The indirect effects of Covid-19 on the Italian NHS: evidence on healthcare utilization of non-Covid patients in Lombardy

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1. Introduction

Since the end of 2019, the Covid-19 pandemic has been a challenge that most countries in the world have been facing. Depending on the number of infections, different countries have implemented more or less restrictive policies in an attempt to stem the spread of the virus. These responses had an impact on various aspects of everyday life, including working and leisure activities. The healthcare system has been one of the most severely hit by the emergency. In general, the years in which countries have been in the grip of the pandemic have recorded a decrease in the activities of national healthcare systems.

Reduced or delayed healthcare utilization during the pandemic can have detrimental health consequences such as late diagnoses. As a consequence, the identification of the real effects that the pandemic and the measures put in place to contain it have had on the provision of health services has become the subject of interest by researchers from all over the world.

Since the issue consists of estimating changes in outcomes over time, the difference-in-difference setting is the most suitable for conducting this type of analysis. In this direction proceeded the pioneering work of Ahn et al. (2020), one of the first attempts to grasp how the pandemic was affecting healthcare utilization. Their analysis aimed to assess the associations of the Covid-19 pandemic with healthcare utilization, out-of-pocket medical costs, and perceived health status in Singapore using monthly individual-level panel data between June 2018 and June 2020. First of all, the authors show that individuals were less likely to visit medical doctors during the outbreak. About 30% of survey participants met medical doctors between July 2018 and May 2019 each month; however, the share sharply decreased to around 20% to 25% during the pandemic. This has probably affected the likelihood of individuals being told by a doctor that they suffer from a chronic condition such as diabetes or hypertension, which relates to decreased spending on outpatient care.

Similarly, Xu et al. (2021) investigate changes in healthcare utilization in California between 2019 and 2020. The stay-at-home order was enacted in California on March 19$^{\text{th}}$, 2020. The authors use a similar model to that used in Ahn et al. (2020), and estimated visit rates by week during the pre-pandemic and pandemic years separately for inpatient, ED, outpatient, and telehealth visits. After adjusting for pre-pandemic secular trends, the reduction in total outpatient visits rates from week 8 to week 12 during the pandemic was about 70%. Inpatient care and ER visit rates suffered milder reductions. Moreover, this analysis suggests that the increase in telehealth visits did not completely offset the reduction in outpatient visits during the early months of the pandemic.

Another major contribution to the study of the effects of the Covid-19 pandemic on healthcare provision comes from Cantor et al. (2022). As the authors point out, evidence of a decrease in healthcare utilization resulting from the introduction of shelter-in-place orders

does not allow to conclude whether the decline was in response to the implementation of SIP policies or due to patients' fears of Covid-19 infection while in a healthcare facility. To disentangle these two effects, authors employ a two-way fixed effects model controlling for county-level variations in exposure to the Covid-19 pandemic. Fully controlling for variations in exposure to the Covid-19 pandemic significantly reduces the magnitude of SIP policies on healthcare utilization for many forms of preventive (colonoscopy screenings and infant immunizations) and elective care (MRIs, musculoskeletal surgery, and cataract surgery). In contrast, smaller changes in non-elective care (chemotherapy and angiograms) were observed.

The first study to assess the impact of the Covid-19 pandemic on healthcare access after rigorous consideration of past trends in Japan has been Makiyama et al. (2021). As the authors suggest, patients in Japan have most likely refrained from seeking healthcare for fear of nosocomial infection at healthcare facilities during the first wave of the Covid pandemic. This observational study evaluated the monthly average number of outpatients per day at hospitals from December 2010 to June 2020, using the hospital reports data. These numbers were compared with those from the same period of previous years, using a quasi-Poisson regression model. In general hospitals, the observed number of outpatient visits fell below the 95% lower bound of the predicted values after March 2020 and until June 2020. Conversely, in psychiatric hospitals, the observed number was below the 95% lower bound only in May 2020.

Huang & Liu (2022) investigated the impact of the Covid-19 pandemic and related policy responses on different types of outpatient care up to October 2020 in China. Conceptually, this paper identifies two main sources of variation in healthcare utilization: regarding demand, people may have chosen to avoid or delay face-to-face care because of fear of infection; regarding supply, many hospitals purposefully suspended non-emergency outpatient services.

The largest reduction appeared, during the lockdown, for preventive care visits. The need for chronic care among people with hypertension and diabetes makes it difficult to postpone hospital visits, with a decrease between 30% and 33% following the most restrictive policies. During 2020, ED care visits decreased too, while a significant increase was observed in stress-related care visits and reproductive visits. Overall, total visits decreased by 60% during the first lockdown period (from January 23rd to March 1st, 2020) and did not recover to pre-pandemic levels even seven months later.

To corroborate their results, Huang and Liu conclude their work by implementing an event-study analysis. To do so, they regress the number of outpatient visits for a particular health condition with a sequence of dummy variables for periods up to six months before and nine months after the outbreak of the Covid-19 pandemic in China. They use the month immediately before the implementation of the first responses (January 23rd, 2020) as the reference category. Estimates of the pre-pandemic dummies are statistically insignificant. After January 2020, there was a significant drop in total visits for most health conditions at the onset of the pandemic, except for mental and sleep disorders and medical abortion.

The study of changes in the number of healthcare visits delivered following the introduction of a policy critically relies on the existence of parallel trends. In this context, the parallel trend assumption requires that in the absence of the Covid-19 outbreak, trends in healthcare utilization should be similar in the treated and the untreated years. In Tsai & Yang (2022)

this assumption is examined by using the diff-in-diff event-study design. The key variables used for identification are a set of week dummies interacted with the treated year dummy, with treatment being the announcement of the first confirmed Covid-19 case in Taiwan. The coefficients of interest measure the difference in healthcare utilization between a given week and the baseline week for 2020 (the treated year), relative to the difference for 2014–2019 (the untreated years). Estimates of these coefficients for the weeks before treatment are close to 1, supporting the validity of the parallel trend hypothesis.

Taiwan did not implement any lockdown policy in 2020, so the estimated change in demand for healthcare utilization represents the voluntary response to the Covid-19 pandemic rather than government restrictions on mobility. On average, the number of outpatient visits and inpatient admissions decreased by 19% and 10% during the pandemic period, respectively. Moreover, the authors find that the demand for healthcare services from ILI (influenza-like diseases) patients had not recovered to pre-pandemic levels even 45 weeks after the first case was announced.

The heterogeneous impacts of Covid-19 on health outcomes of different population groups have been deeply researched as well. Adhikari et al. (2023) examine longitudinal trends in routine healthcare utilization during the first year of the pandemic among veterans with diabetes from an existing large national cohort. The authors outline a 57% reduction in monthly rates of HbA1c measurements starting March 2020 compared to the pre-pandemic period. However, stratified analyses showed differential impacts on telehealth visits by community type and race/ethnicity. The increase in monthly rates of telehealth visits starting in March 2020 was lowest in rural communities and highest in high-density urban communities. Moreover, rates of telehealth visits increased most among non-Hispanic Black veterans followed by Hispanics and non-Hispanic AAPI (Asian American Pacific Islander), and least among non-Hispanic White.

This preliminary analysis aims to quantify the indirect effects of the Covid-19 pandemic on non-Covid healthcare utilization. Using a large dataset from the ATS system of the Metropolitan Area of Milan, we examine trends in the provision of healthcare services for the branches of endocrinology and urology following the introduction of emergency containment measures by the Italian government in early 2020. We try to disentangle the effect of policy responses from the direct effect of Covid-19 by adding control variables for the number of weeks since the first case. Finally, we conduct an event study analysis in order to explore the full dynamics of the effects of Covid in the post-pandemic year.

Italy was the first European country to be dramatically hit by the Covid-19 pandemic, recording the highest number of victims in the world up to Easter 2020. The first Covid case was reported in Codogno, in the province of Lodi, on February 20$^{\text{th}}$. Of course, the Covid emergency has put under pressure the Italian National Health Service (INHS), a Beveridge-type healthcare system characterized by universal coverage.

The rest of the paper is organized as follows. Section 2 discusses the resilience of the Italian NHS in the early months of the pandemic. In Section 3 we present the data used and a review of descriptive measures of healthcare provision. In Section 4 we define the methods used for evaluating the impact of policies on municipality-level healthcare utilization. Section 5 reports the results. Section 6 discusses the main limitations we faced and concludes.

2. The Italian NHS during the Covid pandemic

Introduced in 1978, the INHS is a public service funded primarily by general taxation that provides comprehensive healthcare at the point of use. The system is highly decentralized and the 20 Italian regions are each legally responsible for planning services and allocating financial resources: healthcare is by far the largest item of all regional budgets. Local autonomy implies financial accountability that allows regions to develop substantially different health strategies.

Since antiviral treatments for Covid-19 were non-existent at the time, Italy adopted its first lockdown strategy on 9th March 2020, which lasted till 3rd May 2020. This decision was preceded by the declaration of a state of emergency for the duration of 6 months at the end of January. Then, on 23rd February, the Government ordered the isolation of the ten municipalities in the Lodi area already affected by the pandemic. On the same day, the Ministry of Health issued new provisions valid for the remaining areas of Lombardy, including the closure of nursery schools, early childhood education services, and schools of all levels and the suspension of events or initiatives of any nature. Finally, with the Prime Ministerial Decree of 25th February, school heads of institutions in which teaching activities have been suspended were able to activate distance learning measures.

A week since the first case being identified in Codogno, Lombardy, the number had grown to 821, with 21 deaths. As of April 22nd, nearly half of the national cases were diagnosed in Lombardy. With clinical data available for 52,577 cases, 35.7% were classified as having mild pneumonia but 17.4% were severe (dyspnea, blood oxygen saturation $\leq$93%), and 1.9% were critical (respiratory failure, septic shock, and/or multiple organ dysfunction or failure), while 30% had few or no symptoms. By April 22nd, Italy had 23,085 deaths, giving a case fatality rate of 12.3%. This is higher than has been reported in many other countries but is likely to be explained, at least in part, by the age distribution.

The death rate from Covid-19 has been higher in Italy than in other European countries for several possible reasons: the method of counting which included the deaths of people who died only from Covid-19 and people who died with Covid-19 but had other serious diseases; a relatively high proportion of older people in the population; bad environmental conditions and pollution present in Padania (Lombardy, Emilia and Veneto). In addition, Italy was the first European country to be affected by the disease, allowing little time to implement procedures for testing for the virus. Very soon, the northern regions had overflowing ICUs and hospitals forced many people to deal with their illness at home.

The approaches taken by the Italian regions to the Covid-19 emergency in the early stages of the pandemic fall into three broad types. Type 1 is a hospital-based model, adopted in Lombardy. Type 2 is a territorial-based model, in Veneto. Type 3 is a combined hospital-territorial model, as in Emilia-Romagna and Piedmont. The first type places the main emphasis on the role of hospitals, with a relatively low level of community testing. This has, as might be expected, been associated with substantial pressure on hospitals and, particularly, ICU beds. The territorial management approach is characterized by a lower hospitalization rate and a higher incidence of testing. In Veneto, only 22% of patients with a positive result are hospitalized (compared to 45–50% of the other Italian regions). The combined hospital-territorial management model, adopted in Emilia-Romagna and

Piedmont, is characterized by an intermediate level of hospitalization and an intermediate level of testing.

3. Data and descriptive statistics

The ATS of the Metropolitan City of Milan includes 194 municipalities and brings together the territories of the four former ASLs: Milan, Milan 1, Milan 2, and Lodi. Data at our disposal include the total number of visits by disease for a sample of individuals with chronic diabetes and the total number of urologic visits. The type of healthcare service is identified by an identification code of the branch of specialization. So for example, endocrinology is number 9, while urology is number 25. Our observations range from January 2017 and July 2021.

Furthermore, we make use of a dataset reporting various statistics regarding the progress of the Covid-19 pandemic in the municipalities of the Metropolitan Area of Milan, including the number of swabs taken in the referenced municipality, number of total deaths, number of Covid-19 deaths, new cases, and hospitalizations. We also have information on a set of demographic characteristics of patients who benefited from healthcare services in the period considered, including gender, age group, presence of chronic conditions, and municipality of residence. We constructed weekly, municipality-level panel data to estimate weekly variations

TABLE 1 Summary statistics

	2019	2020
ANESTHESIA	194	128
CARDIOLOGY	5417	4036
GENERAL SURGERY	667	473
PLASTIC SURGERY	121	89
VASCOLAR SURGERY	215	159
DERMOSIPHILOPATHY	468	306
DI: NUCLEAR MEDICINE	330	268
DI: DIAGNOSTIC RADIOLOGY	5799	4516
ENDOCRINOLOGY	3426	2503
GASTROENTEROLOGY	362	259
LABORATORY	3040	2571
PHYSICAL MEDICINE AND REHABILITATION	1248	852
NEPHROLOGY	913	1036
NEUROSURGERY	2.7	2.2
NEUROLOGY	731	534
OCULISTICS	2721	1831
ODONTOSTOM, AND MAXILLOFACIAL	441	206
ONCOLOGY	536	494
ORTHOPEDICS AND TRAUMA	1080	704
OBSTETRICS AND GYNECOLOGY	692	542
OTOLARYNGOLOGY	853	522
PNEUMOLOGY	786	521
PSYCHIATRY	148	107
RADIOTHERAPY	117	123
UROLOGY	732	522
OTHER SERVICES	4594	3558
CHILD NEUROPSYCHIATRY	13	10

Note: We aggregated data by branch of specialization and year and then computed the mean.

in healthcare provision of endocrinology and urology services following the implementation of policy responses to the pandemic.

Table 1 reports summary statistics on healthcare provision. Between 2019 and 2020 there was a decrease of 27%, 25%, and 29% in the average weekly provision of diabetes, cardiology, and urology services, respectively.

Other contributions report similar results for the decrease in diabetic services. Analyzing the period ranging from March 9th (data of the start of global lockdown in Italy) to the end of December 2020, Torre et al. (2021) shows that out of 20,491 diabetic patients treated in ASL 3 clinics in Genoa only 14,819 had been visited at least once, meaning that 28% of in-presence visits were missed.

Figure 1 presents unadjusted trends of the number of outpatient visits relative to the number in the same week in the previous year by care type. In the six weeks before the Covid-19 outbreak and the first policy responses, the trends were generally similar between 2019 and 2020 for all care types, except for diabetic care and pneumology. Week 8 (February 19-25th) saw a large drop in all outpatient care visits. Endocrinology, cardiology, and diabetic care visits returned to the pre-pandemic level around week 24. Conversely, gynecological care, pneumology, and urology visits remained consistently below the pre-pandemic level, even by week 30.

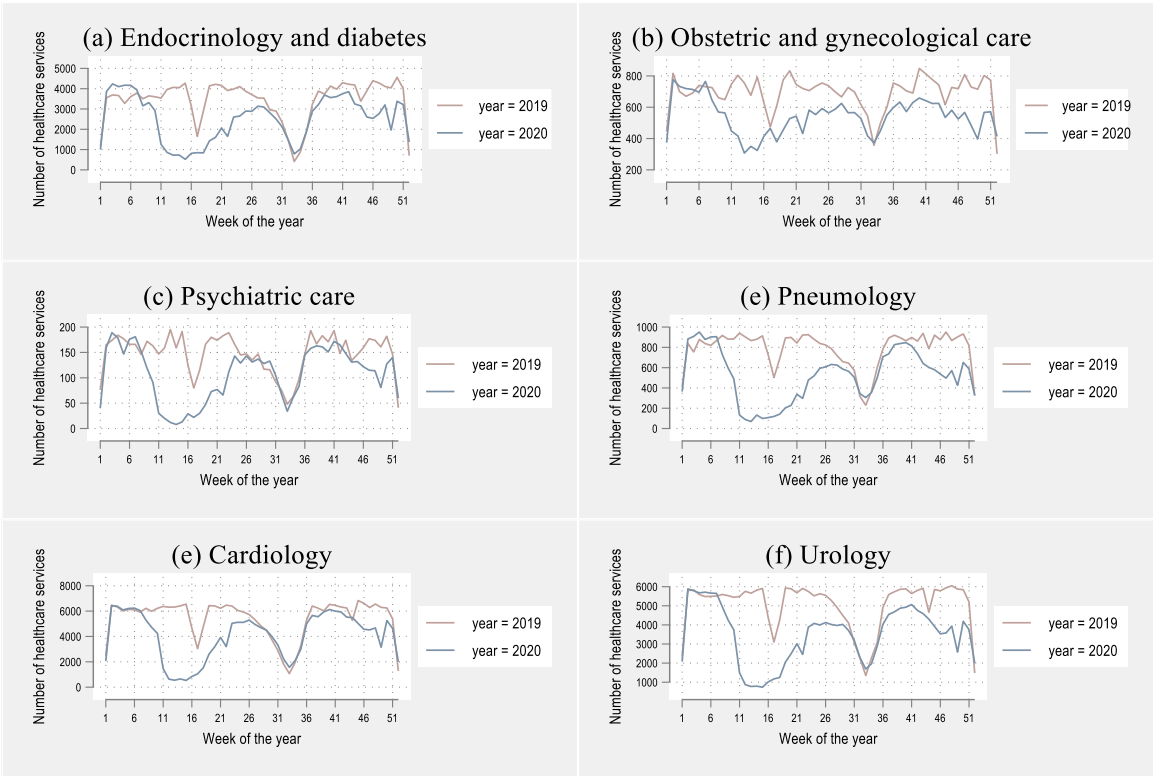

FIGURE 1: Unadjusted trend in outpatient visits by care type in 2019 and 2020

Figure 2 highlights that diabetic services have relatively converged to Covid-free years levels in the first months of 2021, while the volume of urologic services has not returned to pre-pandemic standards as of May 2021. From this preliminary evidence it appears that patients found it easier to postpone urologic care rather than diabetic services, which are deemed more urgent.

Figure 3 concludes the descriptive section with a spatial visualization of Covid mortality and changes in healthcare utilization in each municipality. It reports the percentage variation of visits received and the mortality from Covid-19 in the same municipalities between February and May 2020. Mortality is defined as the ratio between the number of deaths with Covid-19 and the number of total deaths.

A visual inspection of the results seems to suggest the presence of a positive correlation between mortality and variation in healthcare utilization, for municipalities with the highest mortality from Covid are also those that suffered the largest decreases in healthcare services provided.

This impression is confirmed when calculating the Pearson correlation coefficient between the variation in diabetes services provided and mortality at the municipality level, which is as high as 0.58, indicating a strong correlation between the variables. The strength of the correlation is significantly lower when we study the correlation between mortality and change in performance for the branch of urology, where the value of Pearson coefficient is 0.12.

Being a simple correlation between two variables, this evidence cannot be interpreted in a causal sense. Nevertheless, these results raise major concerns and highlight the need to monitor the resilience of a healthcare system during emergencies that impose restrictions on the mobility of individuals.

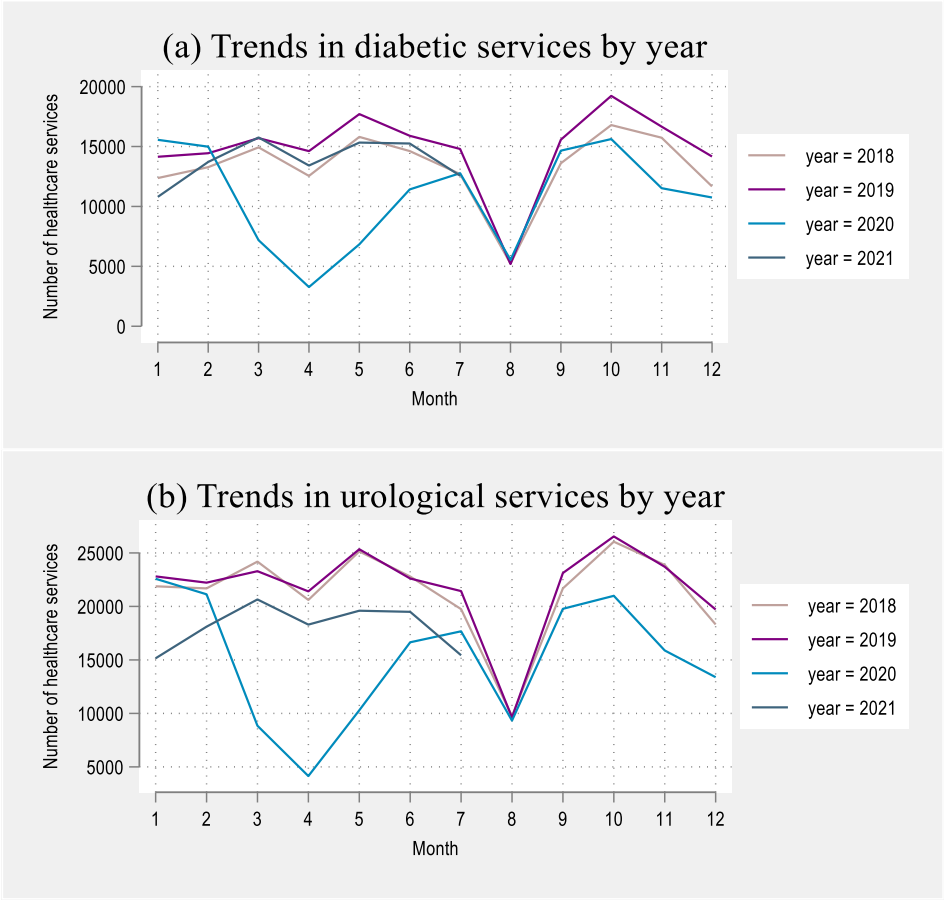

FIGURE 2: Trends in diabetic (a) and urologic (b) services, years 2018-2021

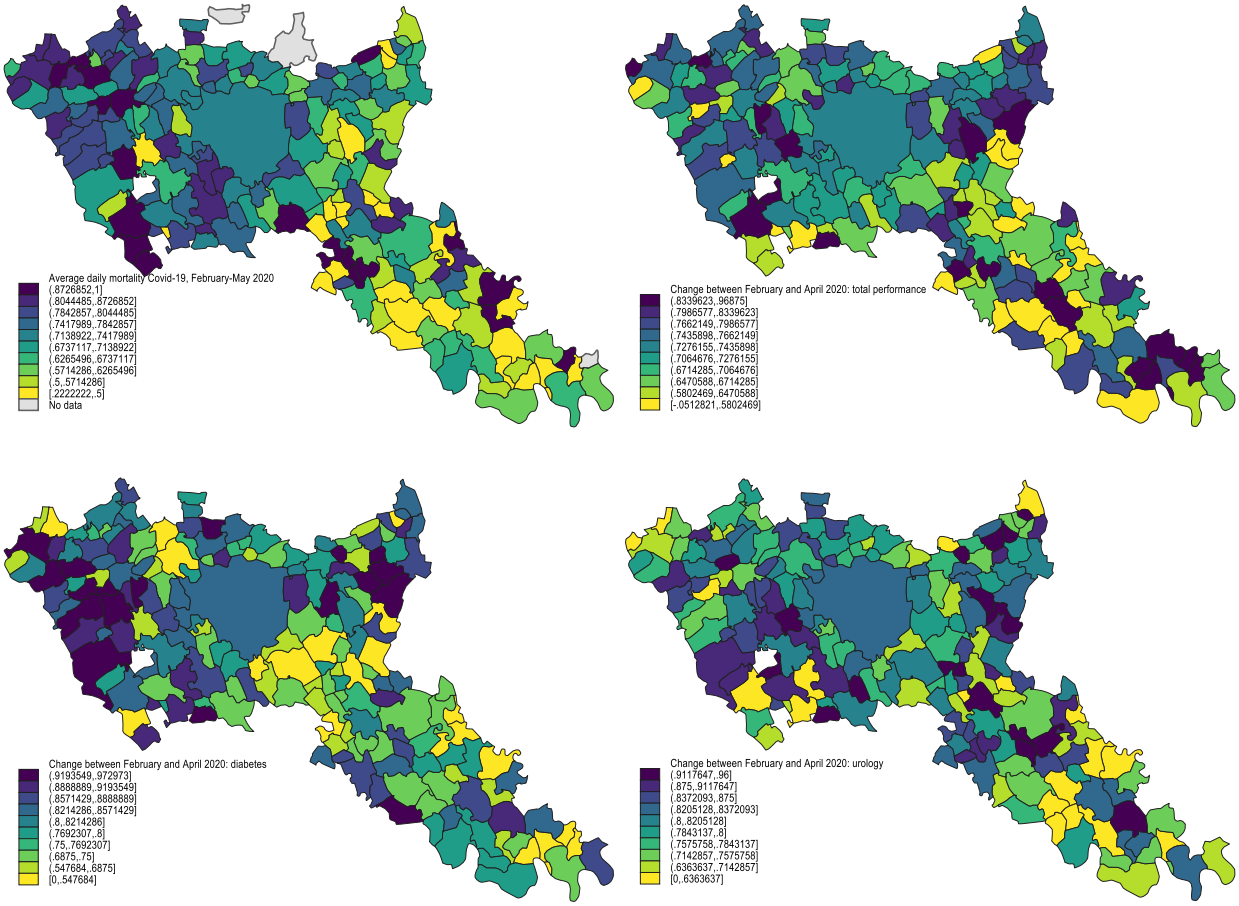

FIGURE 3: Mapping Covid-19 mortality and change in healthcare services in the metropolitan area of Milan and the province of Lodi

4. Empirical analysis

To examine the impact of the pandemic and related policy responses on healthcare utilization, we employ different specifications. We start from a simple model that compares changes in healthcare utilization before and after the period of interest, namely, week 8 (February 19-25$^{\text{th}}$), when the first responses were implemented in Lombardy during the pandemic year 2020, to the corresponding period in the pre-pandemic years.

We estimated our regression models using ordinary least squares and clustered the standard errors at the municipality level. The regression equation is the following:

$$log\ Visite_{ist} = \alpha + \sum_{s=1}^{52} \beta_s \times Year_{2020} \times Week_s + \mu_i + \delta_s + \theta_t + \varepsilon_{ist} \qquad (1)$$

where the dependent variable is the log-transformed number of visits for diabetic or urologic conditions in municipality i, week s, and year t. $Year_{2020}$ is an indicator taking the value of 1 for the pandemic year and 0 for the pre-pandemic years. We use $Week_s$, where s = 1, 2, 3,... 52 to denote a set of dummy variables for each week of the year. μ_i, δ_s, and θ_t are, respectively, the municipality, week, and year fixed effects. The week fixed effects work just like the inclusion of a full set of weekly dummy variables for the pre-pandemic years.

Next, in order to improve our estimates and obtain a causal interpretation for the results, we modify the previous regression equation by adding a set of dummy variables indicating exposure to Covid-19. Following Cantor et al. (2022), for each municipality i and week s, we calculate the number of weeks since the first registered Covid case. As before, we estimate a regression equation that includes municipality, week, and year fixed effects:

$$log\ Visite_{irt} = \alpha + \sum_{r=1}^{4} \beta_r \times Year_{2020} \times PR_r + \sum Caseweek_t + \mu_i + \delta_s + \theta_t + \varepsilon_{ist} \qquad (2)$$

$Year_{2020} \times PR_r$ refers to four post-outbreak (February 19-25th) period indicators representing the sample periods corresponding to the introduction of policy restrictions to deal with the Covid emergency. Level 1 response refers to the implementation of the first measures in Lombardy, including the suspension of all public events, commercial activities not of public utility, sporting activities, and the closure of schools in ten municipalities in the province of Lodi (from February 19th to March 3rd, 2020). Level 2 response comprises the lockdown period, during which the containment measures implemented in Lombardy are extended throughout the national territory (from March 4th to May 5th, 2020). Level 3 response denotes the period of reopening and of coexistence with the pandemic (from May 6th to October 6th, 2020). Level 4 response corresponds to the last three months of the year and the beginning of the second wave, when the rise of the contagion curve required the introduction of new restrictive measures (from October 7th to the end of the year).

The omitted benchmark period is the period before the announcement of the Level I response (January 1st to February 18th). As no major restriction was imposed during the first seven weeks of the pandemic year, this serves as a reasonable baseline for our analysis. The first legislative provision, dated January 28th, prescribed only generic preventive measures such as repeated hand washing, use of personal protective devices (PPD) as well as the disinfection of public and private areas (Baldino et al., 2020). The set of coefficients β_r shows how outpatient care visits changed with different policy responses.

As already argued, there might have been confounding factors influencing healthcare utilization even in the absence of policy responses. In particular, the trajectory of the Covid pandemic may have reduced outpatient visits directly, because of, for example a fear of contagion or a sense of social responsibility. We attempted to address this type of concern by controlling for the number of weeks from the first registered Covid case in each municipality. $Caseweek_t$ denotes a set of dummy variables corresponding to each week of the year 2020 since the first case.

In order to disentangle the effect of restrictions on healthcare provision from the direct effect of the Covid pandemic, we ran two separate regressions, with and without the term $Caseweek_t$. Our assumption is that controlling for the number of weeks since the first registered case reduces the magnitude of the policy responses coefficients.

5. Results

5.1. Main results

Figure 4 provides a graphical representation of the estimated coefficients from equation **Errore. L'origine riferimento non è stata trovata.**. Regarding diabetic and urologic services, healthcare utilization decreased between week 7 and week 27 (July 1-7th). However, it appears that diabetic visits have started to decline later than visits for the urology branch, when the first national lockdown was implemented.

Urologic care saw a 20% (= exp[–0.22] – 1) decline right after the announcement of the first restrictions in Lombardy in week 8, while diabetic services remained relatively stable until the implementation of the national lockdown, when a 64% drop was registered. The estimated coefficient for the contraction in diabetic services in week 8 is not statistically significant.

In 2020, healthcare provision reached its minimum during the fifteenth week of the year corresponding to the period April 8-14th, which saw a drop in both diabetic and urologic services of 84% (= exp[– 1.83] – 1) with respect to week 7, compared to the difference for the same period in the pre-pandemic years (between week 15 and week 7, diabetic services have increased by approximately 6% in 2018 and 2019). However, the fact that Easter was celebrated on April 12th in 2020 may overestimate the effect of closures on healthcare utilization for that week.

Both the number of diabetes services and that of urological services returned to Covid-free levels during summer and started to decline again by the forty-third week of the year (21-27th October), in correspondence with the introduction of new restrictive measures to deal

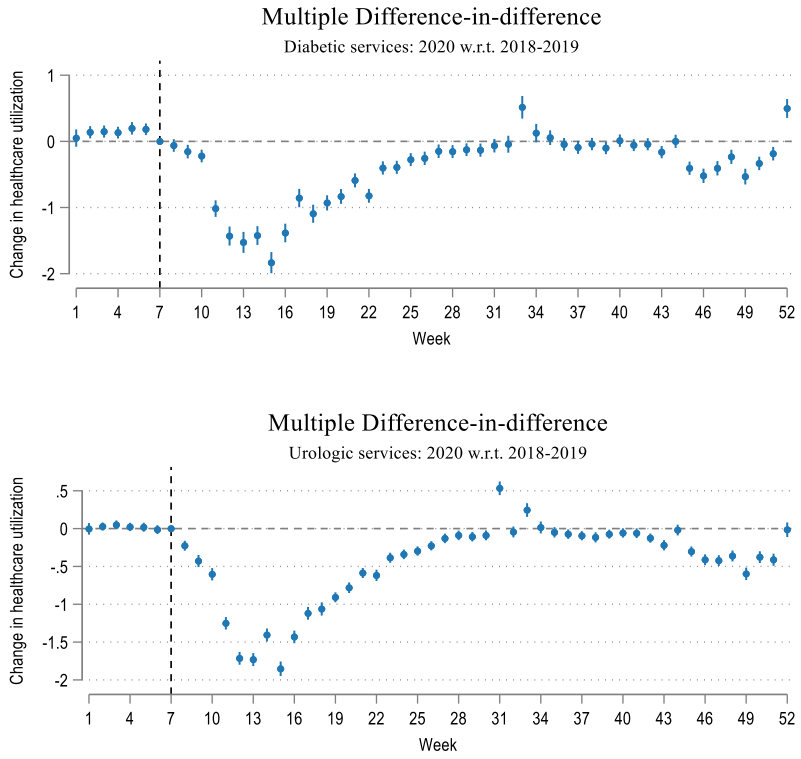

FIGURE 4: Change in healthcare utilization for diabetic and urologic services: 2020 with respect to pre-pandemic levels

with the second wave of the pandemic. In week 50, healthcare provision fell short of about 28% with respect to week 7 for diabetic care, relative to the pre-pandemic standards.

Table 2 reports the estimated coefficients of the four post-outbreak periods from equation (2), measuring the effect on total outpatient visits in the Metropolitan City of Milan and in the province of Lodi of the implementation of policy responses. The weekly number of visits decreased by 27% (= exp[–0.312] – 1) during the first two weeks since the Covid outbreak in Lombardy, 74% during the lockdown period, 22% during summer and 21% during the first months of the second wave. Again, these results are to be interpreted with respect to the same period in the pre-pandemic years.

While controlling for the direct exposure to Covid-19 in Column 2, the estimated changes in outpatient care visits reduced to 56% after the Level 2 response (lockdown period). This suggests that direct exposure to Covid-19 accounted for 32% (= [74% – 56%]/74%) of the reduction in outpatient care visits following the implementation of the lockdown.

TABLE 2 Effects of the Covid-19 and policy responses on outpatient visits

	(1)	(2)
VARIABLES	Model 1	Model 2
Level 1 response	-0.312***	-0.290***
	(0.0267)	(0.0283)
Level 2 response	-1.340***	-0.817***
	(0.0186)	(0.0743)
Level 3 response	-0.242***	-0.238***
	(0.0117)	(0.0311)
Level 4 response	-0.236***	-0.242***
	(0.0141)	(0.0407)
Observations	38,750	38,750
R-squared	0.941	0.945
Controls	NO	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Based on this specification, in the weeks between the outbreak of pandemic in the province of Lodi and the deployment of the national lockdown, the 27% contraction in the number of health care services delivered was due almost exclusively to policy restrictions, as the behavioral effect caused a decline of about 8% (27% - 25%/27%) in total services. The contraction due to direct exposure to Covid-19 was less significant in the post-lockdown periods, as the estimates in the two columns of the table are similar.

The results are not surprising and highlight how people have decided to postpone healthcare visits during the period of maximum emergency, which is when the Government introduced the most severe restrictions. Conversely, in the other periods the decrease in the volume of healthcare services provided is almost entirely due to the pandemic policy responses, without there being a further behavioral effect on the part of individuals.

Table 3 replicates the previous analysis for the branches of diabetes and urology separately. Results are essentially consistent with our prediction and suggest that the effects are stronger for conditions with elastic demands and less-urgent care. However, it is challenging to completely disentangle the relative impacts of the lockdown and the direct effects of the pandemic because of the high correlation between the two variables.

Nonetheless, the evidence is compatible with our earlier findings. Urologic care contracted more (75%) during the lockdown period in response to the restrictions on Covid-19 with respect to diabetic services (72%) and the behavioral effect was stronger for urology than for diabetes, accounting for 13% (= [72% – 62%]/ 72%) of total reduction in healthcare utilization for the latter and 16% in the case of the former.

TABLE 3 Effects of the Covid-19 and policy responses on diabetic and urologic visits

VARIABLES	(1) Diabetes	(2) Diabetes	(3) Urology	(4) Urology
Level 1 response	-0.230***	-0.270***	-0.253***	-0.285***
	(0.0301)	(0.0325)	(0.0282)	(0.0307)
Level 2 response	-1.286***	-0.965***	-1.391***	-1.000***
	(0.0390)	(0.0434)	(0.0278)	(0.0410)
Level 3 response	-0.341***	-0.243***	-0.330***	-0.207***
	(0.0189)	(0.0323)	(0.0165)	(0.0276)
Level 4 response	-0.332***	-0.180***	-0.337***	-0.132***
	(0.0235)	(0.0457)	(0.0178)	(0.0331)
Observations	33,044	33,044	34,854	34,854
R-squared	0.846	0.853	0.884	0.889
Controls	NO	YES	NO	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.2. Event study

To provide an estimate of the dynamic effects of the Covid pandemic in the post-Covid year, we conducted an event study analysis by replacing the four post-outbreak indicators with a set of dummy variables for weeks up to 13 months prior and 15 months post week 19-25th February 2020. The event study design is ideal to obtain a good visual description of the effects of Covid-19 and the relative policy responses on healthcare utilization, and allows to test the common trend assumption. Common trend is a critical assumption in difference-in-difference and event study models. In our context, it requires that in the absence of treatment, trends in weekly visits would have remained constant across years.

Figure 5 plots the estimates of the weekly variation in healthcare utilization between January 2019 and July 2021. Our model accounts for municipality and week fixed effects, the inclusion of which serves to eliminate seasonal patterns that would otherwise be observable in the pre-

treatment weeks. For both diabetic and urologic services, the estimates of the pre-pandemic period dummies are generally statistically non-significant.

The increase between late 2019 and the first weeks of 2020 in the number of diabetes care services are most likely due to an annual increase in the number of individuals diagnosed with diabetes, rather than an increase in the demand for diabetic services from individuals already diagnosed. As a matter of fact, repeating the analysis on the total number of health care services received for any branch by individuals with chronic diabetes, this pre-treatment increase does not show up. Moreover, this variation disappears by subtracting from the number of weekly services provided for the diabetes branch the average for that year. The latter procedure works in a similar manner as adding year fixed effects in the event study regression. Overall, the two graphs show no evidence that changes in healthcare utilization occurred before the implementation of the first policy measures.

FIGURE 5: Event study results of the impact of policy responses on diabetic and urologic visits

For the pandemic year, the event study analysis replicates the results summarized in Figure 4. Again, healthcare utilization dropped dramatically after the outbreak of Covid-19 in February, and urologic services declined before diabetic visits. Healthcare provision returned to pre-pandemic levels in mid-July and declined again in the last months of the year due to new restrictions introduced to contain the second wave of the pandemic.

Despite the similar trends that diabetes and urology services had in 2020, it is interesting to point out that in the following year, they follow two very different trajectories. While in 2021 diabetic visits had steadily returned to the level of the years 2018 and 2019, visits for the urology branch had remained significantly below the pre-Covid standard as of the end of July 2021 (about seventy-five weeks after the pandemic outbreak). By fifty weeks after the Covid outbreak (February 5-11th 2021), healthcare provision was the same as before 2020 for diabetes, while total services for the urology branch were only 80% of pre-Covid volumes. For total services, the difference between 2021 and the years not affected by the pandemic was smaller than for the urology branch alone, but still statistically different from zero.

Urologic care thus suffered from more prolonged reductions in the post-outbreak year compared with diabetic care. In other words, the demand for diabetic services is "less elastic" than for urologic services, which makes diabetic visits more difficult to postpone. This should not come as a surprise, since our sample consists of patients with chronic diabetes. This kind of patients are recommended to undergo diabetic visits very frequently, typically quarterly or semiannually. Every person with diabetes should have blood glucose drawn at least every six months to assess blood sugar levels. These examinations are to determine the presence or absence of potentially compromising complications in the patient's health status, and are necessary, for example, to obtain a driver's license renewal.

6. Concluding remarks

This preliminary analysis of the effects of the pandemic and related restive measures on the provision of healthcare services adds to several other studies suggesting that the indirect costs of implementing these policies include a significant and sustained reduction in the demand for non-Covid health services.

Our findings show that non-Covid healthcare provision was particularly affected by policy responses to the pandemic during the national lockdown period, which in Italy lasted from March 8th to May 3rd, 2020. During these weeks, total services for diabetes and urology branches decreased dramatically compared to the control period, with negative peaks of 74% decline in the first half of April.

Moreover, the reduction in demand for healthcare during the pandemic period is likely to be partly due to voluntary responses. People may have postponed or foregone visits either because of fear of Covid infections or because of a sense of social responsibility. During the lockdown period, this "behavioral" component accounted for approximately 32% of the overall decline in healthcare utilization. Our results also call for the importance of monitoring the long-term health consequences in non-Covid patients with delayed care.

Furthermore, diabetic care was less affected by policy responses than urologic care. The impact of direct exposure to Covid-19 was also stronger for urologic care and accounted for 13% of the total reduction in healthcare utilization. It is not surprising that people generally regard urologic care as non-urgent and easy to postpone, making the demand for these visits less rigid than that for diabetic care.

This contribution joins many others in recommending that the indirect costs of the restrictions have been substantial and will need to be considered in the event of future

pandemics. We also showed the importance for governments to adopt containment strategies that account for people's behavior in response to such events.

Addressing the voluntary reduction in health care is essential in order to estimate what the impact of the pandemic would have been on the Italian NHS had the government not intervened with strict containment measures. In turn, this is crucial in order to get an idea of the real causal effect of policy responses to the pandemic had and the share of the total contraction in healthcare provision attributable to other factors not dependent on the actions of governments, such as people's fear of contagion and sense of social responsibility.

This study has some limitations. Firstly, data at our disposal include only patients with chronic diabetes. Since these patients need to receive frequent visits because of their condition, it may be that our results underestimate the true impact of closures on healthcare utilization, at least for the endocrinology branch. The same analysis conducted on a sample of non-chronic patients is likely to highlight an even stronger decline in healthcare services. In this regard, it would be interesting to assess the reduction, if any, in the number of new diabetes diagnoses made during the pandemic months.

Secondly, isolating the "behavioral" effect from the effect directly attributable to the restrictions is not an easy task. In this analysis, following examples already existing in the literature, we tried to address this concern by including a dummy variable for post-outbreak weeks in each municipality. However, this attempt may not be sufficient to solve the endogeneity of restrictions, as people may have changed their behaviors also in response to other information on the pandemic trajectory, such as the number of cases in their region of residence or nationwide. If this is the case, our estimates suffer from an identification problem and cannot be interpreted as causal effects.

Moreover, policy responses to the pandemic can have some unintended benefits for public health, leading themselves to changes in healthcare utilization. Containment interventions to tackle Covid-19 in China led to a remarkable improvement in air quality, reducing the incidence of cardiovascular diseases, chronic respiratory diseases, and pollution-related deaths (Chen et al., 2020; He et al., 2020).

Other policy measures, such as mandates of wearing masks, social distancing and health-related recommended practices (e.g., handwashing) may have reduced the transmission of other infectious diseases (e.g., influenza). Finally, the suspension of non-essential business activities probably had the effect of decreasing the delivery of healthcare services too, in consequence of a reduction in occupational accidents.

Thirdly, we dot examine the effects of telemedicine in offsetting the decline in healthcare utilization in Lombardy. Telemedicine significantly reduced the time needed for clinical assessments, allowing healthcare professionals to safely take care of more patients, avoiding hospitals overcrowding, and outreaching to those who have limited access to care for various reasons, including mobility issues.

A richer dataset may help future research to explore some of these issues and provide a more accurate identification of the impact of Covid policy responses on non-Covid healthcare services, thus having a clearer understanding of the overall costs of the implementation of measures to control a pandemic.

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APPENDIX 1: SUPPLEMENTARY MATERIAL

Figure 6: Event study results of the impact of policy responses on healthcare utilization for the branches of diabetes (a) and urology (b). Municipality only fixed effects. Drops in healthcare provision before the event of interest are due to seasonal variations that disappear once controlling for week fixed effects.

Figure 7: Event study results of the impact of policy responses on total healthcare utilization. Municipality fixed effects (a) and municipality and week fixed effects (b). From (b) we see that healthcare utilization has not returned to pre-pandemic standards as of July 2021.

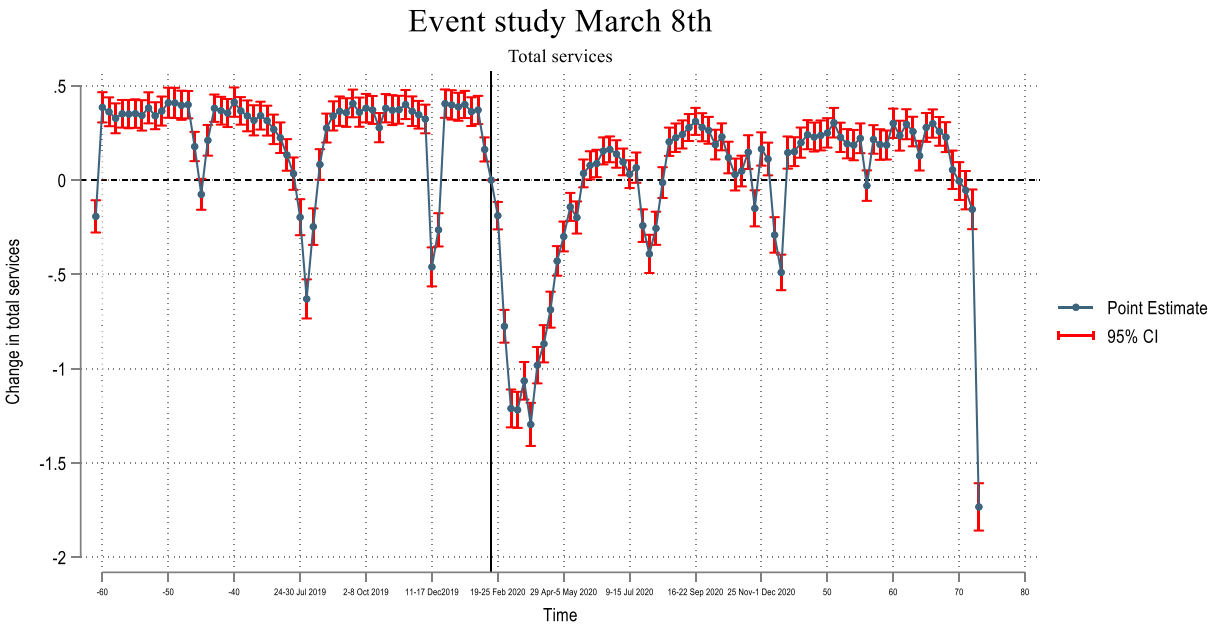

Figure 8: Event study results using week 10 (March 4-10th) instead of week 8 (February 19-25th) as the event of interest. The reference period is then the week from February 26th to March 3rd. When analyzing healthcare variations following the implementation of the national lockdown (March 8th), all coefficients in the period before the baseline week are statistically significant and large in magnitude. These findings highlight that the healthcare provision has changed immediately when the first Covid cases were registered in Codogno.

APPENDIX 2: RESEARCH ASSISTANTSHIP FINAL REPORT

Research question

This project investigates the impact of the Covid-19 pandemic and related policy responses on non-Covid healthcare utilization. In particular, this short study aims to quantify variations in the provision of diabetes and urological services in the metropolitan city of Milan and in the province of Lodi. The empirical approach used is that of the event study. The event study represents the ideal framework for obtaining a before-after vision of an event of interest, which in our case is represented either by the introduction of the first restrictions (19-25th February 2020) or by the imposition of the first national lockdown (4-10 March 2020). A major empirical challenge with evaluating the impacts of Covid-related responses is the endogenous nature of their implementation. Italy, like many other countries worldwide, implemented restrictions in response to or concurrently with rising Covid-19 cases. Therefore, it is important to disentangle the effects of policies from other demand-side effects caused by changes in the trajectory of the pandemic, including a sense of social responsibility and fear of infections. We address this potential issue by controlling for the evolution of the pandemic at the municipality level.

Data

Data at our disposal include a first large dataset containing the total number of healthcare services provided to chronically diabetic patients in each municipality of the geographical area considered. Healthcare provision is distinguished by branch of specialization. A second dataset reports the same data for the branch of urology only. The data, collected on a daily basis, cover the period between 2017 and the first seven months of 2021. Finally, a third dataset comprises information on several indicators capturing the evolution of the Covid-19 pandemic, including the overall number of deaths and cases registered, the number of patients hospitalized in intensive care, and the number of swabs performed.

Project objectives

The project is set within the Centro Ricerche sul Lavoro Carlo Dell'Aringa (CRILDA) and it is part of the Research Project "The post-Covid Syndrome: network building and innovative management to address a new public health emergency (PASCNET)", funded by Fondazione Cariplo. The overarching goal of the PASCNET project is to develop a solid network linking local health providers (Aziende Socio-Sanitarie Territoriali, ASST), central health institutions (Agenzie di Tutela della Salute, ATS), practitioners (Cooperative di Medici di Medicina Generale, IML), and universities to fill the current gap of knowledge on PASC from an epidemiological, clinical, and public health perspective. This multidisciplinary approach will be crucial for the design of intervention plans for the management of PASC.

The PASCNET project articulates into 5 Work Packages (WP). My contribution fits within WP 4, assessment of the indirect effects of the Covid-19 pandemic on the healthcare system in terms of outpatient services. In particular, pre and post-emergency effects on healthcare

utilization are investigated in terms of both organizational factors (supply side) and behavioral effects, such as hesitancy to visit hospitals during the pandemic (demand side).

Description of the RA tasks and acquired skills

As a research assistant, I had the opportunity to work closely with Professor Lucifora and to take part in the following activities:

- review of the existing literature on healthcare utilization during the Covid pandemic;
- building of a panel dataset reporting total outpatient services by municipality starting from data aggregated by cell, where each cell is identified by municipality/postal code of residence, day, gender, age group, branch of specialization code, BDA, and whether the patient is chronic;
- merging of data on total outpatient services provided and data on the trajectory of the Covid-19 pandemic between February 2020 and May 2021;
- preliminary descriptive analysis on monthly trends of outpatient care in Lombardy, with a particular focus on diabetes and urological services;
- empirical estimation of the effects of restrictions on the volume of healthcare services provided for the diabetes and urology branches. The analysis was carried out through different specifications aimed at obtaining causally informative results;
- visual representation of the output produced.

Since the analysis was carried out using the software Stata, this experience allowed me to become more proficient in using this fundamental tool of empirical analysis. Furthermore, I've become acquainted with autonomously finding instructions on the usage of Stata commands, by consulting online guidelines. In particular, during my period as a research assistant, I was able to develop a broad range of competencies transferable to any research environment, including:

- the ability to manage large panel datasets and merge them using the command merge;
- the ability to convert data aggregated by cell into a dataset of sums of weekly healthcare services at the municipality level with the command collapse(sum);
- a deep comprehension of basic empirical approaches used in policy evaluation, such as difference-in-difference and multiple diff-in-diff, and of the econometric methodologies adopted to handle high dimensional fixed effects, both in theory and in practice with the command reghdfe;
- a sound understanding of the panel event study design, including the theoretical set-up and implications, and its implementation through the Stata command eventdd;
- the ability to visualize spatial data by drawing thematic maps by using spmap;
- an improved capacity to communicate results in a clear and coherent way;
- a better ability to write a scientific paper.