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**Cover page:**

**Title:** *" The role of primary healthcare amid the COVID-19 pandemic: Evidence from the Family Health Strategy in Brazil* "

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# The role of primary healthcare amid the COVID-19 pandemic: Evidence from the Family Health Strategy in Brazil


## Abstract

This paper investigates the role of primary healthcare in mitigating the consequences of the COVID-19 pandemic, focusing on the Brazilian Family Health Strategy (ESF) as a case study. ESF is Brazil's major primary care initiative, with prior evidence indicating its effectiveness in improving various health outcomes. The COVID-19 pandemic submitted the Brazilian healthcare system to a rigorous and unprecedented stress test, whose repercussions are still under study. Using comprehensive administrative microdata encompassing dimensions related to mortality, healthcare service, supply of family health teams and vaccination coverage, our empirical strategy accounts for heterogeneous effects based on program intensity and pandemic evolution of the 5,570 Brazilian municipalities. Our findings reveal that municipalities with high-intensity of ESF coverage (i.e. stronger primary care) experienced 347.93 (95% CI: 289.04, 406.81) fewer COVID-19 and cardiorespiratory deaths per million inhabitants throughout the pandemic period, compared to those in low-intensity ESF areas, despite sharing similar profiles of deaths from respiratory and cardiovascular causes. Among the channels contributing to this relative performance, high-intensity ESF municipalities were found to engage in more home-based primary care visits and health promotion activities while maintaining a similar supply of community health workers. Additionally, they achieved higher vaccination coverage, and these effects were more pronounced in areas with greater ESF presence, emphasising the importance of primary care coverage. In conclusion, our findings underscore the relevance of strong primary care in mitigating the consequences of the pandemic and addressing post-pandemic health challenges.



*Keywords:* Primary healthcare, Supply of health services, Health crisis.

## 1. Introduction

The outbreak of the COVID-19 pandemic put healthcare systems under unprecedented strain globally, underscoring the role of primary healthcare in crisis response and long-term resilience. Amidst challenging times, understanding the effectiveness of primary care initiatives becomes crucial, especially considering their impact on mitigating the consequences of a health crisis. The World Health Organisation (WHO) encouraged countries to strengthen primary healthcare services in alignment with their public policies (WHO, 2021, 2023a). The theoretical literature on the role of primary healthcare before the pandemic was focused on understanding the market for healthcare visits (Giuffrida and Gravelle, 2001), service utilisation (Atella and Deb, 2008), and the process of referral to secondary care (Godager et al., 2015). Amidst the pandemic, the rationale for primary healthcare is rooted in its influence on both the production and utilisation of health services to mitigate the effects of the COVID-19 crisis (Bischof and Kaiser, 2021; Ride et al., 2023; Hirani and Wüst, 2024). In terms of production, primary healthcare is expected to contribute to healthcare service provision by ensuring knowledge and awareness of diseases, healthcare system readiness, and capacity through resource availability – such as personal protective equipment, diagnostic tests, and necessary medical supplies. Regarding utilisation, primary healthcare is expected to facilitate appropriate patient referrals, optimising healthcare resource allocation by efficiently triaging patients. An empirical investigation of its contributions, through enhancing both the production of health and the efficient supply of healthcare services, not only illuminates its relevance during the COVID pandemic but also informs strategies for future crisis management and health system resilience.

This study focuses on the Family Health Strategy (ESF), Brazil's main primary healthcare initiative, and its importance in helping the country's healthcare system navigate the complexities of the COVID-19 crisis. Established in 1994 as part of the broader Brazilian Unified Health System (SUS), the ESF follows federal guidelines but is implemented by the municipalities, which have the prerogative to adopt the program (Castro et al., 2019; Macinko and Mullachery, 2022). Predominantly executed by the so-called Family Health Teams, each one comprising community health workers, physicians, nurses and other healthcare professionals, the ESF is characterised by home visits to individuals and households, forming a core component of the program's activities. Evidence from the Brazilian National Health Survey 2019 microdata, therefore one year before the onset of the COVID-19 pandemic shows that 60.0% of households were registered in ESF (Giovanella et al., 2021). By establishing a direct and continuous relationship with households, the ESF focuses on preventive measures, health promotion activities, and the early detection of health issues.

Existing literature emphasises the importance of strong primary care systems in promoting population health (Starfield et al., 2005; Demaio et al., 2014; Mora-Garcia et al., 2024), improving access to healthcare (Aakvik and Holmås, 2006; Bradley et al., 2018; Windle et al., 2023), and fostering preventive behaviours against infectious diseases (Kruk et al., 2010; Peckham et al., 2017). Some studies also recognize the role of robust primary healthcare systems in bolstering public health during crises (Kraus et al., 2023; Moncayo et al., 2024). However, there remains a gap in understanding the effectiveness and specific mechanisms of primary care initiatives, such as the ESF, in mitigating the consequences of a global health crisis like the COVID-19 pandemic. Prior research corroborates the ESF's positive impact on healthcare outcomes (Macinko et al., 2007; Rocha and Soares, 2010; Postali et al., 2021; Ferreira-Batista et al., 2022; Diaz et al., 2022; Ferreira-Batista et al., 2023), yet its direct influence amidst the pandemic and its aftermath lacks an empirical investigation. This study aims to bridge this gap by comprehensively examining the ESF's role during the pandemic, shedding light on its contributions to addressing COVID-19-related challenges and shaping post-pandemic healthcare scenarios. By doing so, our study contributes to the evolving discussion about the indispensable role of primary care during and after crises. The severity of the COVID-19 pandemic in Brazil, compounded by socio-political complexities and contrasting healthcare capacities across regions, accentuated the challenges faced. By December 2023, the country has recorded approximately 702,000 deaths, translating to around 3,276 deaths per million people, significantly higher than the global average of 873 deaths per million (WHO, 2023b). Amidst a context marked by political discord and countervailing responses to the pandemic (Diele-Viegas et al., 2021; Ortega and Behague, 2022; Ajzenman et al., 2023), the primary care sector, led by ESF, emerged as a counterbalance to mitigate the impact of negationism by the country's national leadership.

The main goal of this study is to assess the specific role played by the Brazilian Family Health Strategy in mitigating the health-related consequences of the COVID-19 pandemic. Through an econometric approach that exploits differences in the pandemic's evolution across municipalities, this study examines whether municipalities with a high supply of primary healthcare services (measured by the relative availability of ESF health teams) exhibited better performance in mitigating the impact of the pandemic compared to the others. To isolate this effect, we focus on groups of municipalities that share similar profiles of mortality by cardiorespiratory diseases. We check the sensitivity of the results to different definitions of high and low intensity of primary health care supply. The study also explores the underlying channels contributing to the main outcome, by investigating whether municipalities with strong primary healthcare engaged in more actions of health promotion and prevention, increased home-based primary care visits, or expanded their community health workers. Additionally, we investigate whether such municipalities achieved higher COVID-19 vaccination coverage compared to the others. Ultimately, this analysis contributes to our understanding of the role of primary healthcare during the pandemic and for post-pandemic health trajectories.

## 2. Methods

### *2.1. Data Sources*

We use various sources of administrative data. The first dataset is the mortality microdata from the *Sistema de Informação sobre Mortalidade* (SIMSUS), the Brazilian Mortality Information System. COVID-19-related deaths were defined as those with a primary cause coded as U07.1 (the COVID-19 diagnosis code), U07.2 (when COVID-19 is diagnosed clinically or epidemiologically) or B34.2 (Coronavirus infection, unspecified site). The definition of deaths from respiratory and cardiovascular conditions was based on the classification of avoidable causes as defined in Alfradique et al. (2009). A definition of non-COVID deaths from respiratory and cardiovascular causes was also applied to conduct a robustness exercise. For both mortality definitions, our focus is on individuals aged 0 to 65 years, encompassing the data collection period from 2016 to 2022.

To create a measure of primary care intensity, we extracted the data on the number of ESF's Family Health Teams at the municipal level from Datasus. Municipalities were classified as highly intensive in primary healthcare if they had, on average, at least one Family Health Team per 3,450 inhabitants. In accordance with the National Primary Care Policy (PNAB), there should be at least one Family Health Strategy (ESF) team for every 3,450 inhabitants (Brazil, 2011). This criterion has been a foundational component of the program since its inception and is routinely employed to gauge the extent of ESF coverage. The adherence to this criterion serves as a benchmark for assessing and ensuring the comprehensive reach of the ESF in addressing the healthcare needs of the community it serves. This classification has been utilised by prior literature in impact evaluation studies of the ESF (Diaz et al., 2022; Ferreira-Batista et al., 2023). Figure A.8 depicts the histogram of the population-to-family-health team ratio. Conversely, low-intensity municipalities were defined as those having less than one Family Health Team per 3,450 inhabitants on average. This classification, based on 2019 data, serves as a pre-pandemic baseline measure of primary care strength in each municipality.

We obtained additional data from Datasus to explore potential channels through which primary care may have influenced outcomes. Firstly, we gathered information on the number of procedures related to health promotion and prevention available in the *Sistema de Informação Ambulatorial do SUS* (SIASUS). SIASUS also includes the number of home visits per mid-level professional conducted in primary care for health promotion and prevention actions. Secondly, data on the number of community health workers (CHW) in each Brazilian municipality were collected from *Cadastro Nacional de Estabelecimentos de Saúde* (CNES). Community health workers, who are essential to the Family Health Strategy, have played a vital role in promoting health in Brazil and other countries (Perry et al., 2014; Hartzler et al., 2018; Wintrup, 2023). These workers have also helped mitigate some consequences of the pandemic (Cotrin et al., 2020; Salve et al., 2023). Their direct engagement with communities contributed to containing the spread of COVID-19, through potential pathways including information dissemination, emotional support, and combating stigma (Lotta et al., 2020; Strand et al., 2023). Lastly, we obtained data on the number of COVID-19 vaccine doses administered across Brazilian municipalities from Datasus. These diverse datasets enable a comprehensive investigation of the multifaceted role of primary care in the context of the COVID-19 pandemic in Brazil.

The descriptive statistics presented in Table 1 offer an overview of the variables employed in our analysis, categorised into mortality-related factors and channels representing various health domains. We distinguish between *Before the pandemic* and *Post-pandemic outbreak* to examine shifts pre and post-March 2020. Regarding mortality rates, the data illustrates a pattern: before the pandemic, mortality rates due to Covid-19 and cardiorespiratory causes were statistically similar in high and low-intensity ESF municipalities. However, during the pandemic period, a noteworthy decrease of 23.54 deaths per 100,000 inhabitants was observed in high-intensity municipalities in contrast to low-intensity ones. This initial evidence suggests that the difference in mortality rates between Covid-19 and cardiorespiratory causes could be attributed to a relatively better performance in managing Covid-19-related deaths in high-intensity municipalities. Shifting focus to the channel variables, the descriptive analysis reveals a difference in the period before the pandemic. Prior to the pandemic, actions related to health promotion, primary care home visits, and coverage of Community Health Workers were more prevalent in high-intensity municipalities. Post-pandemic onset, a noticeable increase in the Coverage of Community Health Workers and Coverage of Covid-19 vaccine was observed in high-intensity ESF municipalities.

Table 1: Descriptive statistics

| Variables | Before the pandemic | | | Post-pandemic outbreak | | |
|---|---|---|---|---|---|---|
| | High intensity | Low intensity | Difference | High intensity | Low intensity | Difference |
| ***Mortality rate (deaths per 100,000 inhabitants)*** | | | | | | |
| Covid-19 and Cardiorespiratory causes | 154.60 | 151.93 | 2.66 | 187.17 | 210.71 | -23.54*** |
| Non-Covid deaths from Cardiorespiratory causes | 154.60 | 151.93 | 2.66 | 104.59 | 100.78 | 3.81 |
| ***Underlying Channels*** | | | | | | |
| Actions for health promotion and prevention (per capita) | 11.19 | 8.91 | 2.28*** | 2.64 | 2.80 | -0.16 |
| Primary care home visits (per capita) | 5.88 | 4.39 | 1.50*** | 1.58 | 1.56 | 0.02 |
| Coverage of Community Health Workers (%) | 192.21 | 119.77 | 72.43*** | 195.10 | 120.58 | 74.52*** |
| Coverage of Covid-19 vaccine (per capita) | 0 | 0 | 0 | 2.60 | 2.46 | 0.15*** |

The table displays descriptive statistics of the variables used in our analysis, categorised based on the time periods defined as 'Before the pandemic' and 'Post-pandemic outbreak', representing periods preceding and following March 2020, respectively. High-intensity municipalities have, on average, at least one Family Health Team per 3,450 inhabitants, whereas low-intensity municipalities were classified as those having fewer than one Family Health Team per 3,450 inhabitants on average. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

### *2.2. Empirical strategy*

To analyse the heterogeneous effects of the pandemic on municipalities with strong and weak primary healthcare, our econometric strategy relies on an event study approach (Clarke and Tapia-Schythe, 2021; Sun and Abraham, 2021; Miller, 2023). This approach is grounded on a difference-in-differences strategy and involves the application of locality and time fixed-effects models. It offers distinct advantages over the standard difference-in-differences approach. Firstly, an event study set-up allows the estimation of monthly effects, enabling a detailed analysis of the pandemic's evolution in municipalities with varying strengths of primary healthcare. Secondly, it facilitates the visual assessment of the assumption of parallel trends, a key identification assumption of difference-in-differences estimators. The parallel trends assumption requires the outcome variable to exhibit parallel trajectories between the untreated and treated groups in the absence of treatment. An event study enables the visualisation of coefficients in the pre-treatment period: if, for instance, coefficients are statistically different from zero before the event, one would infer that municipalities with strong and weak primary healthcare already had different, non-parallel trajectories in health outcomes before the onset of the pandemic.

The event study methodology has been extensively employed for assessing various outcomes related to the pandemic. Goodman-Bacon and Marcus (2020) recommended that researchers should present event study estimates to examine the effects of pandemic-related policies comparing periods before and after their implementation. As an example, Lyu and Wehby (2020) explored the effects of social isolation orders on the daily growth rates of COVID-19-related deaths and hospitalisations. Silverio-Murillo et al. (2023) investigated the pandemic's effects on non-COVID-19 deaths, such as heart attacks, diabetes and hypertension, while Silverio-Murillo et al. (2021) estimated the impact of the lockdown measures on fertility rates and women's mental health.

We apply an event study approach to investigate our research questions through the following econometric specification:

$$
\begin{aligned}
Health\ outcome_{itp} = \sum_{\tau \neq -1} \alpha_\tau \cdot 1[Month_t = \tau] \cdot Analysis\ Period_p \cdot ESF_i + \\
+ \sum_{\tau \neq -1} \beta_\tau \cdot 1[Month_t = \tau] \cdot Analysis\ Period_p + \\
+ \sum_{\tau \neq -1} \gamma_\tau \cdot 1[Month_t = \tau] \cdot ESF_i + \\
+ \theta_i + \theta_t + \theta_p + \varepsilon_{itp}
\end{aligned}
$$

The *Health outcome* variable represents a set of indicators of mortality and its potential underlying channels. For the mortality analysis, we examine the corresponding rates attributed to both Covid-19 and cardiorespiratory causes, as well as non-Covid deaths from cardiorespiratory issues, measured as death rates per 100,000 inhabitants. All mortality rates were calculated as age-standardised rates (Rocha et al., 2021; Atalay et al., 2023; Fan et al., 2024). We then extend the analysis to exploring various possible channels, including health promotion and prevention activities, primary care home visits, supply of Community Health Workers, and coverage of Covid-19 vaccines, all measured in per capita terms.

Our specification includes several explanatory variables. $Analysis\ Period_p$ is defined as 1 if it falls within the timeframe spanning from July 2019 to June 2022, and 0 if it falls within the period between July 2016 and June 2019 (our baseline period). The two time intervals in the *Analysis Period* variable aim to account for the prior seasonality of the *Health outcome* variable, requiring symmetrical time intervals for the comparative analysis. The first time period starts in July 2019 to enable the visualisation of estimates for months preceding the onset of the pandemic. The only exception is for the estimation of vaccination coverage. Given that the beginning of Covid-19 vaccination in Brazil took place in January 2021 ($\tau = 0$ in this case), the variable $Analysis\ Period_p$ is defined as 1 for the period July 2020 to June 2023, and 0 for the period July 2017 to June 2020. The variable $1[Month_t = \tau]$ denotes the specific month for the impact assessment of the pandemic. Considering the onset of the pandemic as February 2020 ($\tau = 0$), our reference point for this variable is the preceding month, January 2020 ($\tau = -1$). The values taken by the variable $\tau$ encompass both the analysis period and the baseline period. The variable $ESF_i$ denotes whether the municipality is categorised as high intensity or low intensity with respect to the Family Health Strategy, as defined previously.

The parameter $\alpha_\tau$ is our coefficient of interest, identifying the heterogeneous effect of the pandemic between high-intensity and low-intensity ESF municipalities, over successive months. $\beta_\tau$ identifies the impact of the pandemic that is common across all municipalities. $\gamma_\tau$ gauges the effect of the ESF both preceding and following the pandemic outbreak. $\theta_i$, $\theta_t$, $\theta_p$ represent the municipal, time and period fixed effects, respectively. All regressions were weighted by municipal population and robust standard errors were clustered at the municipality level.

## 3. Results

Figure 1 summarises the conceptual framework behind the results presented in this section. The first main set of analyses (a) investigates whether municipalities with high-intensity primary healthcare had better performance post-pandemic outbreak concerning mortality from COVID-19, respiratory, and cardiovascular causes, compared to the low-intensity municipalities. Subsequent analysis explores the sensitivity of these results to the definition of high and low ESF intensity. We further examine whether the two sets of municipalities exhibited comparable profiles of mortality rates linked to cardiorespiratory diseases. As a second set of analyses (b), we study the potential underlying channels for changes in the main outcomes, by examining whether municipalities with strong primary healthcare implemented more intense health promotion and prevention actions, increased home visits for primary care, expanded their community health agent workforce, or achieved higher COVID-19 vaccination coverage.

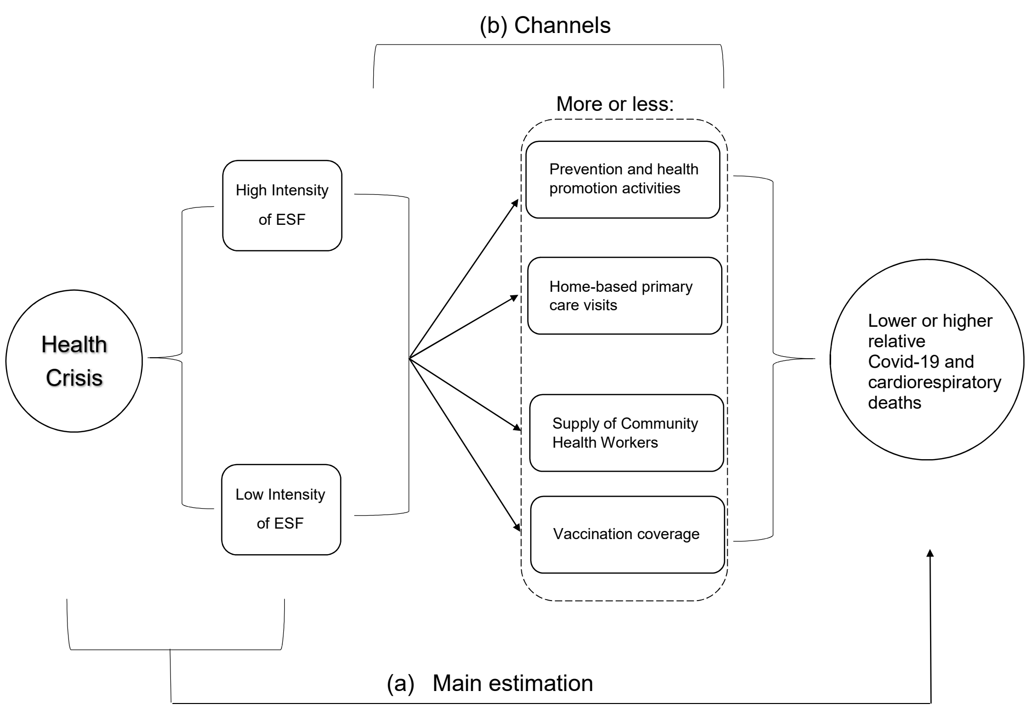


Figure 1: Conceptual framework: The heterogeneous effects of the pandemic on municipalities with strong and weak primary healthcare, and its specific channels.

*3.1. Main estimation*

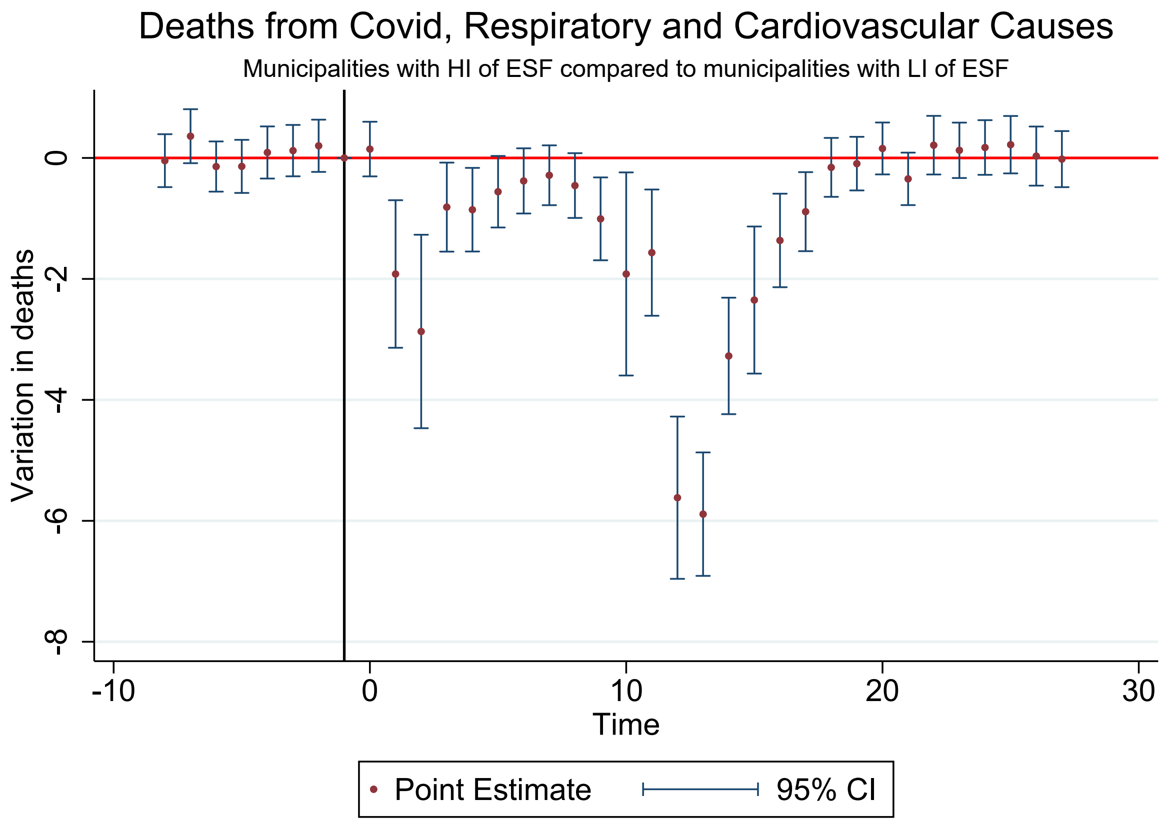


Figure 2: Mortality data from SIMSUS. COVID-19-related deaths were identified by primary cause codes U07.1 (COVID-19 diagnosis), U07.2 (clinical or epidemiological COVID-19 diagnosis), or B34.2 (Coronavirus infection, unspecified site). Respiratory and Cardiovascular causes are based on the classification of avoidable causes. Reported coefficients $\alpha_\tau$ from an event-study estimation with respective 95% confidence intervals, comparing municipalities with high intensity (HI) of ESF to those with low intensity (LI) of ESF. The X-axis represents the number of months before and after the onset of the pandemic, while the Y-axis represents age-standardised deaths per 100,000 inhabitants. Estimation controls for fixed effects of municipality, time, and period. Regressions weighted by municipal population. Robust standard errors clustered at the municipality level. Estimates of the regressions shown in Figure 2 are provided in the Table A.1 of the Appendix.

Figure 2 presents the findings from the main estimation examining Covid-19 and cardiorespiratory-related deaths in municipalities with high versus low ESF intensity. In an additional exercise presented in Figure A.9, we use the cumulative mortality from Covid-19, respiratory, and cardiovascular causes as the outcome of interest. Municipalities with strong primary health-care exhibited 34.793 (95% CI 28.904, 40.681) fewer COVID-19 and cardiorespiratory deaths per 100,000 inhabitants throughout the pandemic. This equates to 347.93 fewer COVID-19 and cardiorespiratory deaths per million inhabitants compared to low-intensity ESF areas. Results are reported monthly, with February 2020 being considered the reference month, as it immediately preceded WHO's declaration of the pandemic (WHO, 2023a). Our results indicate no statistically significant differences in mortality between high and low-intensity ESF municipalities before the pandemic. For the post-pandemic period, we find a statistically significant difference across almost the entire period, highlighting that municipalities with strong primary healthcare systems performed better in terms of mortality compared to others. In particular, there was a difference of -2.869 deaths (95% CI: -1.270, -4.469) per 100,000 inhabitants in the second month of the pandemic, which increased to -5.890 deaths (95% CI: -4.869, -6.910) per 100,000 inhabitants by the thirteenth month, gradually decreasing in subsequent months.

*3.2. Sensitivity of Coverage*

To assess the role of the intensity of ESF, Figure 3 presents a sensitivity analysis of the definition of the ESF coverage measure. In the first scenario, municipalities with high intensity of ESF are defined as (i) having 1 team available for every 2,500 inhabitants on average, representing an even higher coverage than traditionally used. In the second scenario, municipalities with low intensity of ESF are defined as (ii) having 1 team available for every 6,000 inhabitants on average (and 3,450 at minimum), indicating a lower and more flexible coverage than the traditionally applied measure.

Once again, our findings point to the absence of any statistically significant differences in mortality between high and low-intensity ESF municipalities, for both coverage definitions. In the post-pandemic period, the mortality differences become statistically significant in more months than in the analysis with our first coverage definition. In particular, the most substantial difference is observed as -6.560 deaths (95% CI: -5.002, -8.118) per 100,000 inhabitants in the twelfth month of the pandemic for the first coverage definition, while it stands at -4.451 deaths (95% CI: -2.590, -6.313) per 100,000 inhabitants for the same period under the second coverage definition. Overall, this sensitivity exercise reinforces the message that municipalities with stronger primary healthcare performed better in terms of COVID-19 and cardiorespiratory-related mortality compared to other municipalities.

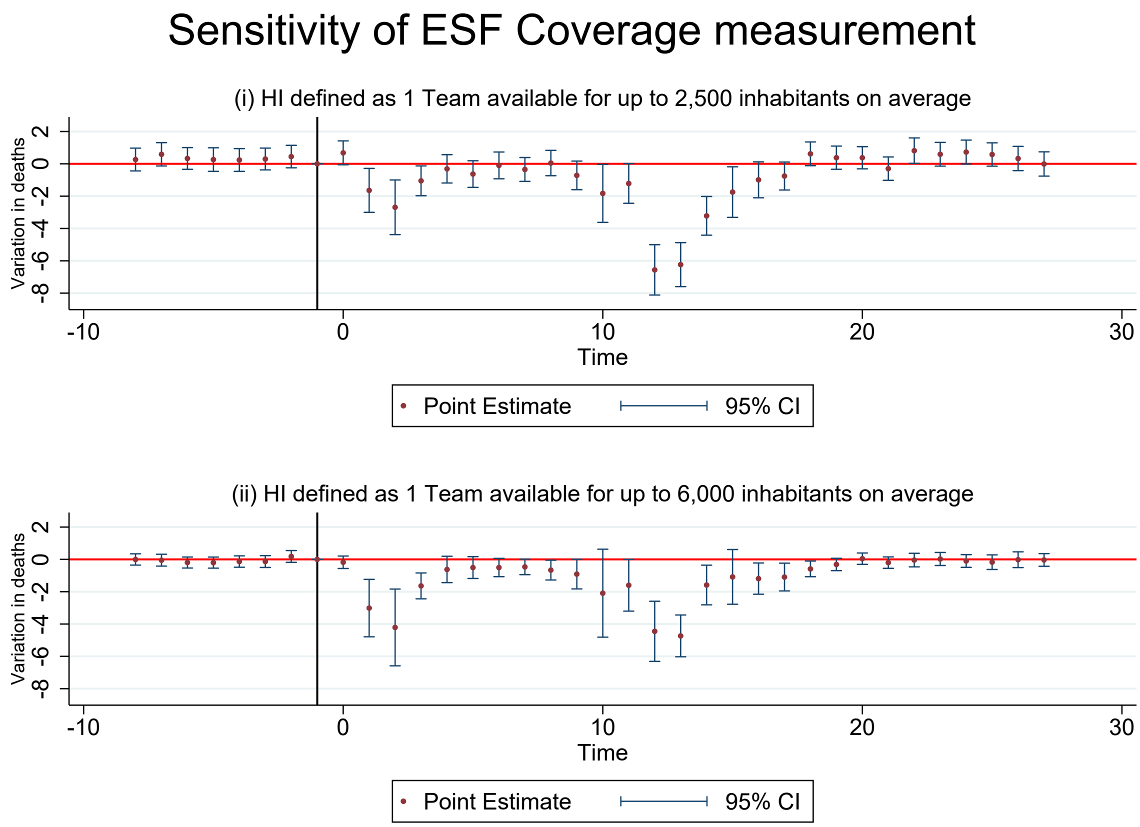


Figure 3: Sensitivity of coverage. In this sensitivity analysis, (i) HI was defined as 1 team available for up to 2,500 inhabitants on average and LI as 1 team available for more than to 3,450 inhabitants on average; (ii) HI defined as 1 team available for up to 6,000 inhabitants (and 3,450 at minimum) on average and LI as 1 team available for more than to 6,000 inhabitants on average. Mortality data from SIMSUS. Reported coefficients $\alpha_\tau$ from an event-study estimation with respective 95% confidence intervals, comparing municipalities with high intensity (HI) of ESF to those with low intensity (LI) of ESF. The X-axis represents the number of months before and after the onset of the pandemic, while the Y-axis represents COVID-19 age-standardised deaths per 100,000 inhabitants. Estimation controls for fixed effects of municipality, time, and period. Regressions weighted by municipal population. Robust standard errors clustered at the municipality level. Estimates of the regressions shown in Figure 3 are provided in the Table A.1 of the Appendix.

### *3.3. Robustness check*

Potential concerns around our main results may arise if there were substantial differences in pre-pandemic mortality from respiratory and cardiovascular causes between municipalities with high and low ESF intensity, or if the pandemic systematically altered mortality for such conditions between these groups. Figure 4 displays the evolution of non-Covid deaths attributed to respiratory and cardiovascular causes. For both periods, before and after the pandemic, there were no statistically significant differences in mortality between municipalities with high and low ESF intensity. This exercise offers reassurance that both groups of municipalities exhibited similar patterns regarding cardiorespiratory mortality, and that these patterns remained unchanged post-pandemic. Furthermore, this result reinforces our conclusion that the difference observed in Figure 2 is attributable to the better performance concerning COVID-19 mortality among municipalities with stronger primary healthcare, compared to other municipalities.

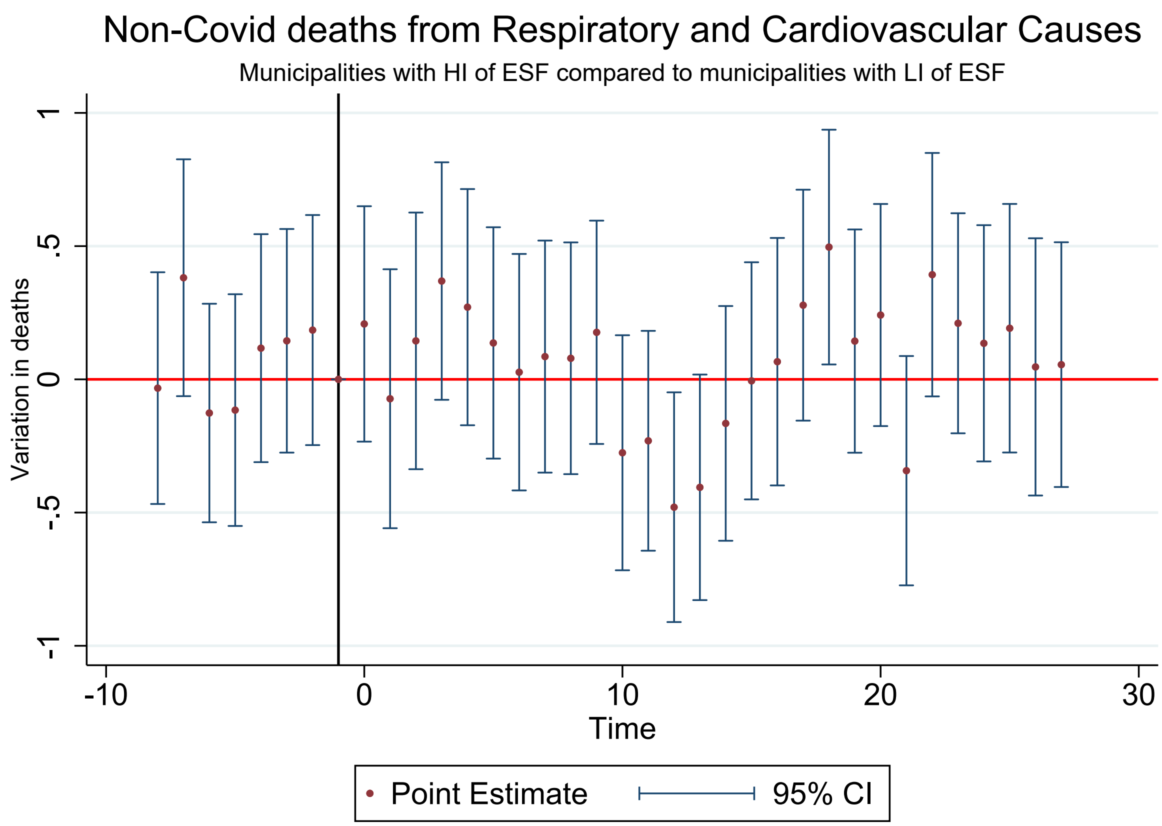


Figure 4: Robustness check. Mortality data from SIMSUS. For this exercise, the COVID-19-related deaths were not considered. Respiratory and Cardiovascular causes are based on the classification of avoidable causes. Reported coefficients $\alpha_\tau$ from an event-study estimation with 95% confidence intervals, comparing municipalities with high intensity (HI) of ESF to those with low intensity (LI) of ESF. The X-axis represents the number of months before and after the onset of the pandemic, while the Y-axis represents age-standardised deaths per 100,000 inhabitants. Estimation controls for fixed effects of municipality, time, and period. Regressions weighted by municipal population. Robust standard errors clustered at the municipality level. Estimates of the regressions shown in Figure 4 are provided in the Table A.1 of the Appendix.

### *3.4. Channels*

In order to understand the potential mechanisms through which primary healthcare helped mitigate COVID-19 mortality in Brazil, we examine various operational channels. Firstly, we scrutinise how municipalities with high ESF intensity performed in terms of health promotion and prevention activities undertaken, relative to low-intensity municipalities. Health promotion and prevention activities are conducted within the primary healthcare system; in our analysis, these activities serve as an indicator of the degree of engagement of a given municipality with primary healthcare actions. Within SIASUS, these activities are categorised as follows: health education, oral health, home visits, nutrition and dietary practices, integrative or complementary practices, sanitary surveillance, and worker health surveillance. Figure 5 indicates that both groups of municipalities exhibited similar patterns in terms of health promotion and prevention actions before the pandemic, and this similarity was sustained at the onset of the pandemic. However, after 6 months into the pandemic, a noticeable intensification of actions is observed among municipalities with high ESF intensity compared to others. Our estimation suggests that municipalities with strong primary healthcare had 0.13 (95% CI: 0.078, 0.189) more health promotion and prevention actions per capita in the sixth month, maintaining a difference of 0.11 (95% CI: 0.044, 0.178) in the final month of analysis.

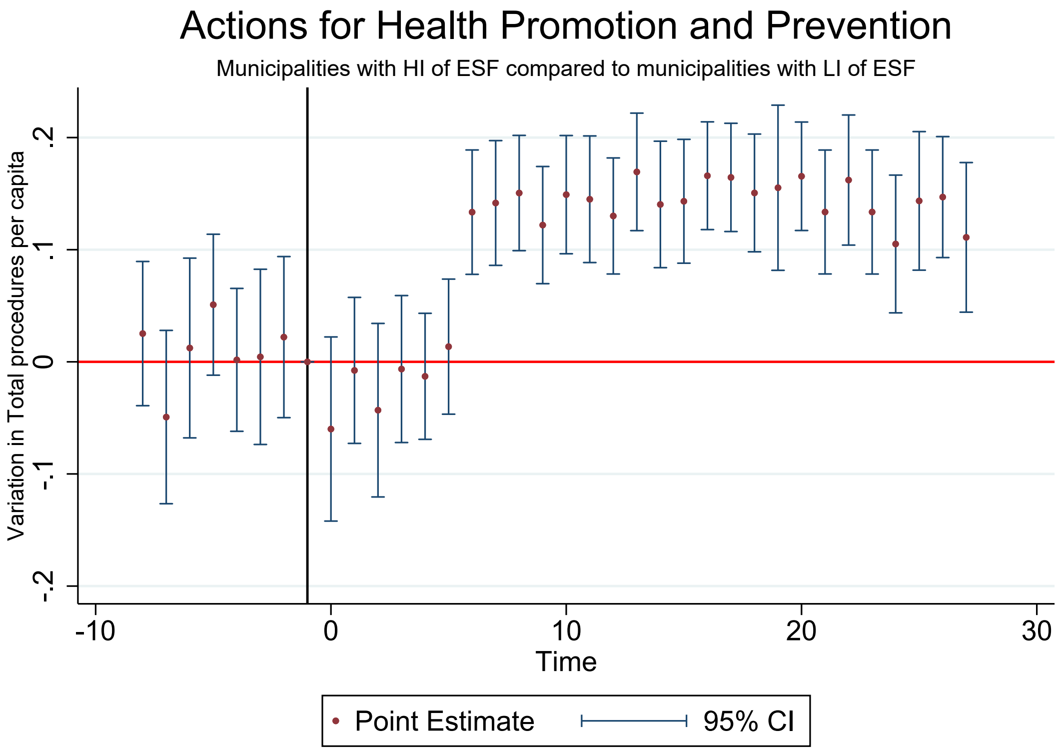


Figure 5: Channel I - Actions for health promotion and prevention. Data on procedures related to health promotion and prevention were collected from SIASUS. Reported coefficients $\alpha_\tau$ from an event-study estimation with 95% confidence intervals, comparing municipalities with high intensity (HI) of ESF to those with low intensity (LI) of ESF. The X-axis represents the number of months before and after the onset of the pandemic, while the Y-axis represents Total procedures per capita. Estimation controls for fixed effects of municipality, time, and period. Regressions weighted by municipal population. Robust standard errors clustered at the municipality level. Estimates of the regressions shown in Figure 5 are provided in the Table A.2 of the Appendix.

Secondly, we assess the evolution of primary healthcare home visits in municipalities. This is an important aspect since the cornerstone of the Family Health Strategy are the home visits undertaken by the ESF community health workers. Figure 6 indicates a similar pattern to that observed for health promotion and prevention actions. After 6 months into the pandemic, municipalities with high intensity of ESF intensified their home visits relative to other municipalities. Our estimation suggests that municipalities with strong primary healthcare conducted 0.08 (95% CI: 0.054, 0.114) more primary care home visits per capita in the sixth month, sustaining around 0.12 (95% CI: 0.087, 0.153) in the last month of analysis.

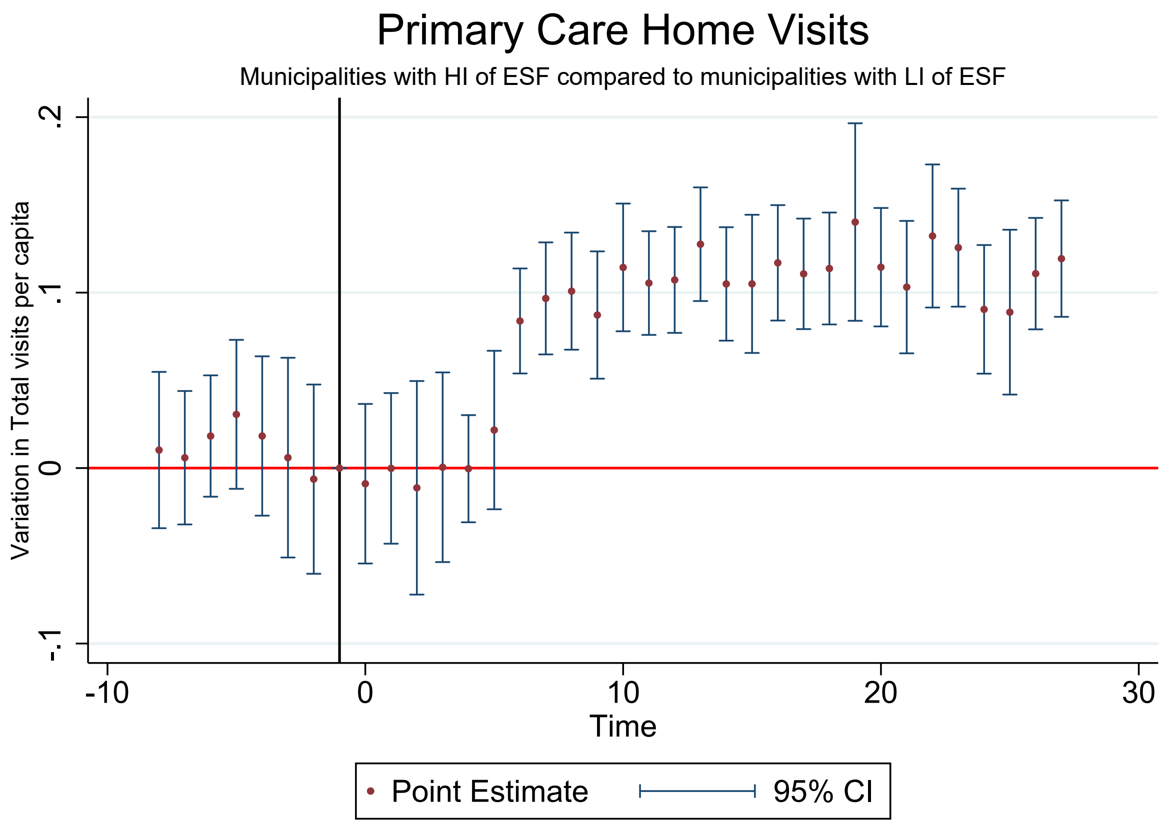


Figure 6: Channel II - Primary care home visits. The numbers of home visits per mid-level professional conducted in primary care for health promotion and prevention actions are from SIASUS. Reported coefficients $\alpha_\tau$ from an event-study estimation with 95% confidence intervals, comparing municipalities with high intensity (HI) of ESF to those with low intensity (LI) of ESF. The X-axis represents the number of months before and after the onset of the pandemic, while the Y-axis represents Total visits per capita. Estimation controls for fixed effects of municipality, time, and period. Regressions weighted by municipal population. Robust standard errors clustered at the municipality level. Estimates of the regressions shown in Figure 6 are provided in the Table A.2 of the Appendix.

Thirdly, we investigated the evolution of municipalities in terms of their coverage by community health workers (CHW). CHW coverage was calculated based on the Ministry of Health's recommendation that each worker should be responsible for the care of a micro-area with a maximum of 750 individuals. As an example, a municipality with 100,000 inhabitants and 90 CHWs would have a coverage of 67.5% of the population. Figure 7 shows the results of the estimation for CHWs, revealing relative stability in coverage between high and low-intensity municipality groups, despite wider confidence intervals in the final analysis period. This finding indicates that the rise in home visits and health promotion and prevention actions was not accompanied by (or achieved through) an increase in the coverage of CHWs. In fact, the implication is that high-intensity ESF municipalities managed to deliver more primary care visits and activities while maintaining the same workforce.

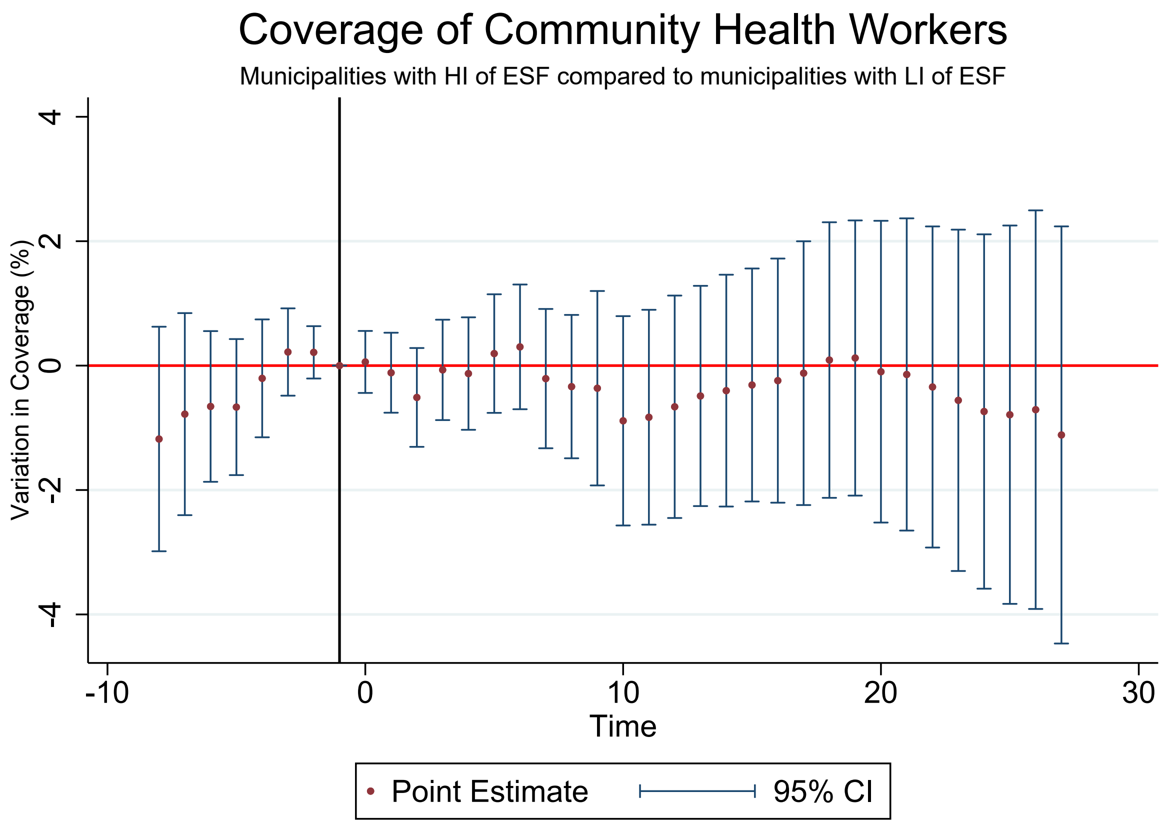


Figure 7: Channel III - Coverage of Community Health Workers. Data on the number of community health workers in each Brazilian municipality were collected from CNES. Reported coefficients $\alpha_\tau$ from an event-study estimation with respective 95% confidence intervals, comparing municipalities with high intensity (HI) of ESF to those with low intensity (LI) of ESF. The X-axis represents the number of months before and after the onset of the pandemic, while the Y-axis represents the Coverage of Community Health Workers. Estimation controls for fixed effects of municipality, time, and period. Regressions weighted by municipal population. Robust standard errors clustered at the municipality level. Estimates of the regressions shown in Figure 7 are provided in the Table A.2 of the Appendix.

Finally, we explored the COVID-19 vaccination coverage as a possible channel for the main mortality effects. The outcome variable was defined as the cumulative total of monovalent and bivalent doses divided by the municipal population. Figure A.10 provides estimations for four different scenarios. In (i), high-intensity ESF municipalities are defined as having one team available for every 1500 inhabitants on average, and LI as one team available for more than 3,450 inhabitants on average. In the other scenarios, HI is defined as 2,500 inhabitants on average in (ii), the standard 3,450 inhabitants on average in (iii), and 6,000 inhabitants (and 3,450 at minimum) on average in (iv). In general, we find that as the ESF intensity increases, vaccination coverage also increases. This conclusion is evident in (i); however, as we relax the definition of high intensity, this result becomes statistically insignificant or even reverses its trend. Specifically, the estimated differential concludes the analysis period at 0.46 (95% CI: 0.254, 0.668) in (i), -0.05 (95% CI: -0.195, 0.092) in (ii), -0.17 or (95% CI: -0.306, -0.026) in (iii), and -0.35 or (95% CI: -0.553, -0.151) in (iv). Across all scenarios, the estimated differential in cumulative coverage was limited to around 0.5 of COVID-19 vaccine doses per capita.

## 4. Discussion

This study investigates the role of primary healthcare, specifically the Brazilian Family Health Strategy (ESF), in mitigating the health-related effects of the COVID-19 pandemic. By examining comprehensive administrative microdata including mortality, vaccination, supply of healthcare services, and the operation of family health teams, our investigation has provided insights into the impact of primary care during this challenging period. The results of this research underscore the relevance of primary care in facing health crises like the COVID-19 pandemic. They also reinforce the importance of a strong primary care model with an emphasis on community engagement, enabling the establishment of a long-term relationship between healthcare professionals and households.

These findings resonate with previous studies that have emphasised the critical role of primary healthcare systems in the context of health crises (Kraus et al., 2023). Studies by Macinko and Mendonça (2018), Bigoni et al. (2022), and Kringos et al. (2015) align with our conclusion of a direct connection between strong primary care infrastructure and improved health outcomes in similar contexts of health vulnerability.

Moreover, our study elucidates key mechanisms through which primary care-intensive municipalities achieved better health results during the COVID-19 pandemic. Enhanced home-based primary care visits and active health promotion initiatives emerged as factors contributing to the health resilience of municipalities with stronger primary care systems. Furthermore, the higher vaccination coverage achieved by the latter group of municipalities highlights the link between primary care coverage and a more successful pandemic response (Bastos et al., 2022; Lo et al., 2022). The implications of our findings extend beyond the immediate context of the pandemic. They emphasise the enduring importance of investing in and bolstering primary healthcare infrastructure to effectively address not only ongoing health challenges but also potential future crises (Bollyky et al., 2022; Frieden et al., 2023; Williams et al., 2024). This study provides valuable empirical evidence to support the implementation of policies that prioritise and strengthen primary care systems as a cornerstone of public health resilience.

It's important to acknowledge some limitations of this research. The study's focus on Brazilian municipalities might limit the generalisation of findings to different healthcare contexts globally, particularly for non-universal health coverage systems. Additionally, although we have examined comprehensive administrative data, this is an ecological study with estimations at the municipality level where relationships observed at the population level may not necessarily hold for all individuals or subgroups of the Brazilian population. Our analysis does not account for potential heterogeneous effects within the high and low intensity groups of the Family Health Strategy (ESF), which could introduce additional complexities not captured in the current study. Further research is important to improve our understanding of the nuanced dynamics between primary care and pandemic preparedness. This includes, for example, exploring variations in the role of primary care for health protection across different socioeconomic groups (Bitton et al., 2017), dimensions related to equity (Love-Koh et al., 2021; Barron et al., 2023) and evaluating the long-term impact of primary care strategies on public health outcomes (Liu et al., 2023).

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**Appendix A.**

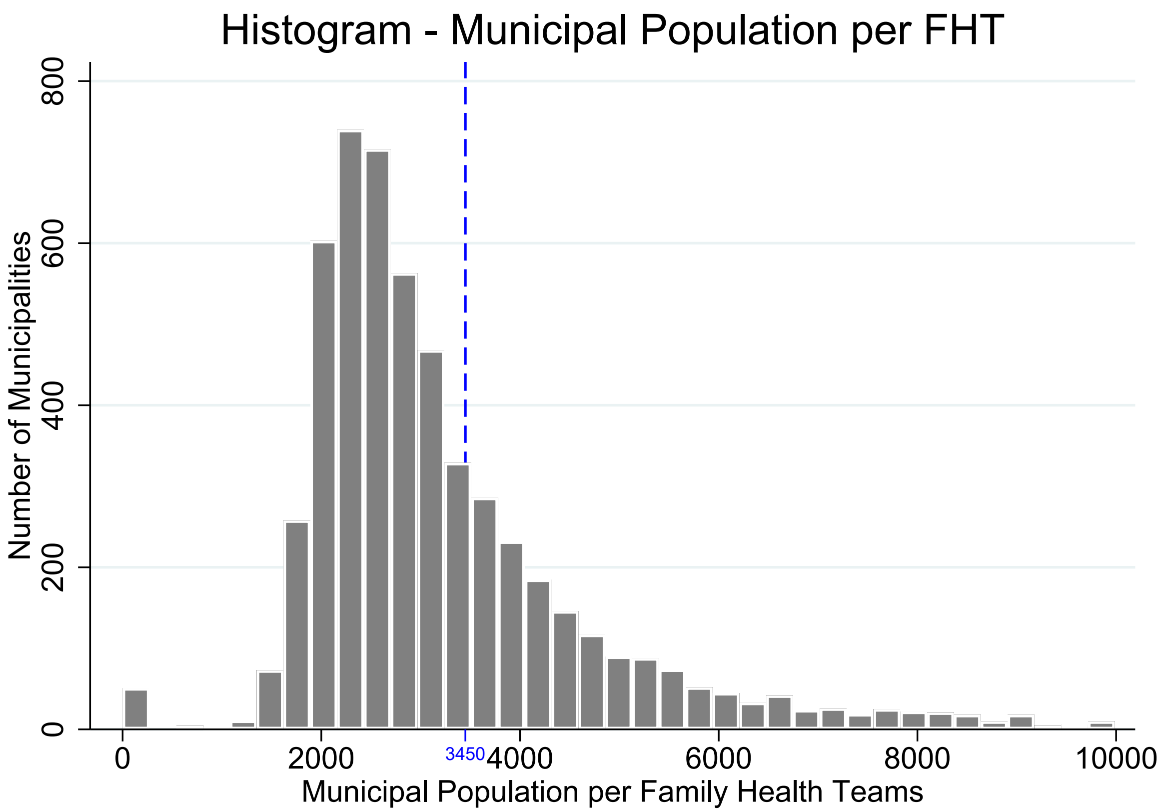


Figure A.8: Data on the number of Family Health Teams at the municipal level was extracted from Datasus for each of the 5,570 municipalities. In accordance with the National Primary Care Policy (PNAB), there should be at least one Family Health Strategy (ESF) team for every 3,450 inhabitants (Brazil, 2011), as displayed in the dotted line. 157 (or 2,82%) outlier municipalities were not shown in this visualisation due to presenting a population-to-family-health-team ratio exceeding 10,000.

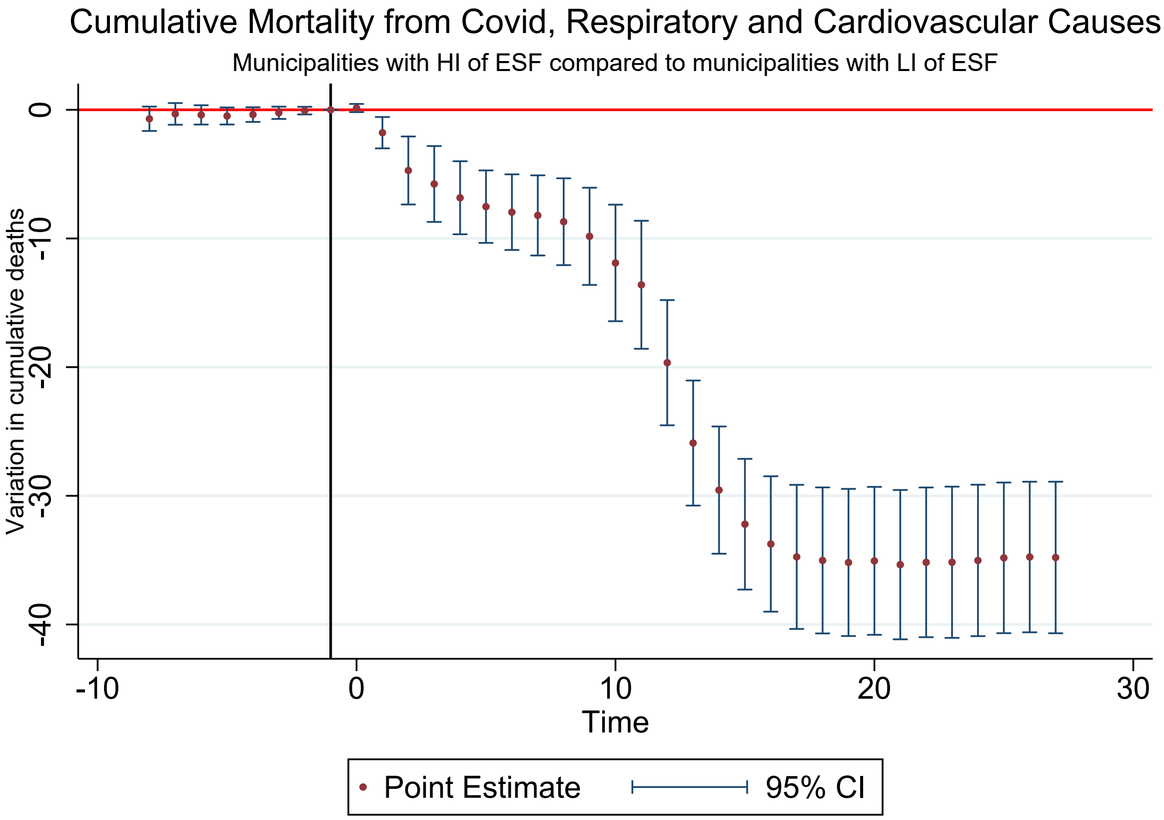


Figure A.9: Mortality data from SIMSUS. COVID-19-related deaths were identified by primary cause codes U07.1 (COVID-19 diagnosis), U07.2 (clinical or epidemiological COVID-19 diagnosis), or B34.2 (Coronavirus infection, unspecified site). Respiratory and Cardiovascular causes are based on the classification of avoidable causes. Reported coefficients $\alpha_\tau$ from an event-study estimation with respective 95% confidence intervals, comparing municipalities with high intensity (HI) of ESF to those with low intensity (LI) of ESF. The X-axis represents the number of months before and after the onset of the pandemic, while the Y-axis represents cumulative age-standardised deaths per 100,000 inhabitants. Estimation controls for fixed effects of municipality, time, and period. Regressions weighted by municipal population and robust standard errors clustered at the municipality level. Estimates of the regressions shown in Figure A.9 are provided in the Table A.2 of the Appendix.

Table A.1: Regression estimates for Mortality

| $\tau$ | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| -8 | -0.0452 (0.2232) | 0.2660 (0.3591) | -0.0047 (0.1786) | -0.0329 (0.2218) | -0.6968 (0.4829) |
| -7 | 0.3598 (0.2276) | 0.5888 (0.3680) | -0.0498 (0.1872) | 0.3814 (0.2267)* | -0.3180 (0.4302) |
| -6 | -0.1423 (0.2117) | 0.3331 (0.3427) | -0.1946 (0.1741) | -0.1263 (0.2092) | -0.3957 (0.3820) |
| -5 | -0.1398 (0.2238) | 0.2641 (0.3728) | -0.2000 (0.1750) | -0.1154 (0.2219) | -0.4792 (0.3382) |
| -4 | 0.0903 (0.2198) | 0.2392 (0.3594) | -0.1334 (0.1793) | 0.1171 (0.2182) | -0.3711 (0.2914) |
| -3 | 0.1210 (0.2166) | 0.2987 (0.3438) | -0.1333 (0.1867) | 0.1446 (0.2140 | -0.2335 (0.2436) |
| -2 | 0.2010 (0.2203) | 0.4493 (0.3546) | 0.1822 (0.1862) | 0.1849 (0.2202) | -0.0632 (0.1512) |
| 0 | 0.1466 (0.2304) | 0.6811 (0.3766)* | -0.1787 (0.1969) | 0.2080 (0.2254) | 0.1386 (0.1620) |
| 1 | -1.9189 (0.6223)*** | -1.6422 (0.6927)** | -3.0129 (0.9061)*** | -0.0727 (0.2479) | -1.7792 (0.6216)*** |
| 2 | -2.8694 (0.8159)*** | -2.6877 (0.8622)*** | -4.2109 (1.2113)*** | 0.1444 (0.2457) | -4.7140 (1.3477)*** |
| 3 | -0.8131 (0.3753)** | -1.0509 (0.4701)** | -1.6403 (0.4082)*** | 0.3690 (0.2273) | -5.7639 (1.5041)*** |
| 4 | -0.8560 (0.3526)** | -0.3093 (0.4466) | -0.6228 (0.4160) | 0.2710 (0.2261) | -6.8347 (1.4481)*** |
| 5 | -0.5590 (0.3017)* | -0.6328 (0.4206) | -0.5064 (0.3444) | 0.1367 (0.2215) | -7.5249 (1.4369)*** |
| 6 | -0.3798 (0.2749) | -0.0962 (0.4227) | -0.5035 (0.2878)* | 0.0269 (0.2264) | -7.9540 (1.4986)*** |
| 7 | -0.2864 (0.2524) | -0.3476 (0.3770) | -0.4646 (0.2451)* | 0.0854 (0.2221) | -8.2074 (1.5883)*** |
| 8 | -0.4566 (0.2730)* | 0.0494 (0.3999) | -0.6636 (0.3124)** | 0.0791 (0.2218) | -8.6982 (1.7215)*** |
| 9 | -1.0071 (0.3494)*** | -0.7141 (0.4514) | -0.9098 (0.4681)* | 0.1765 (0.2138) | -9.8322 (1.9266)*** |
| 10 | -1.9183 (0.8567)** | -1.8296 (0.9153)** | -2.0910 (1.3883) | -0.2755 (0.2250) | -11.9015 (2.3104)*** |
| 11 | -1.5656 (0.5323)*** | -1.2145 (0.6268)* | -1.6012 (0.8166)** | -0.2306 (0.2104) | -13.5999 (2.5377)*** |
| 12 | -5.6179 (0.6843)*** | -6.5601 (0.7947)*** | -4.4510 (0.9494)*** | -0.4798 (0.2199)** | -19.6536 (2.4815)*** |
| 13 | -5.8899 (0.5206)*** | -6.2358 (0.6934)*** | -4.7338 (0.6592)*** | -0.4053 (0.2159)* | -25.8980 (2.4787)*** |
| 14 | -3.2739 (0.4912)*** | -3.2174 (0.6109)*** | -1.5860 (0.6255)** | -0.1653 (0.2247) | -29.5551 (2.5218)*** |
| 15 | -2.3495 (0.6201)*** | -1.7483 (0.7990)** | -1.0828 (0.8636) | -0.0056 (0.2270) | -32.2057 (2.5915)*** |
| 16 | -1.3642 (0.3945)*** | -0.9876 (0.5664)* | -1.1896 (0.4928)** | 0.0663 (0.2369) | -33.7441 (2.6838)*** |
| 17 | -0.8881 (0.3334)*** | -0.7538 (0.4416)* | -1.0923 (0.4379)** | 0.2783 (0.2211) | -34.7450 (2.8568)*** |
| 18 | -0.1559 (0.2485) | 0.6197 (0.3739)* | -0.5875 (0.2469)** | 0.4964 (0.2247)** | -35.0219 (2.8944)*** |
| 19 | -0.0941 (0.2261) | 0.3798 (0.3658) | -0.3141 (0.1938) | 0.1436 (0.2137) | -35.1790 (2.9159)*** |
| 20 | 0.1566 (0.2189) | 0.3769 (0.3499) | 0.0420 (0.1794) | 0.2413 (0.2126) | -35.0537 (2.9317)*** |
| 21 | -0.3464 (0.2213) | -0.2981 (0.3687) | -0.2000 (0.1803) | -0.3428 (0.2195) | -35.3495 (2.9612)*** |
| 22 | 0.2110 (0.2472) | 0.8143 (0.4023)** | -0.0433 (0.2143) | 0.3929 (0.2330)* | -35.1710 (2.9676)*** |
| 23 | 0.1261 (0.2336) | 0.5925 (0.3744) | 0.0245 (0.2054) | 0.2105 (0.2106) | -35.1637 (2.9973)*** |
| 24 | 0.1726 (0.2305) | 0.7278 (0.3778)* | -0.0992 (0.2007) | 0.1354 (0.2261) | -35.0215 (3.0011)*** |
| 25 | 0.2190 (0.2421) | 0.5766 (0.3683) | -0.1726 (0.2302) | 0.1919 (0.2380) | -34.8206 (2.9868)*** |
| 26 | 0.0308 (0.2494) | 0.3295 (0.3827) | -0.0192 (0.2487) | 0.0468 (0.2463) | -34.7551 (2.9855)*** |
| 27 | -0.0193 (0.2365) | -0.0092 (0.3831) | -0.0345 (0.2002) | 0.0553 (0.2343) | -34.7929 (3.0038)*** |

Regression estimates shown in Figures 2, 3, 4 and A.9. (1) Deaths from Covid, Respiratory and Cardiovascular Causes; (2) Sensitivity of ESF Coverage measurement - HI defined as 1 Team available for up to 2,500 inhabitants on average; (3) Sensitivity of ESF Coverage measurement - HI defined as 1 Team available for up to 6,000 inhabitants on average; (4) Non-Covid deaths from Respiratory and Cardiovascular Causes; (5) Cumulative Mortality from Covid, Respiratory and Cardiovascular Causes. Estimation controls for fixed effects of municipality, time, and period. Regressions weighted by municipal population. Robust standard errors clustered at the municipality level are shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.2: Regression estimates for Channels I to III

| $\tau$ | Actions for Health Promotion and Prevention | Primary Care Home visits | Coverage of Community Health Workers |
|---|---|---|---|
| -8 | 0.0252 (0.0328) | 0.0103 (0.0227) | -1.1799 (0.9207) |
| -7 | -0.0493 (0.0394) | 0.0059 (0.0194) | -0.7801 (0.8285) |
| -6 | 0.0123 (0.0409) | 0.0230 (0.0253)* | -0.6568 (0.618) |
| -5 | 0.0509 (0.0321) | 0.0306 (0.0196)** | -0.6669 (0.5577) |
| -4 | 0.0017 (0.0325) | 0.0288 (0.0185)*** | -0.2049 (0.4834) |
| -3 | 0.0044 (0.0399) | 0.0060 (0.0290) | 0.2183 (0.3579) |
| -2 | 0.0221 (0.0366) | -0.0063 (0.0275) | 0.2131 (0.2146) |
| 0 | -0.0599 (0.0419) | -0.0089 (0.0232) | 0.0585 (0.2542) |
| 1 | -0.0077 (0.0332) | -0.0002 (0.0219) | -0.1145 (0.328) |
| 2 | -0.0431 (0.0395) | -0.0112 (0.0310) | -0.5120 (0.4052) |
| 3 | -0.0064 (0.0334) | 0.0005 (0.0276) | -0.0691 (0.4115) |
| 4 | -0.0129 (0.0287) | -0.0004 (0.0156) | -0.1281 (0.4613) |
| 5 | 0.0135 (0.0307) | 0.0217 (0.0230) | 0.1933 (0.4863) |
| 6 | 0.1335 (0.0283)*** | 0.0838 (0.0153)*** | 0.3010 (0.5113) |
| 7 | 0.1416 (0.0284)*** | 0.0967 (0.0163)*** | -0.2090 (0.5711) |
| 8 | 0.1505 (0.0262)*** | 0.1008 (0.0170)*** | -0.3378 (0.5879) |
| 9 | 0.1219 (0.0266)*** | 0.0872 (0.0185)*** | -0.3638 (0.7971) |
| 10 | 0.1491 (0.0269)*** | 0.1143 (0.0186)*** | -0.8875 (0.8582) |
| 11 | 0.1450 (0.0288)*** | 0.1054 (0.0151)*** | -0.8304 (0.881) |
| 12 | 0.1301 (0.0264)*** | 0.1072 (0.0154)*** | -0.6620 (0.912) |
| 13 | 0.1694 (0.0267)*** | 0.1276 (0.0165)*** | -0.4880 (0.9029) |
| 14 | 0.1403 (0.0288)*** | 0.1049 (0.0165)*** | -0.4025 (0.9505) |
| 15 | 0.1432 (0.0282)*** | 0.1050 (0.0201)*** | -0.3119 (0.9553) |
| 16 | 0.1659 (0.0245)*** | 0.1170 (0.0168)*** | -0.2416 (1.0011) |
| 17 | 0.1645 (0.0246)*** | 0.1107 (0.0161)*** | -0.1215 (1.0815) |
| 18 | 0.1506 (0.0268)*** | 0.1137 (0.0163)*** | 0.0890 (1.13) |
| 19 | 0.1552 (0.0376)*** | 0.1402 (0.0287)*** | 0.1219 (1.1282) |
| 20 | 0.1655 (0.0247)*** | 0.1145 (0.0172)*** | -0.0979 (1.2372) |
| 21 | 0.1336 (0.0282)*** | 0.1031 (0.0193)*** | -0.1424 (1.28) |
| 22 | 0.1621 (0.0296)*** | 0.1323 (0.0208)*** | -0.3437 (1.3165) |
| 23 | 0.1336 (0.0282)*** | 0.1256 (0.0171)*** | -0.5584 (1.3996) |
| 24 | 0.1051 (0.0313)*** | 0.0905 (0.0187)*** | -0.7380 (1.4528) |
| 25 | 0.1435 (0.0315)*** | 0.0889 (0.0240)*** | -0.7894 (1.5513) |
| 26 | 0.1469 (0.0275)*** | 0.1108 (0.0162)*** | -0.7085 (1.6343) |
| 27 | 0.1110 (0.0340)*** | 0.1194 (0.0169)*** | -1.1150 (1.7103) |

Estimates of the regressions shown in Figures 5, 6, and 7. Estimation controls for fixed effects of municipality, time, and period. Regressions weighted by municipal population. Robust standard errors clustered at the municipality level are shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

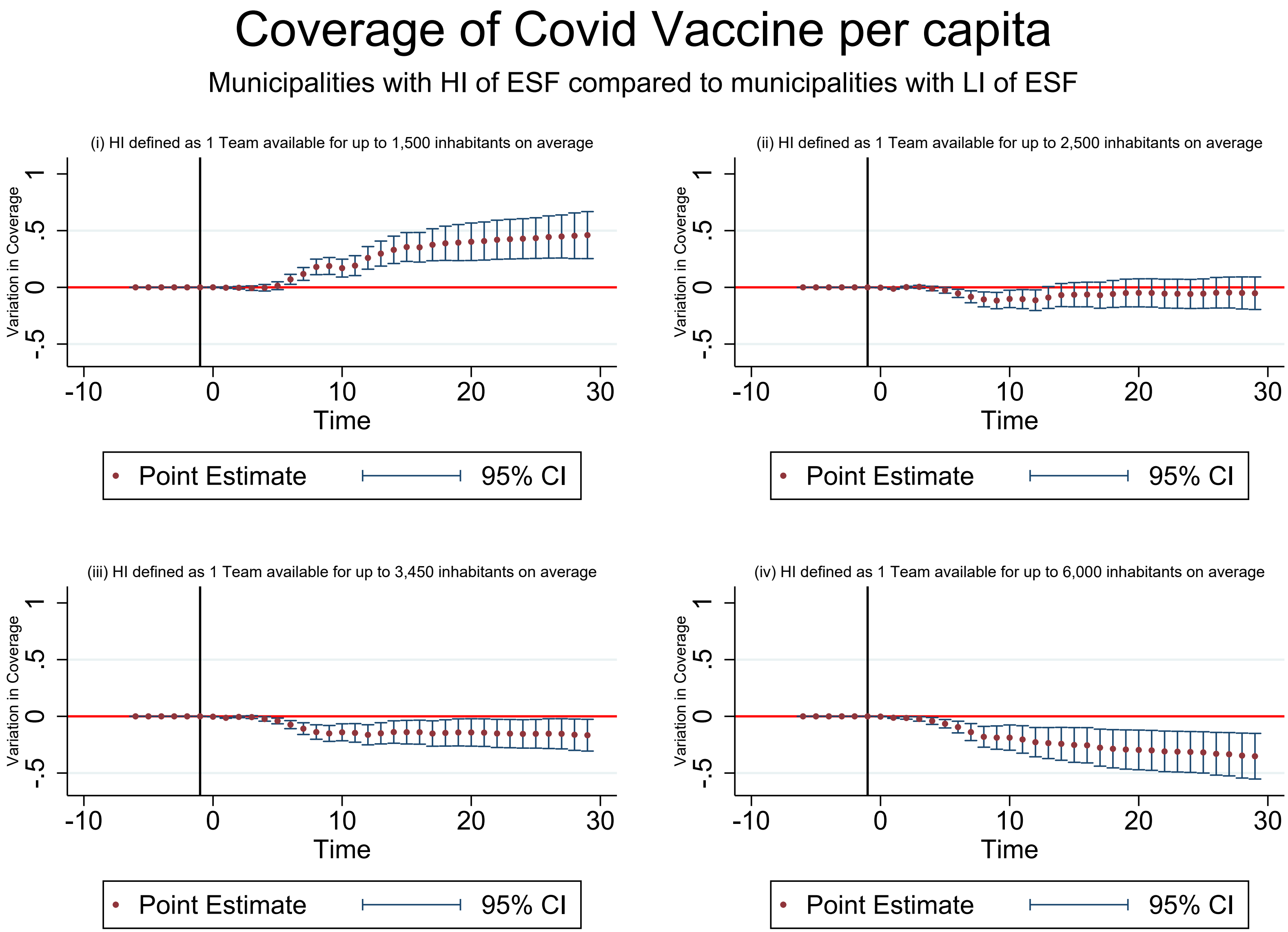


Figure A.10: Channel IV - Coverage of Covid Vaccine per capita. Data on the number of COVID-19 vaccine doses administered across Brazilian municipalities from Datasus. Reported coefficients $\alpha_\tau$ from an event-study estimation with respective 95% confidence intervals, comparing municipalities with high intensity (HI) of ESF to those with low intensity (LI) of ESF. The X-axis represents the number of months before and after the onset of the pandemic, while the Y-axis represents the Coverage of Covid Vaccine per capita. Estimation controls for fixed effects of municipality, time, and period. Regressions weighted by municipal population and robust standard errors clustered at the municipality level. Estimates of the regressions shown in Figure A.10 are provided in the Table A.3 of the Appendix.

Table A.3: Regression estimates for Coverage of Covid Vaccine per capita (Channel IV)

| $\tau$ | (i) | (ii) | (iii) | (iv) |
|---|---|---|---|---|
| 0 | 0.0005 (0.0012) | -0.0024 (0.0006)*** | -0.0029 (0.0005)*** | -0.0020 (0.0008)** |
| 1 | -0.0028 (0.0031) | -0.0121 (0.0022)*** | -0.0128 (0.0020)*** | -0.0125 (0.0028)*** |
| 2 | -0.0035 (0.0059) | 0.0020 (0.0038) | -0.0046 (0.0036) | -0.0142 (0.0055)*** |
| 3 | -0.0072 (0.0102) | 0.0046 (0.0065) | -0.0068 (0.0063) | -0.0231 (0.0099)** |
| 4 | -0.0036 (0.0146) | -0.0104 (0.0101) | -0.0233 (0.0099)** | -0.0406 (0.0155)*** |
| 5 | 0.0144 (0.0176) | -0.0258 (0.0130)** | -0.0406 (0.0128)*** | -0.0651 (0.0189)*** |
| 6 | 0.0706 (0.0225)*** | -0.0532 (0.0184)*** | -0.0731 (0.0181)*** | -0.0944 (0.0263)*** |
| 7 | 0.1181 (0.0288)*** | -0.0833 (0.0270)*** | -0.1084 (0.0264)*** | -0.1389 (0.0382)*** |
| 8 | 0.1802 (0.0350)*** | -0.1060 (0.0334)*** | -0.1383 (0.0326)*** | -0.1803 (0.0468)*** |
| 9 | 0.1884 (0.0380)*** | -0.1165 (0.0368)*** | -0.1506 (0.0358)*** | -0.1874 (0.0524)*** |
| 10 | 0.1697 (0.0402)*** | -0.1020 (0.0390)*** | -0.1408 (0.0382)*** | -0.1874 (0.0568)*** |
| 11 | 0.1916 (0.0448)*** | -0.1039 (0.0427)** | -0.1463 (0.0418)*** | -0.2037 (0.0617)*** |
| 12 | 0.2596 (0.0508)*** | -0.1134 (0.0464)** | -0.1627 (0.0452)*** | -0.2276 (0.0659)*** |
| 13 | 0.2977 (0.0562)*** | -0.0896 (0.0491)* | -0.1497 (0.0477)*** | -0.2356 (0.0697)*** |
| 14 | 0.3307 (0.0616)*** | -0.0682 (0.0518) | -0.1385 (0.0504)*** | -0.2422 (0.0739)*** |
| 15 | 0.3558 (0.0649)*** | -0.0649 (0.0545) | -0.1396 (0.0531)*** | -0.2523 (0.0780)*** |
| 16 | 0.3531 (0.0665)*** | -0.0631 (0.0554) | -0.1398 (0.0540)*** | -0.2552 (0.0793)*** |
| 17 | 0.3755 (0.0720)*** | -0.0694 (0.0586) | -0.1515 (0.0571)*** | -0.2760 (0.0832)*** |
| 18 | 0.3886 (0.0770)*** | -0.0584 (0.0606) | -0.1462 (0.0591)** | -0.2860 (0.0858)*** |
| 19 | 0.3944 (0.0811)*** | -0.0501 (0.0623) | -0.1418 (0.0608)** | -0.2925 (0.0881)*** |
| 20 | 0.4021 (0.0843)*** | -0.0485 (0.0631) | -0.1420 (0.0616)** | -0.2964 (0.0892)*** |
| 21 | 0.4084 (0.0856)*** | -0.0492 (0.0636) | -0.1437 (0.0621)** | -0.2998 (0.0898)*** |
| 22 | 0.4197 (0.0879)*** | -0.0553 (0.0649) | -0.1507 (0.0633)** | -0.3090 (0.0913)*** |
| 23 | 0.4249 (0.0891)*** | -0.0563 (0.0652) | -0.1523 (0.0636)** | -0.3114 (0.0916)*** |
| 24 | 0.4291 (0.0899)*** | -0.0583 (0.0655) | -0.1548 (0.0638)** | -0.3142 (0.0918)*** |
| 25 | 0.4342 (0.0914)*** | -0.0553 (0.0662) | -0.1539 (0.0646)** | -0.3180 (0.0928)*** |
| 26 | 0.4438 (0.0950)*** | -0.0476 (0.0687) | -0.1525 (0.0670)** | -0.3300 (0.0960)*** |
| 27 | 0.4485 (0.0968)*** | -0.0456 (0.0695) | -0.1538 (0.0678)** | -0.3343 (0.0973)*** |
| 28 | 0.4548 (0.1027)*** | -0.0494 (0.0721) | -0.1619 (0.0703)** | -0.3458 (0.1010)*** |
| 29 | 0.4607 (0.1056)*** | -0.0518 (0.0732) | -0.1662 (0.0714)** | -0.3517 (0.1026)*** |

Regression estimates shown in Figure A.10. (i) HI defined as 1 Team available for up to 1,500 inhabitants on average; (ii) HI defined as 1 Team available for up to 2,500 inhabitants on average; (iii) HI defined as 1 Team available for up to 3,450 inhabitants on average; (iv) HI defined as 1 Team available for up to 6,000 inhabitants on average. Estimation controls for fixed effects of municipality, time, and period. Regressions weighted by municipal population. Robust standard errors clustered at the municipality level are shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.