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In the eye of the storm. Long-term impact of the Covid-19 pandemic on healthcare utilization in Lombardy[☆]

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ABSTRACT

Covid-19 induced an increase in unmet health needs due to mobility restrictions and social distancing policies, fear of contagion and overload of healthcare facilities. Using administrative data for the Metropolitan Area of Milan in Lombardy and a rigorous empirical strategy, this paper investigates the impact of Covid-19 on the provision of outpatient care between January 2018 and June 2021. We find a large and persistent drop in outpatient treatments, with heterogeneous variations across age groups and chronic status of patients, as well as diagnostic categories of treatments. Results also reveal a significant role played by policy response to Covid-19 and behavioral changes in health-seeking behaviors in shaping the Covid-induced variation in outpatients. Finally, we estimate a cumulative and persistent loss in outpatient care around 25 percent over the period of interest, with an accumulated delay of 4.5 standard months.

1. Introduction

The Covid-19 pandemic has wrought profound changes in the lives of individuals across Europe and globally, impacting various facets such as education, economy, and social activities (Baranov et al., 2022; Immordino et al., 2022). In the realm of health, the pandemic has precipitated significant disruptions in healthcare services. A substantial number of European Union citizens reported heightened unmet health needs as countries redirected healthcare resources to address the urgent demands of the pandemic. At the same time, public health directives that reduced physical and social interactions to contain the outbreak further exacerbated the challenges in accessing health care (OECD and European Union, 2022). Eurofound's Living, Working, and Covid-19 e-survey (Ahrendt et al., 2022) revealed that between March and July 2020 more than one in five respondents who needed a medical examination or medical treatment did not receive it, reporting Covid-related reasons in 90 percent of the cases. Moreover, healthcare systems in the EU had not managed to catch up with the backlog accumulated during the pandemic, as unmet needs in 2022 appear to be as high as in spring 2021 (almost 20 percent of respondents).

This study investigates the consequences of the Covid-19 pandemic on outpatient care, since its outbreak through the early recovery period, with a specific focus on the Metropolitan Area of Milan (193 municipalities in the provinces of Milan and Lodi), in Lombardy, which was the first region outside China hit by the pandemic.

The disruption in the provision of health care is a multifaceted phenomenon influenced by several factors, including the implementation of restrictive measures, public perceptions of safety, and potential excess mortality. The early studies on the impact of the Covid-19 pandemic on healthcare utilization in 2020 in China reveal a significant drop in healthcare spending and utilization (Zhang et al., 2020), both in preventive and outpatient care (Huang and Liu, 2023), as well as for emergency care and inpatient hospital visits (Xiao et al., 2021). Similar evidence is found in the US during the initial stages of the pandemic, both in retrospective cohort studies (Xu et al., 2021) as well as using medical claims and cellphone data to identify the effects of shelter-in-place (SIP) policies (Cantor et al., 2022). Results from the latter study reveal a significant reduction in the use of preventive care, elective services and weekly visits to physician offices and hospitals associated with Covid-19 outbreak and the introduction of SIP policies. Moreover, systematic and scoping reviews of the impact of Covid-19 on healthcare utilization worldwide provide evidence of an overall reduction – across both high- and low-income countries –, with considerable cross-country

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variation and larger drops among individuals with less severe health conditions (Moynihan et al., 2021; Roy et al., 2021).

While existing literature identified a negative effect of Covid-19 on the provision of a wide range of healthcare services in many countries (Lee and You, 2021; Xu et al., 2021; Tsai and Yang, 2022; Cantor et al., 2022; Makiyama et al., 2021), evidence on Italy is rather scarce and often focusing on specific categories of healthcare services (Percudani et al., 2020; Lastrucci et al., 2022; Gualano et al., 2021; Santi et al., 2021).

This paper contributes to existing literature in a number of ways. First, we provide novel evidence on the indirect effects of Covid-19 on healthcare utilization in Italy, with a specific focus on the Metropolitan Area of Milan, the largest metropolitan area of Northern Italy (approximately 3.2 million inhabitants). Using rich administrative data from the healthcare system of Lombardy and a rigorous empirical strategy, we evaluate the consequences of Covid-19 and policy responses on the provision of outpatient treatments over the period from January 2018 to June 2021. Second, we consider a longer time span, allowing for an assessment of possible long-lasting effects of the delays and interruptions in healthcare provision associated with the outbreak of Covid-19. Third, we address concerns about the role of excess mortality in explaining variations in outpatient care. Fourth, we investigate the behavioral response of individuals facing the risk of infection and restricted access to healthcare facilities. To do this, we exploit variation in patients' age and presence of chronic conditions and in the intensity of the contagion effects over the different waves. While we cannot separately identify demand factors – driven by individual risk attitudes and precautionary behavior – and supply factors – determined by supply limitations and congestion effects –, we show that the observed patterns in outpatient care are consistent with a demand-driven behavior, with a significant drop in the number of patients seeking care relative to the pre-Covid period. Finally, we provide an assessment of the cumulative loss in outpatient care due to the pandemic and accumulated delay, along with an estimate of the potential duration for a full recovery under various scenarios.

Our results show a marked and enduring decline in outpatient treatments, with distinct patterns across ordinary, emergency, and screening treatments. We also find heterogeneous effects across different population groups: a larger impact is found among individuals aged 60 to 84, for outpatients belonging to Diagnostic Imaging and for patients without any chronic condition, reflecting the disruption in the provision of elective care and a reduced demand for non-urgent health care. Mobility restrictions and SIP policies are shown to account for a significant part of the overall reduction in outpatients, especially in the first period after Covid-19 outbreak. Finally, the cumulative loss in outpatient care is estimated around 25 percent with an accumulated delay of about 19 weeks.

The paper is structured as follows. Section 2 provides an brief description of the Italian NHS as well as an overview of trends in Covid-19 diffusion and policy responses. The data and methodology are described in Section 3. Section 4 presents the results and concluding remarks are provided in Section 5.

2. Institutional setting

The Italian National Health Service (NHS) is a public (tax-funded) insurance scheme, that provides universal coverage to all citizens and residents largely free of charge, with a small share of co-payments for pharmaceuticals and outpatient care.[1] The level of cost-sharing ranges from total exemption (for people aged 65 and over, children below 6, unemployed or individuals with a gross family income below a given threshold, individuals with severe disabilities) to a coverage of part of the costs. Exemptions also apply to chronic patients and pregnant women, as far as the needed treatments are related with their condition. Each individual is assigned to a general practitioner (or pediatrician for children below the age of 14) who provides family medicine free of charge and acts as a gatekeeper to higher levels of care and pharmaceuticals. The central government is responsible for general legislation and financing, while leaving to the regional governments the management and provision of care.

Italy has been the first country outside China to be hit by Covid-19 outbreak, with the first case reported in Codogno (province of Lodi) on February 20th, and recorded the highest number of victims in the first quarter of 2020, with nearly half of the national cases diagnosed in Lombardy. Since January 31st, 2020 Italy started its proactive management of the Covid-19 pandemic, with a six-month state of emergency declared, providing authorities with essential tools to face the alarming epidemic. As the situation intensified, on February 23rd, 2020 new actions were taken, with the isolation of ten municipalities in Lombardy and one in the province of Padua (Veneto), including mobility restrictions within and to these areas, along with milder restrictions across the Lombardy region, including school closures and the suspension of entertainment events.[2] On March 9th, 2020 SIP policies were introduced,[3] with the implementation of the first nationwide lock-down. This unprecedented measure, aimed at containing the spread of Covid-19, introduced severe social distancing policies, prohibiting all forms of gatherings in public places. Meanwhile, elective and non-urgent medical procedures were largely delayed or canceled as a means to prevent hospital overcrowding, while maintaining the provision of outpatient care for chronic patients (Delibera n. XI/2906-2020). Subsequently, on March 22nd, 2020, further restrictions were imposed, including the closure of non-essential businesses and mobility restrictions between municipalities. These measures were extended until May 3rd. Starting May 4th, a gradual easing of containment measures characterized "Phase Two" of the pandemic management strategy, that lasted until October 2020, when the second pandemic wave struck, leading to a resurgence of Covid-19 cases and the reinstatement of restrictive measures. Fig. 1 provides an overview of the time trends for Covid-19 infections and of the timing of the different policy measures. The solid vertical line represents the introduction of the first mobility restrictions in Lombardy and the isolation of the ten most affected municipalities; the two dash-dotted lines delimit the national lock-down; the long-dashed line coincides with the beginning of the second pandemic wave.

3. Data and methods

3.1. Data and descriptive statistics

We use administrative data from the Agency for Health Protection (*Agenzia di Tutela della Salute*) of the Metropolitan Area of Milan, with information on the universe of healthcare services for the whole population of 193 municipalities in the Lombard provinces of Milan and Lodi (former ASL Milan, Milan 1, Milan 2, and Lodi). In the empirical analysis we focus on outpatient treatments provided between January 2018 and June 2021, aggregated on a weekly basis[4] and

[1] There is also a co-payment for the "inappropriate" use of emergency care, defined as any access to emergency departments with non-critical or non-urgent conditions.

[2] The municipalities involved were: Codogno, Castiglione d'Adda, Casalpusterlengo, Fombio, Maleo, Somaglia, Bertonico, Terranova dei Passerini, Castelgerundo and San Fiorano in the province of Lodi in Lombardy and Vò in the province of Padua in Veneto.

[3] Shelter-in-place generally means finding a safe indoor location and staying there until the situation outside is safe. SIP orders during the Covid-19 pandemic implied staying at home until further notice, minimizing social interactions.

[4] Each year is composed of 52 weeks, with the first week starting on January 1st, week 52 starting on December 24th and lasting until December 31st, to complete the calendar year.

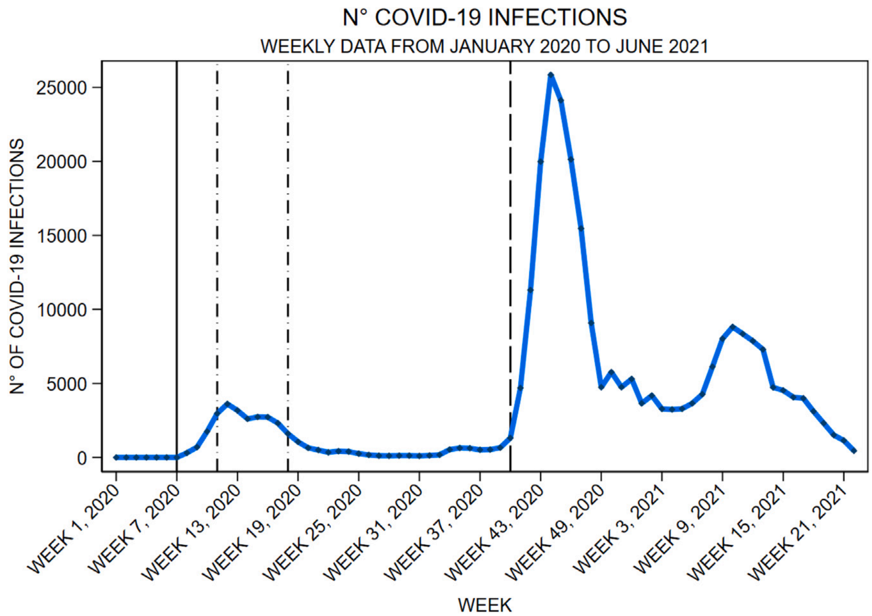

Fig. 1. Trends in Covid-19 cases and timing of social distancing policies.

by municipality/zip code[5] of residence of patients, combined with data on Covid-19 outbreak. We further exploit information on the age group of patients (7 categories[6]), the diagnostic category of outpatient treatments (14 categories[7]) and the presence of any diagnosed chronic condition (3 categories[8]) to provide a comprehensive analysis of outpatient care patterns during and after the Covid-19 pandemic. Descriptive statistics of our final sample of 42,042 observations – 231 territorial units observed for 182 weeks – are reported in Table 1. On average, more than 1,160 outpatient treatments are provided every week in a single municipality/zip-code area, 20 percent of which are provided as emergency care and around 1 percent represent screening tests.[9]

Looking at the distribution of outpatient treatments among age groups (Table A.5 in the Appendix A) and diagnostic categories (Table A.6 in the Appendix A), the data show that a substantial portion comes from individuals aged 50 to 84, accounting for more than half of the total number of treatments, especially for screening tests, and that most of the treatments belong to Diagnostic Imaging. Ordinary outpatient treatments are mainly provided to chronic patients (i.e. those with at least one chronic condition diagnosed by a doctor), representing almost 60 percent of the total, while screening tests are more equally distributed between chronic and non-chronic patients (Table A.7 in the Appendix A).

Table 1
Descriptive Statistics.

	Mean	SD	Max	Min
Total outpatient treatments	1,166	1,423	10, 677	0
Ordinary outpatient treatments	913.8	1,143	8, 770	0
Emergency outpatient treatments	236.6	290.5	2, 666	0
Screening outpatient treatments	16.09	22.53	420	0

Fig. 2 illustrates the time patterns for weekly outpatient treatments over the period of interest, Jan 2018–Jun 2021, with overlapping lines for each year. Panel (a) displays the total number of outpatients; panel (b) plots ordinary outpatient treatments; panel (c) emergency outpatient treatments and panel (d) screening tests. Vertical lines indicate the week before the introduction of the first set of mobility restrictions and social distancing policies in Lombardy (week 7 of 2020) and the week before the beginning of the second pandemic wave (week 40 of 2020).

Overall, outpatient treatments exhibit marked seasonal patterns across all years, with notable drops occurring during holiday periods, such as Christmas (observed in the first and last week of the year), mid-August (during week 33), Easter, and other festive occasions. A substantial drop in outpatient treatments can be identified on the green line for 2020, in the immediate aftermath of the implementation of restrictive measures (first vertical line), and a less pronounced reduction is observed following the second wave of the pandemic in early October 2020 (second vertical line). Compared with the reference week (week 7 of 2020), total outpatients fell by up to 80 percent in the first pandemic wave and around 30 percent between October and December 2020. Interestingly, despite a gradual recovery during summer 2020, the volumes of outpatient treatments never fully rebound to pre-Covid levels, even during the first semester of 2021. Such trend is particularly pronounced for outpatient treatments provided as emergency care (panel (c)), which also experienced a more sizeable drop after Covid-19 outbreak. Conversely, the decline in screening tests (panel (d)), while substantial, was less enduring, with the numbers eventually converging toward pre-Covid levels. Such preliminary evidence suggests that

[5] Each geographic area is defined matching the information on the municipality and zip code, to identify the smallest cell. In most cases municipality and zip code identify the same area, but this is not always the case. For big municipalities characterized by multiple zip codes (like Milan) the unit of observation is at the zip-code level, while for some small municipalities sharing the same zip code the identifier is the municipality. Our final sample is based on 231 territorial units, i.e. 193 municipalities and 38 zip codes for the city of Milan.

[6] Individuals aged 14 or less, 15–24, 25–34, 35–49, 50–64,65-84, 85 and over.

[7] Cardiology, Diagnostic Imaging, Cytology and Microbiology, Neurology/Neurosurgery/Psychiatry, Pulmonology, Dermatology/ObGyn, General Surgery and Anesthesia, Plastic/Maxillofacial Surgery and Dentistry, Ophthalmology and Other specialties, Endocrinology, Orthopedics and Traumatology/Physical Medicine and Rehabilitation, Gastroenterology, Oncology, Nephrology and Urology.

[8] No chronicity, presence of one chronic condition, presence of at least two chronic conditions.

[9] Additional statistics by age group, diagnostic categories and chronic status are provided in Tables A.1, A.2, A.3 and A.4 in Appendix A.

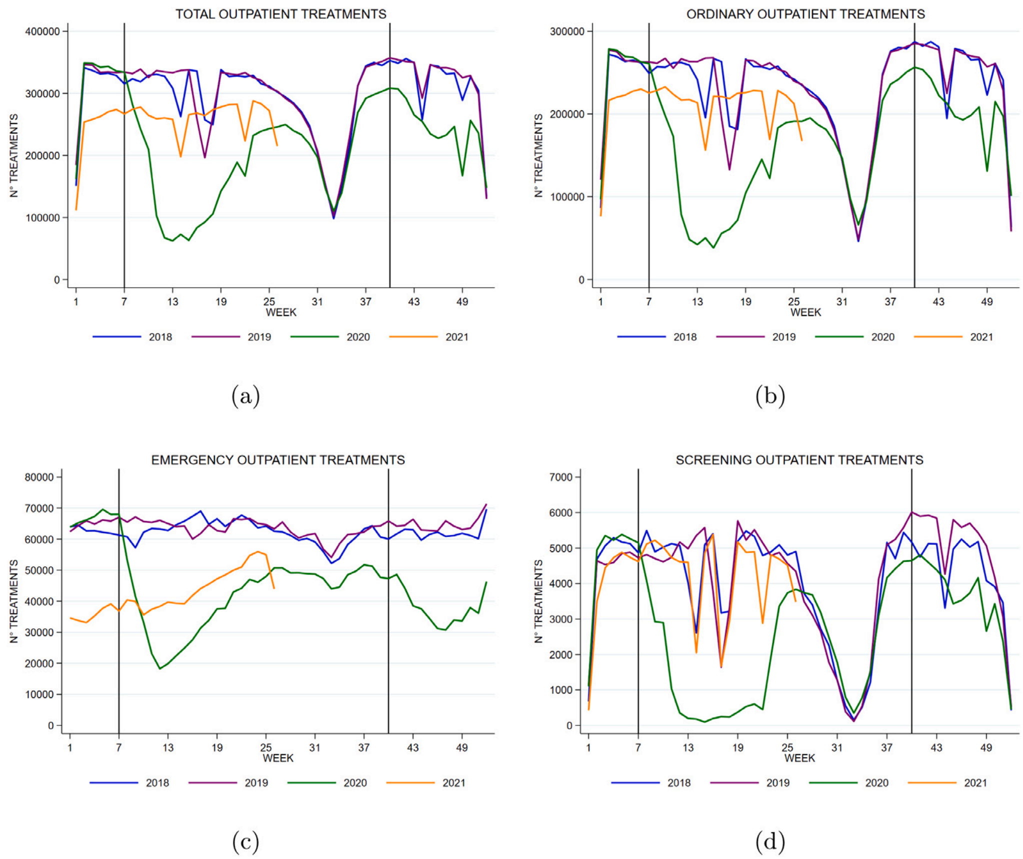

Fig. 2. Trends in outpatient treatments.
Note. Each panel plots the total volume of weekly outpatient treatments over the period of interest (Jan 2018–Jun 2021), with overlapping lines for the four years. Vertical lines correspond to the introduction of the first set of mobility restrictions and social distancing policies in Lombardy (week 7 of 2020) and the beginning of the second pandemic wave (week 40 of 2020).

Covid-19 and containment policies had a non-negligible impact on the provision of outpatient care, with distinct trajectories for different types of services, and a long-lasting effect.

3.2. Empirical strategy

In the empirical analysis we first investigate the impact of Covid-19 on the provision of outpatient treatments in the 231 territorial units belonging to the Metropolitan Area of Milan using a standard event-study specification:

$$Y^{adj}{}_{m,t} = \alpha + \sum_{t\neq 7} \beta_t \cdot D_t + \text{munzip}_m + \epsilon_{m,t} \tag{1}$$

where $Y^{adj}{}_{m,t}$ represents the volume of outpatient treatments (total, ordinary, emergency and screening) provided in municipality/zip code m in week $t \in [1;130]$ between January 2019 and June 2021, adjusted for seasonality. For each year, the first week starts on January 1^{st}, week 52 starts on December 24^{th} and lasts until December 31^{st}, to complete the calendar year. Given the marked seasonality in outpatient treatments shown in Fig. 2, our dependent variable is transformed as the simple difference between the weekly volume of outpatient treatments provided over the period 2019–2021 and the weekly volume of outpatients provided in the corresponding week of 2018, as follows:

$$Y^{adj}{}_{m,t} = Y_{m,t} - Y_{m,2018(t)}$$

The first week of each year starting on January 1^{st} allows to compute a proper adjustment for seasonality, differentiating each week of the years 2019, 2020 and 2021 from the exact same period of the reference year 2018. The sample employed in this exercise is composed of 130 weeks (52 for 2019 and 2020 plus 26 weeks from 2021), while the 52 weeks of 2018 are excluded from the sample and used as reference weeks.[10]

D_t is a set of dummy variables, equal to one for each specific week $t \in [1;130]$ excluding week 59, i.e. the 7^{th} week of 2020, and β_t are the corresponding coefficients, capturing the variation in the volume of outpatient treatments in week t, relative to the reference week, compared with 2018. Finally, munzip_m are municipality/zip code fixed effects and $\epsilon_{m,t}$ is the error term, representing unexplained variation in

[10] While we acknowledge that having a longer time span as a reference period is ideal in event-study settings, data on outpatient treatments for previous years were not available for this study. However, aggregate data on the volumes of outpatient treatments provided in Lombardy between 2012 and 2018 (available at https://www.dati.lombardia.it/) show a relatively stable growth pattern (around 1%–3% yearly increase) between 2012 and 2014 and 2016–2018, leading us to think that no idiosyncratic shocks or unusual patterns in healthcare utilization characterize 2018. Conversely, in 2015 and 2016 a significant drop in outpatients have been recorded, likely due to the so-called Lorenzin reform, aimed at containing healthcare costs by restraining general practitioners' ability to prescribe outpatient treatments (Lucifora et al., 2021), so that the inclusion of those years might have been troublesome for our identification. Moreover, the graphical testing of the parallel-trends assumption (Fig. 3) provides evidence against the presence of any pre-trend and the coefficients for 2019 do not show significant deviations with respect to the weekly pattern of 2018, leading us to believe that 2018 might be a reasonable choice as a reference year.

the model. Standard errors are clustered at the municipality/zip-code level.

As a second step, in order to assess the average weekly variation in the volume of outpatient treatments after Covid-19 outbreak and the implementation of containment measures, we estimate the following regression equation:

$$Y_{m,w,t} = \alpha + \beta \text{PostCovid}_{w,t} + \text{munzip}_m + \text{week}_w + \text{year}_t + \epsilon_{m,w,t} \quad (2)$$

where $Y_{m,w,t}$ represents the volume of outpatient treatments (total, ordinary, emergency and screening) provided in municipality/zip code m, in week $w \in [1;52]$ and in year $t \in [2018;2021]$, between January 2018 and June 2021. In this exercise we thus exploit the entire time span, composed of 182 weeks (52 weeks for each full year plus 26 weeks in 2021). $\text{PostCovid}_{w,t}$ is a dummy variable equal to one for all the weeks after the seventh of 2020; munzip_m are municipality/zip code fixed effects, week_w are week fixed effects (accounting for weekly seasonality) and year_t are year fixed effects; $\epsilon_{m,w,t}$ is the unobservable disturbance. Standard errors are clustered at the municipality/zip code level. In this specification, the coefficient of interest β measures the average weekly change in the number of outpatient treatments due to Covid-19 outbreak and the introduction of mobility restrictions.

We further explore the heterogeneous effects of the pandemic on outpatient treatments according to the diagnostic category of outpatients, chronic status and across different age groups of patients, by estimating Eq. (2) for each specific subsample.

As the overall variation in the volume of outpatient treatments is associated with the growth of the Covid-19 pandemic both directly (through concerns of infection that might lead to care avoidance and supply limitations to prevent hospital overcrowding) and indirectly (through mobility restrictions and SIP policies), in an additional exercise we disentangle the contribution of containment measures from that of the intensity of the pandemic. To this end, we estimate Eq. (2) including additional controls for the intensity of the Covid-19 pandemic within cell, calculated as the cumulative number of Covid-19 cases ($\text{cases}_{m,w,t}$) and Covid-related deaths[11] ($\text{deaths}_{m,w,t}$) in each municipality/zip code m, week w and year t (re-scaled in groups of 100 for Covid-19 cases and 10 for deaths). Two sets of fixed effects for each category of $\text{cases}_{m,w,t}$ and $\text{deaths}_{m,w,t}$ are then added to Eq. (2), as follows[12]:

$$Y_{m,w,t} = \alpha + \beta \text{PostCovid}_{w,t} + \text{munzip}_m + \text{week}_w + \text{year}_t + \text{cases}_{m,w,t} + \text{deaths}_{m,w,t} + \epsilon_{m,w,t} \quad (3)$$

Note that within the effect of mobility restrictions and SIP policies we also partly capture the disruption in the provision of outpatient care, as in March 2020 the local government passed a resolution announcing multiple supply limitations (Delibera n. XI/2906-2020), followed by a memorandum of the Ministry of Health (Circolare n. 7422-2020), indicating guidelines for the delay and interruption of a set of elective and non-urgent procedures. However, the application of such guidelines was left to the decision of the single healthcare facility and has been strictly connected with the Covid-related overload, so that additional controls for the intensity of the Covid-19 pandemic are likely to capture a significant part of this supply-side effect, which we are not fully able to isolate. With this specification, the β coefficient can be interpreted as the effect of mobility restrictions and SIP policies (and part of the supply-side effect) on outpatient care, net of the exposure to growth in the pandemic.

Moreover, in an additional exercise, we split our variable of interest $\text{PostCovid}_{w,t}$ into four period indicators according with the trajectory of the pandemic and the associated policy responses. The benchmark (omitted category) is the period before Covid-19 outbreak (until week 7 of 2020); the second period indicator ($PR1$) covers week 8 to week 10 of 2020 and refers to the implementation of the first restrictive measures, with the isolation of ten municipalities and the introduction of mobility restrictions within and to these areas, along with milder restrictions across the Lombardy region; the third period indicator, $PR2$, comprises the lock-down period (week 11 to week 18 of 2020); the fourth period, $PR3$, is characterized by gradual re-openings and relaxation of mobility restrictions, and basically coincides with the summer (week 19 to week 40 of 2020); the final period, $PR4$, goes from October 2020 to the end of the sample period, and is characterized by the second and successive waves of the pandemic along with the introduction of new restrictive measures.

Finally, we try to assess the extent of outpatients lost during the pandemic.

4. Results

4.1. Main results

Fig. 3 presents estimation results from our event-study analysis, offering insights into the dynamic shifts in outpatient care throughout the study period. The four panels report the $beta_t$ coefficients (and 95% confidence intervals) of Eq. (1), estimated separately for total outpatients, ordinary outpatient treatments, outpatients provided as emergency care and screening tests. Vertical lines indicate the week before the introduction of mobility restrictions in Lombardy (week 7 of 2020) and the week before the beginning of the second pandemic wave in October 2020 (week 40).

Overall, looking at the coefficients of the event study for the pre-Covid period, Jan 2019–Jan 2020, no evidence of pre-trends is found, as no significant deviations from typical patterns of outpatient treatments are observed. Conversely, a sizeable drop in the volumes of outpatients is recorded in each of the four panels after the Covid-19 outbreak and the implementation of mobility restrictions in Lombardy, reflecting both the disruption in the provision of non-urgent care and a drop in the demand for outpatient care. Demand-side drivers of the reduction in outpatient care both include mobility restrictions, social distancing and SIP policies, that encouraged the public to stay at home and avoid healthcare facilities, as well as behavioral responses of individuals who might be afraid of Covid-19 infection while in healthcare facilities (care avoidance). The most notable contraction occurred during the lock-down period, spanning from March 8^{th} to early May 2020, followed by a gradual recovery during summer, when Covid-19 cases shrank and mobility restrictions were cautiously eased. The second wave of the pandemic (October 2020) marks a second significant decline in outpatient treatments, though less severe as compared to the first wave. Interestingly, the volume of total outpatient treatments never fully rebounds to pre-pandemic levels over the period of interest, which might be explained both by supply and demand factors. On the supply-side, the overload on healthcare facilities brought about by Covid-19 patients induced a reallocation of resources from non-urgent outpatient treatments to hospital care, up to a disruption in the provision of the former (Delibera n. XI/2906-2020). The impact of Covid-19 on healthcare provision and resources available has been so severe that the volume of outpatient treatments could not get back to normal, at least until mid-2021. On the demand-side, care avoidance and the response to social distancing policies might have reduced patients' overall demand for non-urgent care even when the epidemic was less biting.

Although consistent across categories, the decline in outpatient treatments shows different magnitudes. Screening tests experienced a decline of up to 25 treatments (with a pre-pandemic average of 18 treatments per week) immediately after the Covid-19 outbreak and during the extended lock-down, with a gradual recovery back to pre-pandemic

[11] Covid-related deaths refer to deaths occurred within 30 days since a positive PCR test has been recorded.

[12] The additional controls for Covid-19 cases and deaths are added to Eq. (2) as binary indicators for each category of $\text{deaths}_{m,w,t}$ (i.e. 0, 10, 20, …, etc cumulative Covid-related deaths) and $\text{cases}_{m,w,t}$ (i.e. 0, 100, 200, …, etc. cumulative Covid-19 cases).

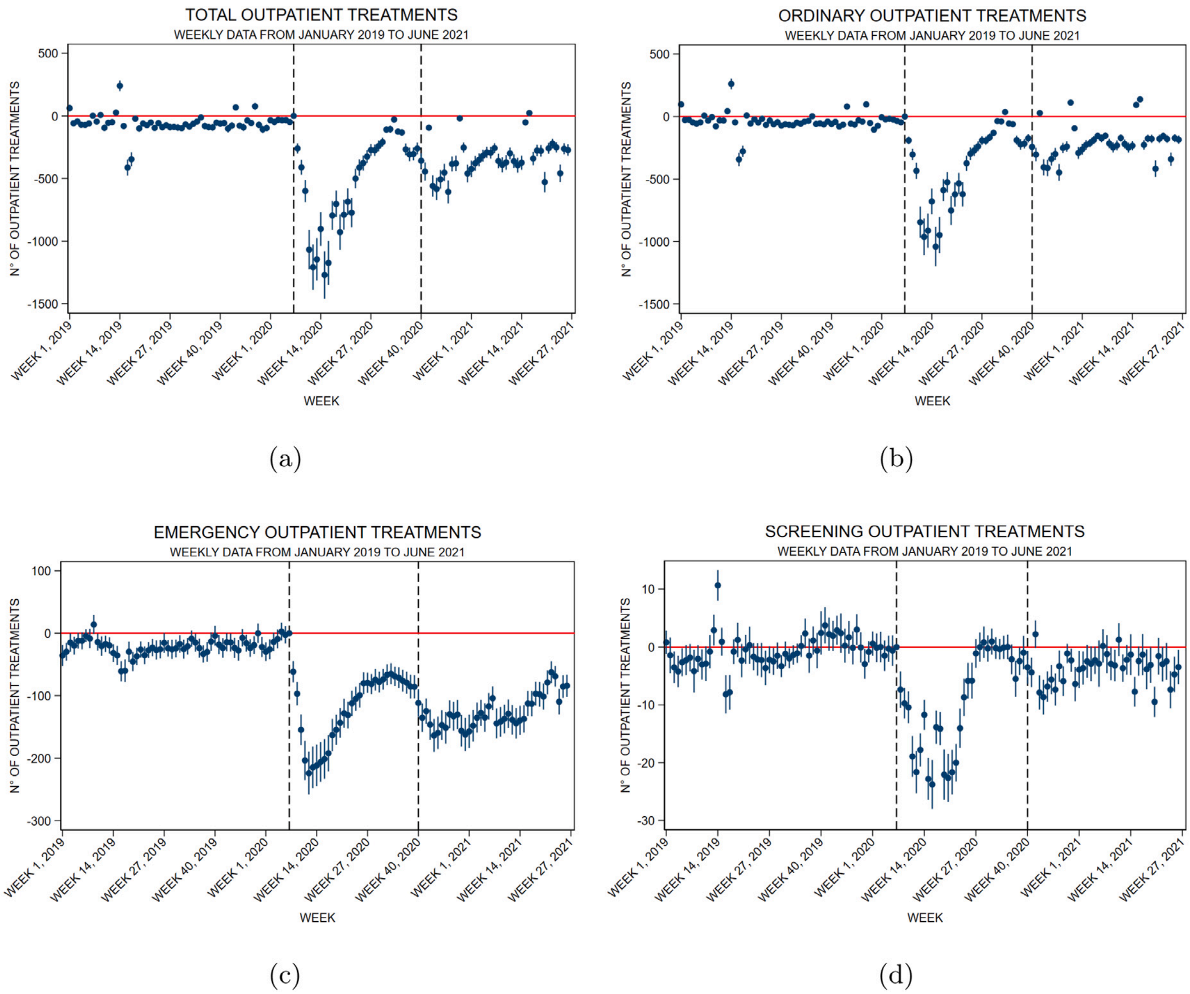

Fig. 3. Event study analysis.
Note. Each panel plots the β_t coefficients (and 95% confidence intervals) of Eq. (1), estimated separately for each category of outpatient treatments. The dependent variable is adjusted for seasonality and the sample is composed of 130 weeks (from Jan 2019 to Jun 2021), while the 52 weeks of 2018 are excluded and used as reference weeks. Vertical lines correspond to the introduction of the first set of mobility restrictions and social distancing policies in Lombardy (week 7 of 2020) and the beginning of the second pandemic wave (week 40 of 2020). Standard errors are clustered at the municipality/zip-code level.

levels around summer. The second wave of the pandemic had only a mild effect on outpatient patterns for this category, suggesting possible positive organizational spillovers from the first wave in the provision of preventive care. Conversely, outpatient treatments provided as emergency care show an 87 percent decline at first (approximately −240 treatments with a pre-pandemic average around 274 treatments per week) that was only partially recovered over the summer, and set to −100/150 treatments all over the first semester of 2021. Similar trends are shown for the first period after Covid-19 outbreak for ordinary outpatients, while the trend during the second wave shows a larger reduction, from 25 to 40 percent.

Taken altogether, these results reveal an enduring effect of Covid-19 pandemic on outpatient care and possible mechanisms at play. The significant and persistent drop observed for all categories of outpatient care until spring 2020 suggests that, beyond supply-side constraints, individuals postponed non-essential health care as a result of both fear of Covid-19 infection while in healthcare facilities and social distancing policies. While this mechanism seems reasonable when it comes to preventive medicine, represented by screening outpatient treatments, the sizeable drop in outpatient treatments provided as emergency care might appear puzzling at first. However, around 10 to 20 percent of emergency care admissions in Lombardy before the pandemic were deemed to be inappropriate, identified by a “white” triage code (health is not at risk and no suffering is present so the patient should have addressed the family doctor) and treated after all other more urgent cases. Given the overload of emergency departments over the pandemic period, waiting times for less urgent cases significantly increased and this might well explain the decline in outpatient treatments provided within this setting. Such hypothesis has been recently confirmed by data on access to emergency departments of the territories of the Metropolitan Area of Milan in the first semester of 2023, revealing that up to 20 percent of (plausibly non-critical) patients left the hospital without being visited, due to excess waiting time. Moreover, as Covid-19 has been largely a healthcare-associated infection, fear of contagion might have discouraged individuals with less urgent situations from resorting to emergency care.

One alternative explanation to the persistent reduction in outpatient treatments, is Covid-related excess mortality. As we do not observe sample mortality, to address this concern we run several exercises.

We first replicate the event study analysis of Eq. (1) adding excess mortality as a regressor. To this end we retrieve data from the Italian National Institute of Statistics on week by week cumulative mortality in excess with respect to the years 2018–2019 for each municipality in our sample. Results from this exercise, presented in Fig. A.1 in the Appendix A, are consistent with our baseline event study, suggesting that the drop in outpatients is not entirely attributable to Covid-related mortality.[13]

Second, we explore the correlation between excess mortality and the percentage change in total cumulative outpatient treatments between January 2020 and June 2021, relative to the corresponding period in the years 2018–2019, both in overall terms and for people over 65 (the group with the highest exposure to Covid-19). A positive correlation would imply that the observed decrease in the number of outpatient treatments is a consequence of higher-than-average mortality. However, no correlation is found between these two variables, as shown in Fig. A.2 in Appendix A.

A final exercise, presented in Table A.8 in the Appendix A, involves a back-of-the-envelope calculation of the volumes of outpatients that would have occurred in the period from January 2020 to June 2021 under different hypothetical scenarios, based on the number of individuals who might have died due to Covid-19. We start considering individuals with a *regular* use of outpatient care in the pre-pandemic years 2018–2019 (at least one outpatient treatment in 3 out of 4 semesters) and explore their patterns of participation in outpatient care over the period of interest to make hypotheses about sample mortality. We identify three possible participation patterns that might suggest that the individual left the sample due to death: (1) individuals no longer observed in the 1^{st} semester of 2021 (418,389 individuals); (2) individuals no longer observed in the 2^{nd} semester of 2020 and in the 1^{st} semester of 2021 (236,924 individuals); (3) individuals no longer observed in the 1^{st} semester of 2020, in the 2^{nd} semester of 2020, and in the 1^{st} semester of 2021 (153,779 individuals). We then hypothesize three different scenarios for average outpatient treatments in each semester of the period from January 2020 to June 2021 that would have been associated with these individuals, had not they left the sample: (1) an average volume of outpatients equal to the average observed for 2018–2019; (2) 75 percent of the average observed for 2018–2019; (3) 50 percent of the average observed for 2018–2019. By comparing these numbers with the volume of cumulative missed outpatients for the period Jan2020–Jun2021 (5,650,978) - with respect to the corresponding period of 2018–2019 - we can explore the role played by mortality in explaining the drop in outpatient treatments observed after the pandemic outbreak. Results suggest that, even in our upper-bound/worst-case scenario (which considers as dead all individuals who had *regular* outpatients until the end of 2020 and exit the sample in the first semester of 2021), mortality alone cannot explain the entire drop in outpatient treatments (in worst-case scenario it accounts for 83 percent of such reduction).

4.2. Overall change in outpatient care, policy response and Covid-19 exposure

In order to assess the overall average weekly change in the volume of outpatient treatments associated with Covid-19 outbreak we estimate Eq. (2) separately for each category of outpatients. Results from this exercise, reported in column (1) of Table 2, show an average reduction in total outpatients of about 482 treatments, representing a 37 percent decrease evaluated at the pre-pandemic sample average. The decrease is −349 (column 5 Panel A) for ordinary outpatients (−35 percent), −123 (column 1 Panel B) for emergency treatments (almost −45 percent) and −9 (column 5 Panel B) for screening treatments (−50 percent).

Using Eq. (2) we also investigate heterogeneous effects across age groups and chronic status of patients, as well as diagnostic categories of treatments. Figs. A.3, A.4 and A.5 in the Appendix A present a graphical inspection of the β coefficients associated with each group.

Age patterns in the provision of outpatient treatments after Covid-19 outbreak reveal a drop in ordinary and screening tests mainly attributable to patients aged 65 to 84, while among the oldest patients (85+) we observe a modest contraction with respect to pre-pandemic levels. The relatively small coefficient observed for individuals aged 85 or over might be explained both by a higher incidence of mortality within this population group, and by the fact that this group has been significantly exposed to Covid-19 and account for half of Covid-related hospital admissions (https://covid19.infn.it/iss/), thus receiving most treatments within this setting. Interestingly, individuals aged 60 to 79 have significantly lower mortality rates and are also less likely to develop severe complications, so that part of the notable reduction in outpatients observed within this age group might be explained by demand-side factors - i.e. postponing non-urgent care to avoid Covid-19 infection. The interpretation of the above results in terms of avoided care is also supported by the fact that supply limitations introduced in March 2020 by the local government explicitly excluded outpatient and inpatient care for chronic patients, whose incidence is highest among the oldest age groups.[14] This is also consistent with our findings suggesting a smaller drop in outpatients among individuals with chronic conditions, relative to other patients, irrespective of the type of treatments. Finally, the effect of Covid-19 on emergency outpatients is more heterogeneous across age groups with respect to ordinary and screening tests.

Looking at differences across diagnostic categories, the most significant drop is observed for Diagnostic Imaging across all types of outpatients, which is likely to be explained by the reallocation of most resources to Covid-19 cases, mainly treated within hospital settings (thus not observed in the outpatients sample) and that generated a large demand of chest-X-rays and assimilated procedures. For screening tests, the drop in the provision of outpatients in almost exclusively attributable to this category of treatments. The same explanation also applies to the reduction in the provision of ordinary outpatients for Pulmonology and Otorhinolaryngology, as most of Covid-19 symptoms fall in these specialties and often caused patients' hospitalization, particularly for most exposed individuals (who were also likely to have regular patterns in the use of outpatient treatments before the pandemic). Ophthalmology also experienced a large decline after the outbreak of Covid-19 both in ordinary outpatient treatments and among outpatients provided as emergency care, while orthopedics and cytology/microbiology declined by a relatively smaller amount. Overall, heterogeneous patterns across diagnostic categories reflect both the disruption in the provision of elective care and a reduced demand for non-urgent health care.

In order to disentangle the contribution of containment measures from that of the intensity of the pandemic to the overall variation in the volume of outpatients associated with the pandemic, we exploit data on the number of Covid-19 cases and deaths recorded in each municipality/zip code and week of the period of interest. On the one hand, an increase in the number of Covid-19 cases might reduce outpatient care, both due to demand-side factors (care avoidance due to fear of infection) and to the supply limitations to prevent hospital

[13] The unit of observation in this and following exercises exploring the role of mortality is the municipality (not municipality/zip code) as external data on excess mortality are only available at this level of aggregation. Note that with this cell specification we lose significant data variation – as the Milan municipality with 38 zip codes only accounts for one cell –, leading to inflated standard errors (clustered at the municipality level) in the estimated coefficients of the event study specification.

[14] https://www.dati.lombardia.it/Sanit-/Dataset-Popolazione-Cronica-Regione-Lombardia/siyc-rtsu/about_data

Table 2
Effect of Covid-19 exposure and policy response on outpatient care.

PANEL A	Total outpatient treatments				Ordinary outpatient treatments			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PR1			−403.1***	−399.1***			−287.5***	−283.3***
			(28.79)	(28.03)			(20.29)	(19.71)
PR2			−1,008***	−866.2***			−800.0***	−685.8***
			(75.87)	(61.94)			(60.81)	(49.66)
PR3			−330.0***	−64.83***			−230.0***	−20.16
			(25.35)	(18.96)			(18.32)	(15.79)
PR4			−371.4***	−113.4***			−231.3***	−47.49***
			(28.33)	(19.08)			(18.25)	(12.66)
PostCovid	−481.7***	−305.7***			−349.2***	−215.9***		
	(36.25)	(24.99)			(26.72)	(18.34)		
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Week FE	✓	✓	✓	✓	✓	✓	✓	✓
Municipality/zip code FE	✓	✓	✓	✓	✓	✓	✓	✓
Covid-19 cases FE		✓		✓		✓		✓
Covid-19 deaths FE		✓		✓		✓		✓
N	42,042	42,042	42,042	42,042	42,042	42,042	42,042	42,042
R^2	0.914	0.921	0.920	0.929	0.896	0.902	0.903	0.911

PANEL B	Emergency outpatient treatments				Screening outpatient treatments			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PR1			−106.3***	−106.7***			−9.306***	−9.101***
			(8.465)	(8.358)			(0.849)	(0.835)
PR2			−189.1***	−164.7***			−18.50***	−15.77***
			(14.36)	(11.91)			(1.379)	(1.152)
PR3			−92.94***	−42.42***			−7.058***	−2.244***
			(6.989)	(4.424)			(0.730)	(0.580)
PR4			−134.0***	−62.61***			−6.136***	−3.303***
			(10.21)	(7.940)			(0.824)	(0.622)
PostCovid	−123.2***	−83.39***			−9.304***	−6.506***		
	(9.271)	(7.786)			(0.837)	(0.630)		
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Week FE	✓	✓	✓	✓	✓	✓	✓	✓
Municipality/zip code FE	✓	✓	✓	✓	✓	✓	✓	✓
Covid-19 cases FE		✓		✓		✓		✓
Covid-19 deaths FE		✓		✓		✓		✓
N	42,042	42,042	42,042	42,042	42,042	42,042	42,042	42,042
R^2	0.919	0.935	0.922	0.940	0.610	0.629	0.617	0.637

* p < 0.1, ** p < 0.05, *** p < 0.01; robust standard errors in parentheses, clustered at the municipality/zip-code level.

overcrowding. On the other hand, the spread of the pandemic leads to the implementation of mobility restrictions and SIP policies, which in turn reduce healthcare utilization. In order to isolate the effect of containment measures on the provision of outpatient care, a set of additional controls capturing the weekly cumulative number of Covid-19 cases and Covid-related deaths are added to Eq. (2). Results obtained from this specification (Eq. (3)) are reported in column (2) of Table 2 and suggest that the introduction of mobility restrictions and social distancing policies is associated with a reduction of almost 306 outpatient treatments, a relative decrease of 24 percent with respect to the pre-pandemic sample average. Thus, controlling for the trajectory of the pandemic reduces the impact of mobility restrictions and social distancing measures on outpatient care by 37 percent. This result is consistent across all types of outpatient treatments (columns 2 and 6 of Panels A and B), with a slightly larger (smaller) drop in the coefficient observed among emergency (screening) treatments. These results, and especially the significant reduction observed also on emergency outpatient treatments, might bear significant policy implications. If mobility restrictions implemented to reduce Covid-19 circulation have a negative impact also on the provision of non-deferrable and necessary health care, then they might impose some costs in terms of delayed or forgone care (which in turn might translate into higher costs for the NHS due to long-term detrimental health effects) and lead to additional efforts to restore pre-pandemic levels of health care.

When we split the PostCovid$_{w,t}$ dummy into four period indicators according with the trajectory of the pandemic and the associated policy responses, results show that the overall reduction in outpatient treatments (provided in each setting) is largest during the lock-down period (columns 3 and 7 of Table 2), but is persistent across all periods. When we control for Covid-19 exposure (cols 4 and 8), we find that the effect of mobility restrictions and SIP policies is much larger in the first period after Covid-19 outbreak, until early may 2020, as the coefficient of $PR1$ is virtually unchanged and $PR2$ is reduced by less than 15 percent across all types of outpatient treatments. However, focusing on the period following the end of the lock-down ($PR3$), controlling for Covid-19 exposure reduces the effect on total outpatients by 80 percent (53 and 46 percent for outpatients provided as emergency care and for screening tests, respectively), and it is not statistically different from zero for ordinary outpatient treatments, suggesting that changes in health-seeking behaviors among individuals are persistent throughout the period of interest. The difference between the coefficients of $PR3$ in the two specifications might also be suggestive of some supply-side effect. During this period, restrictive measures regarding mobility and social distancing were gradually relaxed (explaining the significant reduction in the coefficient of $PR3$, net of Covid-19 exposure), so that the drop in outpatients can be mostly attributable to the trajectory of the pandemic, which is however characterized by a very low number of Covid-19 cases and deaths. In this setting, the overall effect of the pandemic (coefficient of $PR3$ in column 7) is also likely to capture the differential exposure to Covid-19 in the previous months and the congestion effect on healthcare facilities, with an associated contraction in the provision of non-urgent care.

Finally, in an additional exercise we explore whether the overall decline in outpatient treatments found above can be attributed to a decrease in the number of patients or to a lower volume of treatments provided for the same individuals. A lower number of individuals

Table 3
Decomposition of the overall variation in outpatient treatments.

Quarter	Total treatments	Δ% Total treatments	N. of individuals at least one treatment	Δ% N. of ind. at least one treatment	Average n. treatments	Δ% Average n. treatments
1 - 2020	3,180,459	−22.53	1,036,444	−16.12	3.0686	−7.63
2 - 2020	2,039,131	−49.08	663,203	−45.76	3.0747	−6.12
3 - 2020	2,957,588	−10.66	934,227	−11.33	3.1658	0.75
4 - 2020	3,117,140	−24.18	1,006,488	−18.63	3.0970	−6.82
1 - 2021	3,243,530	−20.99	1,004,540	−18.71	3.2289	−2.81
2 - 2021	3,440,273	−14.08	1,067,579	−12.68	3.2225	−1.60

The Table reports (i) col. 2 — the volume of outpatient treatments provided to individuals receiving at least one treatment in each quarter of the period Jan 2020–Jun 2021; (ii) cols.4 and 6 — the number of individuals receiving at least one treatment in each quarter and the average number of treatments provided; (iii) col.3 — the quarterly percentage change in the volume of outpatients with respect to the average 2018–2019 for this sample; (iv) cols.5 and 7 — the quarterly percentage change in the number of individuals receiving at least one treatment and in the average number of treatments provided.

resorting to healthcare facilities might be interpreted as avoided care, due to fear of infection or in response to social distancing policies. On the other hand, if the drop in outpatient care is more supply- than demand-driven, we might expect individuals visiting healthcare facilities receiving on average a lower volume of treatments during the pandemic (congestion effects induce much longer waiting times so that a lower volume of treatments might be prescribed by the doctor and/or provided to patients).

We thus compare, over six consecutive quarters (Q1-2020 to Q2-2021), the percentage changes with respect to the 2018–2019 mean of various key metrics: the number of individuals who received at least one treatment, the total volume of outpatient treatments provided to this subsample of the population, and the average number of treatments. Results from this exercise are reported in Table 3). Overall, the second quarter of 2020 records the largest drop in outpatient treatments, with an almost 50 percent reduction with respect to the same period before Covid-19 outbreak, followed by a 24 percent decrease during the second wave of the pandemic in the fourth quarter of the same year. Interestingly, the time pattern of the variation in the number of individuals with at least one treatment per quarter is very close to the overall variation, with a 46 percent gap during Q2-2020, with respect to the 2018–2019 average over the same period, and an almost 19 percent reduction over the second wave of the pandemic. Conversely, average treatments for the same individuals decreased by 6–7 percent in each pandemic wave, and the percentage change with respect to the pre-pandemic average is very small (and positive) during summer 2020.

Overall, although we cannot fully disentangle the role played by demand and supply factors in shaping the variation in outpatient care associated with the pandemic, the results presented in the above sections suggest that avoided care might be a significant driver. The overall reduction in outpatients in fact appears to be related with a decrease in the number of patients rather than a decrease in the intensity of outpatient care use, is significant also for chronic patients (that should have been unaffected by supply limitations imposed by the local and national government) and is observed also for emergency outpatient treatments.

4.3. Cumulative loss of outpatient treatments

In this final section of the paper we explore the cumulative loss in outpatient treatments associated with the pandemic as well as the accumulated delay in the provision of these services.

We assess the extent of outpatient treatments lost during the pandemic comparing cumulative treatments provided between January 2020 and June 2021 on a weekly basis with the average weekly number of cumulative treatments provided in the years 2018 and 2019.[15] The percentage change in cumulative outpatients for the period Jan 2020-Jun 2021 with respect to average in the pre-pandemic years is plotted in Fig. 4. All outpatient treatments – be they ordinary, emergency, or screening tests – show a consistent decline of approximately 25 percent in cumulative figures by mid-2021, confirming a lasting effect of Covid-19 on outpatient care and a persistent deviation from pre-pandemic figures. Using the same figures we are also able to assess the accumulated delay in the provision of outpatients in "standard months", i.e. the number of months of activity that would be necessary to offset the delay if the volume of outpatients provided is comparable with the pre-pandemic period, i.e. the 2018–2019 average number of weekly outpatient treatments (Mantellini et al., 2020). The calculation involves a multiplication of the average percentage reduction in the volume of outpatients over a specific period, with the number of months in the time interval. On average, from January 2020 to June 2021 the accumulated delay is around 4.5 standard months. In other words, assuming that starting from June 2021 the provision of outpatient treatments follows a trajectory mirroring "normal times" — the average number of treatments provided in 2018–2019 —, it would take approximately 19 weeks to fully recover all the lost treatments. Alternatively, if we consider more optimistic scenarios, where the provision of outpatients is increased by 10 or 20 percent with respect to pre-pandemic levels, the recovery period shrinks approximately to 18 and 16 weeks, respectively.[16]

5. Conclusions

The Covid-19 pandemic has left an indelible mark on global societies, reshaping various facets of daily life. In this paper, we show evidence of a negative and lasting impact of Covid-19 on the provision of outpatient care in the Metropolitan Area of Milan, in Lombardy. Using rich administrative data from the Agency for Health Protection of the Metropolitan Area of Milan for the period January 2018 and June 2021, we estimate a 37 percent average weekly reduction (with respect to pre-pandemic average) in the provision of outpatient treatments associated with the Covid-19 pandemic, which is largest for preventive care (−50 percent) but consistent across all types of outpatients (−35 percent for ordinary and −45 for emergency outpatients). Such contraction was only partially recovered, revealing an enduring effect of the pandemic on outpatient care. Overall, a decline of approximately 25 percent in cumulative outpatients is observed until the end of the period of interest and the accumulated delay in the provision of care is estimated around 4.5 standard months. Results are robust to several exercises to address possible concerns related with sample mortality and are heterogeneous across population groups.

Although an inherent limitation of our study is the lack of indivi dual-level data, that would represent the most suitable setting for the investigation of health-seeking behaviors throughout an epidemic, we exploit the variation in outpatient care across population groups and in

[15] Note that for the first 26 weeks of 2021 we keep the cumulative figures by adding the corresponding mean values from the years 2018 and 2019. This adjustment ensures a valid basis for comparison.

[16] These figures are calculated as the ratio between the total number of outpatient treatments lost from January 2020 to June 2021 and the average weekly number of treatments during the 2018–2019 years, increased by 10 and 20 percent.

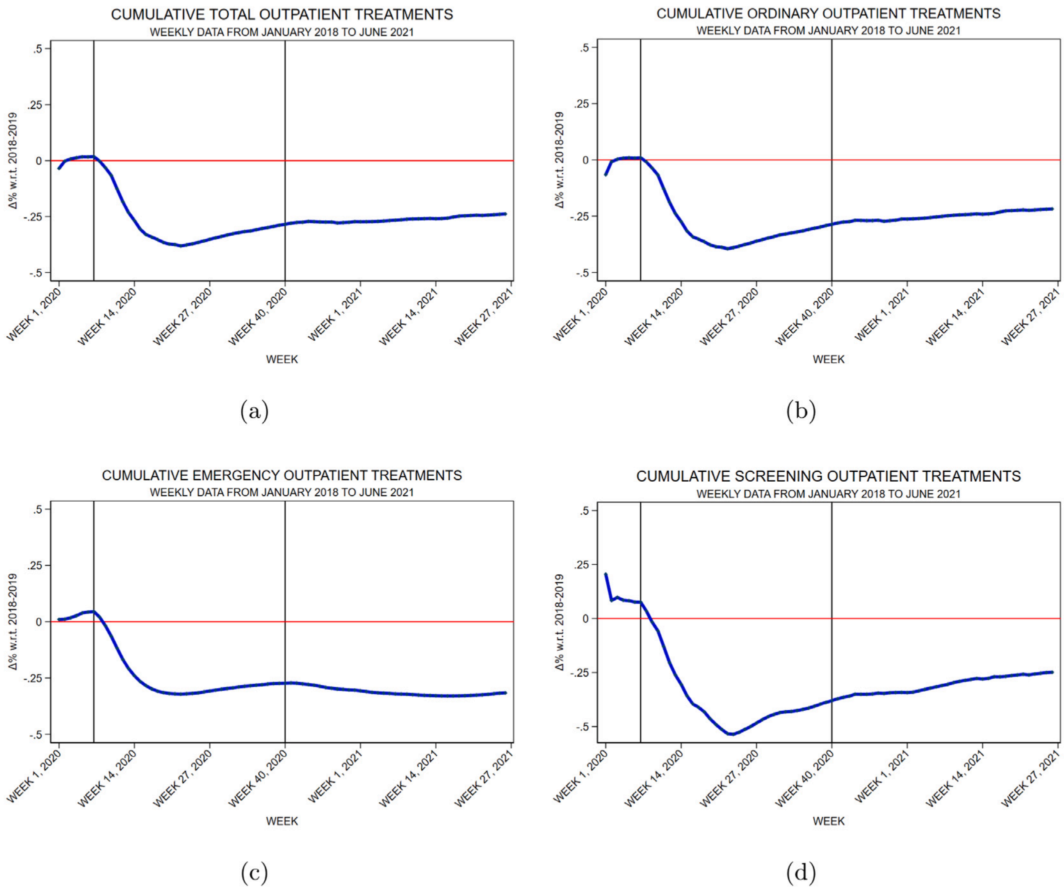

Fig. 4. Cumulative Outpatient treatments.
Note. Each panel plots the percentage change in cumulative outpatient treatments (one panel for each category of outpatients) over the period Jan 2020–Jun 2021, with respect to average cumulative treatments in the years 2018–2019. Vertical lines correspond to the introduction of the first set of mobility restrictions and social distancing policies in Lombardy (week 7 of 2020) and the beginning of the second pandemic wave (week 40 of 2020).

the intensity of the contagion effects over the different waves to analyze the behavioral response of individuals facing the risk of infection and restricted access to health care. We find that mobility restrictions and SIP policies account for a large part of the reduction in outpatient treatments in the immediate aftermath of Covid-19 outbreak, while after the end of the lock-down the reduction in outpatients is mostly driven by behavioral factors, triggered by care avoidance, and congestion effects on healthcare facilities (with an associated contraction in the provision of non-urgent care).

While we are not able to fully disentangle demand and supply drivers of the overall variation in outpatient care, our findings suggest that, beyond the disruption in healthcare provision on the supply side and the congestion effects, changes in health-seeking behaviors played a crucial role in determining the volumes of outpatient treatments during the pandemic, as individuals postponed non-urgent care as a result of both fear of Covid-19 infection and social distancing policies. Although the latter policies have been proven effective in the containment of Covid-19 diffusion, our results reveal that they might also bear additional costs in terms of delayed or forgone care, which in turn might translate into higher costs for the NHS due to potential detrimental health effects in the long run.

Another possible limitation of our study has to do with its external validity. While limited in terms of geographical extension, we would argue that the Metropolitan Area of Milan provides a good example of large densely populated area, mixing large urban areas as well as rural municipalities. Also, this area is where the Covid-19 pandemic all started outside China, thus providing a clean natural experiment for the analysis of both individual behavior and public health policies, with lessons to be learned in terms of the effects across pandemic waves and heterogeneity across different population groups.

Overall, our findings have important implications for the provision of health care, policy formulation, and resource allocation in the aftermath of the pandemic. On the supply side, the estimated 25 percent drop in cumulative outpatients over the period, with almost 20 weeks of accumulated delay in the provision of the latter, suggests that a substantial effort should be made in defining more efficient emergency protocols and models of territorial medicine to ensure the continuity of care, especially for fragile and chronic patients. On the other hand, evidence of care avoidance related with fear of infection and social distancing policies calls for more careful strategies for a rapid and effective communication of health risk information during adverse public health crises, particularly when an overabundance of (often misleading) information are immediately available on digital communication platforms.

Finally, additional effort should be made by future research to separately identify demand and supply factors, to guide policymakers in designing the most suitable policies, as well as to assess long-term effects of the estimated contraction in outpatient care on population health.

CRediT authorship contribution statement

Federico Franzoni: Writing – original draft, Software, Methodology, Investigation, Formal analysis, Data curation. **Claudio Lucifora:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Investigation, Funding acquisition, Conceptualization. **Antonio Giampiero Russo:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization. **Daria Vigani:** Writing – review & editing, Writing – original draft, Software, Methodology, Investigation, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.ehb.2025.101497.

Data availability

The data that has been used is confidential.

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