.0209***
	(0.0027)	(0.0033)	(0.0024)	(0.0039)
High School	-0.0137***	-0.0127***	-0.0025	0.0000
	(0.0024)	(0.0032)	(0.0022)	(0.0035)
College or higher	-0.0262***	-0.0002	0.0033	0.0056
	(0.0043)	(0.0042)	(0.0029)	(0.0044)
Child up to 6 years	0.0008	-0.0208***	-0.0059**	0.0306***
old in the household	(0.0031)	(0.0040)	(0.0028)	(0.0038)
Adult over 54 years	-0.0114***	-0.0062	-0.0070**	0.0054
old in the household	(0.0033)	(0.0045)	(0.0032)	(0.0054)
Log per capita	-0.0089***	-0.0060***	-0.0029**	0.0008
household income	(0.0013)	(0.0018)	(0.0012)	(0.0019)
PCA	-0.0081***	-0.0046***	-0.0040***	-0.0033
	(0.0012)	(0.0015)	(0.0010)	(0.0021)
Urban	0.0124***	0.0228***	0.0133***	0.0132*
	(0.0045)	(0.0070)	(0.0045)	(0.0070)
Population (log)	-0.3488*	-0.9177***	-0.4611**	-0.6787**
	(0.2058)	(0.2948)	(0.2123)	(0.2907)
Taxes per capita (log)	0.0767	-0.0928	0.0872	0.1118
	(0.0823)	(0.1110)	(0.0751)	(0.1310)
GDP per capita (log)	0.1155**	-0.0400	0.0003	0.0426
	(0.0510)	(0.0678)	(0.0465)	(0.0739)
Public hospital	-0.0913*	0.0914	-0.0267	-0.1471**
beds (1,000 inh.)	(0.0475)	(0.0633)	(0.0443)	(0.0740)
Year-fixed effects	yes	yes	yes	yes
Metropolitan areas fixed effects	yes	yes	yes	yes
Observations	**49,874**	**49,874**	**49,874**	**49,874**
Wald chi2	1838.01	1194.95	847.23	914.76
Prob >chi2	0.0000	0.0000	0.0000	0.0001
Pseudo R2	0.1692	0.0772	0.0707	0.0545

Standard errors in parentheses. Weighted by individual's household weights provided in each data set.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix E. Robustness estimate results

Health	Sample 2008-2019		
outcome	ESF_c	ESF_T	ESF_c X ESF_T
SAH bad health	-0.0253***	-0.0009	0.0035
	(0.0066)	(0.0032)	(0.0024)
Limitation of routine activ.	-0.0257***	0.0110***	-0.0094***
(last 2 weeks)	(0.0078)	(0.0038)	(0.0027)
Bedridden	-0.0169***	0.0110***	-0.0070***
(last 2 weeks)	(0.0063)	(0.0027)	(0.0020)
Hospitalisation	-0.0224**	0.0086**	-0.0026
(last 12 months)	(0.0087)	(0.0042)	(0.0030)

Standard errors in parentheses. Weighted by individual's household weights provided in each data set.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$