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KEYWORDS

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This paper studies the causal effect of ultra-broadband (UBB) diffusion on healthcare utilization in Lombardy, Italy, between 2015 and 2019.
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Using rich administrative data on outpatient diagnostic services and emergency room (ER) visits, we analyze how increased internet availability affects healthcare-seeking behavior.
Our results show that higher UBB coverage leads to a significant increase in outpatient diagnostic activity, with heterogeneous effects across diagnostic technologies and stronger responses among older individuals. At the same time, UBB expansion is associated with a reduction in ER utilization, particularly in inappropriate visits among younger individuals.
Overall, the results are consistent with a behavioral mechanism in which improved access to online health information increases diagnostic demand while reducing reliance on emergency care.
These findings highlight the role of digital infrastructure in shaping healthcare utilization patterns and have important implications for health policy in increasingly connected health systems.

The “Dr Google” Effect: Online Health Information and Its Implications *

Berta P.[†], Guerriero C.[‡], Moccia S.[§], Muzzi S.[¶], Sabatino L.[‖]

October 2025

Abstract

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1 Introduction

The internet has become a primary source of health-related information for millions of people across the world. The use of the internet for health-related information, commonly referred to as consulting "Dr Google", has changed how patients engage with their health care system and, in particular, with healthcare providers. In contexts of uncertainty or limited access to medical professionals, the internet is increasingly considered a practical tool for healthcare planning and decision-making (Link et al., 2022; Di Novi et al., 2024). The growing use of web-based health information in the healthcare context is not limited to self-diagnosis. Results of a study conducted in the UK suggest that online health searches are often driven by three complementary reasons: supportive role in health decision (e.g., patients comparing treatment options before choosing a therapy), a stimulating role (e.g., online information motivating patients to adopt healthier lifestyles or seek medical advice), and an interactional role (e.g., patients using online information to ask informed questions during consultations) which impacts the patient-doctor relationship (Bussey and Sillence, 2019). The consequences of this trend are mixed, shaped by a complex interaction between patient characteristics, information quality, and clinical context.

In the United States, survey data indicate that nearly nine out of ten citizens look up their symptoms on the internet before contacting a doctor (Eligibility.com, 2019). This practice is often motivated by the desire to gauge how serious a condition might be before deciding whether professional care is necessary (Eligibility.com, 2019). A similar trend has been documented across Europe, where reliance on digital tools for health-related purposes has systematically grown. According to Eurostat, in Finland, 82% of individuals search online for health information and almost four out of five consult their medical records digitally (Eurostat, 2025).

Italy shows a comparable, though somewhat delayed, trajectory. The most recent survey reports that 62% of Italians between the ages of 16 and 74 search online for health information, a striking increase compared with 32% in 2013 (Eurostat, 2025). A potential key factor contributing to Italy's relative delay is the slower development of UBB infrastructure, compared with more digitally advanced countries such as Finland, where digital connectivity and related services have evolved earlier.

With the rapid diffusion of the "Dr. Google" phenomenon, scientific research is increasingly investigating its potential positive and negative consequences, revealing both advantages and limitations. Patients using online resources tend to arrive at medical visits better informed and more engaged (Powell et al., 2011). Qualitative evidence suggests that patients use online resources to be reassured, increase their understanding of symptoms and potential treatments, and prepare for consultations. Internet use appears to function mainly as a complement to doctor visit rather than a substitute, with patients often using online information as "homework" to support informed decision-making (Powell et al., 2011). With respect to the patient-physician relationship: patients using online resources tend to arrive at medical visits better informed and more engaged (Tan and Goonawardene, 2017). Evidence suggests that the doctor's reaction also matters. When physicians respond respectfully, they are more likely to foster trust and collaboration. Conversely, if patients feel dismissed, especially when online information conflicts with professional advice, the relationship can be undermined. However, this appears to be relatively uncommon, as only around 8% report a decline in trust in their physicians as a result of online searching (Newnham et al., 2006).

Nevertheless, this phenomenon is not without its drawbacks. One of the most prominent concerns is cyberchondria, defined as repeated and compulsive internet searches for medical information, often resulting in heightened anxiety or panic (Jungmann et al., 2020; McMullan et al., 2019). Age seems to play a role in the relationship between online health information seeking and anxiety outcomes. In the meta-analysis conducted by McMullan et al. (2019)studies involving older participants showed a stronger relationship, suggesting that online symptom searches may be more likely to amplify distress among elderly individuals. Many physicians report an increase in the proportion of older patients who arrive at appointments requesting specific diagnostic tests or medications, often based on what they have searched online (Tan and Goonawardene, 2017).

In addition, the tendency to self-diagnose and self-medicate based on unreliable or misunderstood online content can lead to inappropriate and costly diagnostic testing, as well as delays in receiving appropriate care for those who do need them. This tendency may be especially evident in publicly funded healthcare systems, such as Italy's, where diagnostic services are largely free at the point of use. This lowers barriers for patients to request unnecessary tests and may lengthen waiting times for those with legitimate medical needs.

The objective of this study is to assess whether increased access to online health information, the so-called "Dr Google" effect, increases demand for primary care and, in turn, greater utilization of diagnostic medical services. While we do not directly observe General Practitioner (GP) visits, we exploit detailed information on GP-issued diagnostic prescriptions, which represent a close and policy-relevant proxy for primary care interactions.

Using a unique dataset combining medical diagnostic prescriptions, ER visits and UBB coverage across Lombardy between 2015 and 2019, we estimate the causal impact of internet expansion on the volume of diagnostic prescriptions, including magnetic resonance imaging (MRIs), computed tomographies, sonograms, and ER utilization.

In our analysis, we use UBB coverage, measured as the percentage of households with access to UBB connections, as it captures the supply-side expansion of infrastructure. Municipalities experiencing greater growth in coverage record higher volumes of diagnostic prescriptions overall, with robust effects for both general prescriptions and, to a lesser extent, technologically intensive procedures such as MRIs, tomographs, and sonograms. These findings support the interpretation that the structural expansion of digital infrastructure provides individuals with broader opportunities to access online health information, thereby fueling precautionary demand for medical tests.

A central feature of our analysis is the stratification of patients into two age groups, 25–55 years and over 65 years, in order to capture systematic differences in exposure to and use of online health information. Younger adults are more likely to be active users of UBB and are therefore more frequently exposed to digital health content, including misinformation, which can fuel precautionary demand for discretionary diagnostic procedures such as sonograms and tomographs. In contrast, previous studies show that older individuals are less likely to go on-line; nevertheless, health information seeking is increasingly common among them (Lee and Jang, 2022; Di Novi et al., 2024; Powell et al., 2011; D'Andrea et al., 2023). By comparing two cohorts, we want to disentangle demand driven primarily by digital engagement from demand associated with age-related health needs and chronic disease management.

The uniqueness of our dataset, linking individual-level diagnostic prescriptions to detailed information on both patients and their GPs, further allows us to explore heterogeneity in UBB effects across both patient- and provider-related dimensions. There is emerging evidence that being female is a significant predictor of searching for health information on the internet (Bidmon and Terlutter, 2015; Rice, 2006). We further investigate whether the impact of UBB access varies by patient gender, in light of prior evidence documenting systematic differences in health information seeking behavior between men and women, and by GP characteristics, including physician workload (measured by the number of patients under their care) and the duration of the GP–patient relationship.

Our results show that improved internet access leads to a substantial increase in diagnostic activity while simultaneously reducing inappropriate or excessive ER visits. Younger individuals (25–55) respond to increased UBB access mainly by reducing emergency room use, particularly inappropriate visits, while showing more moderate and mixed effects on diagnostic services, including declines in MRIs and sonograms and small increases in tomograph use. On the other hand, older individuals (65+) exhibit a strong and consistent increase in diagnostic utilization across all technologies following UBB expansion, while the effects on ER visits are weaker.

The heterogeneity analysis indicates that UBB's effect on diagnostic utilization is not uniform but varies across both patient and physician characteristics. Consistent with previous studies, women particularly older women experience larger increases in prescriptions. In contrast, for younger men, internet use is associated with a reduction in overall prescriptions, as well as decreased utilization of MRI and sonographic imaging. This result is consistent with qualitative studies surveys results suggesting that suggesting that age may influence how online health information impacts users. According to (McMullan et al., 2019) for younger patients with health anxiety searches may be less likely to escalate anxiety and they may feel more reassured.

Turning to supply side characteristics, physician related factors and particularly GP workload and GP switching also play a significant role in the effect of Dr Google. For those physicians managing moderately sized patient panels (fewer than 1500 registered patients) greater exposure to online health information may translate into increased demand for diagnostic procedures. Conversely among GPs with heavier workloads, UBB coverage is associated with either negligible or even negative changes in diagnostic prescriptions.

When comparing individuals who remain with the same GP throughout the period to those who change their GP at least once between 2015 and 2021 (a proxy for the strength of the patient doctor relationship) we find distinct patterns. For younger patients with a stable GP relationship, higher UBB coverage is associated with lower diagnostic prescriptions and fewer ER visits. By contrast, among older individuals with a stable relationship with their GP, internet use is associated with increased diagnostic utilization across all technologies as well as higher ER visit rates. Taken together, these findings suggest that UBB expansion heightens patient demand, but the extent to which this translates into diagnostic use is mediated by patients and physician characteristics, including age, gender, physician workload, and the relationship the GPs establish with their patients.

This article makes several contributions to the growing literature on digital health behavior and healthcare utilization. Earlier research has documented the widespread practice of online symptom checking and self-diagnosis (see Powell et al. (2011); McMullan et al. (2019); Tan and Goonawardene (2017)) however, there remains a lack of rigorous causal evidence on how this behavior affect the use of medical services. In particular, concerns about cyberchondria-associated overuse of healthcare services, have been highlighted in prior psychological and clinical studies (Starcevic and Berle, 2013). A previous study conducted by Di Novi et al. (2024) related UBB expansion with online health information seeking and subsequent healthcare use. Using evidence from 13,829 Europeans aged 50+, shows that greater regional broadband coverage increased the probability of searching for health information online, which in turn raised doctor visits by about 6% (Di Novi et al., 2024). The study also found a dual effect: while online information seeking directly improved self-perceived health, its indirect effect through increased medical consultations often worsened health perceptions, especially among the 50–69 age group. While Di Novi et al. (2024) focus on survey data linking broadband access, information seeking, and perceived health outcomes, the present study provides causal evidence that broadband availability drives higher use of discretionary diagnostic services, consistent with cyberchondria mechanisms. Taken together, these two sets of results reinforce the conclusion that broadband (and UBB) availability acts as a structural driver of both online health information seeking and increased utilization of diagnostic healthcare services, while reducing emergency room utilization.

Empirically, we provide novel evidence from a large high income European region, Lombardy in Italy, documenting the relationship between diagnostic procedures, ER visits, and UBB coverage. Overall, we find a positive association between increased UBB availability and diagnostic testing, alongside a negative association with ER visits. The robustness checks, which exclude Milan and implement a randomization-based placebo test, confirm that the main findings are not driven by urban outliers or spurious correlations, thereby reinforcing the causal interpretation of the results. In conclusion, these findings support the hypothesis that access to online health content, regardless of its accuracy, can meaningfully influence real world healthcare decisions. Our results contribute to ongoing policy debates on the unintended consequences of digital access in healthcare and underscore the importance of interventions aimed at improving online health literacy and mitigating potential overuse in publicly funded health systems.

The remainder of the paper is structured as follows. Section 2 describes the institutional and healthcare context of Lombardy and outlines the key features of the Italian National Health Service. Section 3 presents the evolution of UBB diffusion in Italy, with a specific focus on Lombardy. Section 4 describes the data sources, including detailed information on UBB coverage and administrative healthcare records. Section 5 introduces the empirical methodology, highlighting the use of a difference-in-differences estimator for continuous treatments. Section 6 provides descriptive statistics on healthcare utilization across different levels of UBB coverage. Section 7 presents the main results on outpatient diagnostic services and emergency room utilization. Section 8 explores heterogeneity in the effects by patient gender, GP workload, and GP switching behavior and illustrates the results for the very old (over 75). Section 9 reports a series of robustness checks. Finally, Section 10 discusses the findings, draws policy implications, and outlines directions for future research.

2 Institutional Background

The Italian National Health Service (NHS) guarantees universal access to healthcare for all citizens. Established in 1978 through Law 833/1978, the Italian NHS is a Beveridge-type system, founded on the principles of equity and universality and financed primarily through general taxation.

Since its establishment, the NHS has undergone several reforms aimed at improving efficiency and effectiveness. The most significant institutional changes occurred in the 1990s, when major reforms introduced a higher degree of decentralization, granting regional governments substantial autonomy in the organization and delivery of healthcare services.

Today, the NHS is structured across three administrative levels: national, regional, and local. At the national level, the Ministry of Health defines general policy objectives and minimum service standards. Regional governments are responsible for organizing and managing healthcare delivery within their territories, while local implementation is carried out by Local Health Authorities (Aziende Sanitarie Locali, ASLs) and accredited healthcare providers. This multi-level governance structure ensures compliance with national standards while allowing regions to adapt service provision to local needs.

GPs play a central role within the Italian healthcare system, acting as the primary gatekeepers to both outpatient and hospital services. GPs are self-employed professionals contracted by the NHS and remunerated mainly through a capitation scheme based on the number of registered patients, complemented by additional payments linked to specific services and performance targets. They are responsible for initial diagnosis and for prescribing most outpatient diagnostic services. Prescriptions for high-cost imaging procedures such as MRI, computed tomography, and selected ultrasound examinations, are also issued by GPs, but are subject to national and regional appropriateness guidelines. Once an electronic prescription is issued, patients must book the examination through the centralized booking system (Centro Unico di Prenotazione, CUP), which enforces regulatory constraints on timing and priority.

Emergency medical services are an integral component of the NHS and provide pre-hospital emergency care, including ambulance dispatch and transportation to hospitals. ER access is unrestricted and does not require referral from a GP. As a result, ER utilization may reflect both urgent medical needs and inappropriate use for non-urgent conditions, making it a relevant outcome for analyzing behavioral responses to information and access to alternative forms of care.

Emergency medical services are an integral part of the National Health Service (NHS) and provide emergency care, including ambulance dispatch and transport to hospital facilities. Access to emergency rooms (ERs) is free and does not require a referral from a general practitioner (GP). As a result, ER utilization reflects at the same time both urgent medical needs and inappropriate use for non-urgent conditions, making it a relevant outcome for studying behavioral responses to information and to the availability of alternative forms of care.

This study focuses on Lombardy, the largest region in Italy, accounting for approximately 16% of the national population and representing one of the most economically advanced and highly educated regions in Europe. With around 10 million residents, Lombardy is comparable to mid-sized European countries such as Portugal or the Netherlands. The regional healthcare system is among the largest in Italy, comprising roughly 150 hospitals and accounting for about 1.3 million hospital discharges annually. Total healthcare expenditure amounts to approximately €20 billion per year, representing nearly 75% of the regional budget.

Lombardy's healthcare system operates under a quasi-market model introduced by the regional reform of the late 1990s, which allows citizens to freely choose among public, private for-profit, and private not-for-profit accredited providers. Hospitals are reimbursed through a prospective payment system based on diagnosis-related groups, subject to annual budget caps set by the regional administration. Within this framework, the Lombardy regional authority is responsible for monitoring provider performance and enforcing quality standards through an accreditation system (Brenna, 2011).

This institutional setting, characterized by universal coverage, strong gatekeeping by GPs, regulated access to diagnostic services, and unrestricted ER access, provides a particularly suitable environment for studying how changes in information access, driven by the diffusion of UBB infrastructure, affect healthcare-seeking behavior. In particular, it allows us to distinguish between changes in planned outpatient diagnostic utilization and potential substitution away from emergency care.

3 Ultra-Broadband Development in Italy and Lombardy

The diffusion of internet connection (broadband and UBB) in Italy has been characterized by significant regional and temporal disparities, reflecting broader structural and institutional inequality within the country. At the beginning, in the early 2000s, broadband access was primarily based on Digital Subscriber Line (DSL) technologies, which operated over the traditional copper telephone network, with speeds of up to 20 Mbps. Later, the development of UBB connection guaranteed a more sophisticated technology capable of delivering internet connection at higher speeds. These technologies include Fiber to the Home (FTTH), Fiber to the Cabinet (FTTC), and Very-high-bit-rate DSL (VDSL), with FTTH providing the highest connection speeds, exceeding 1 Gbps.[1] Coverage and adoption were limited in the early years, and by 2015 they remained very low in several Italian municipalities compared to the European average (79.9%)(European Commission, 2016).

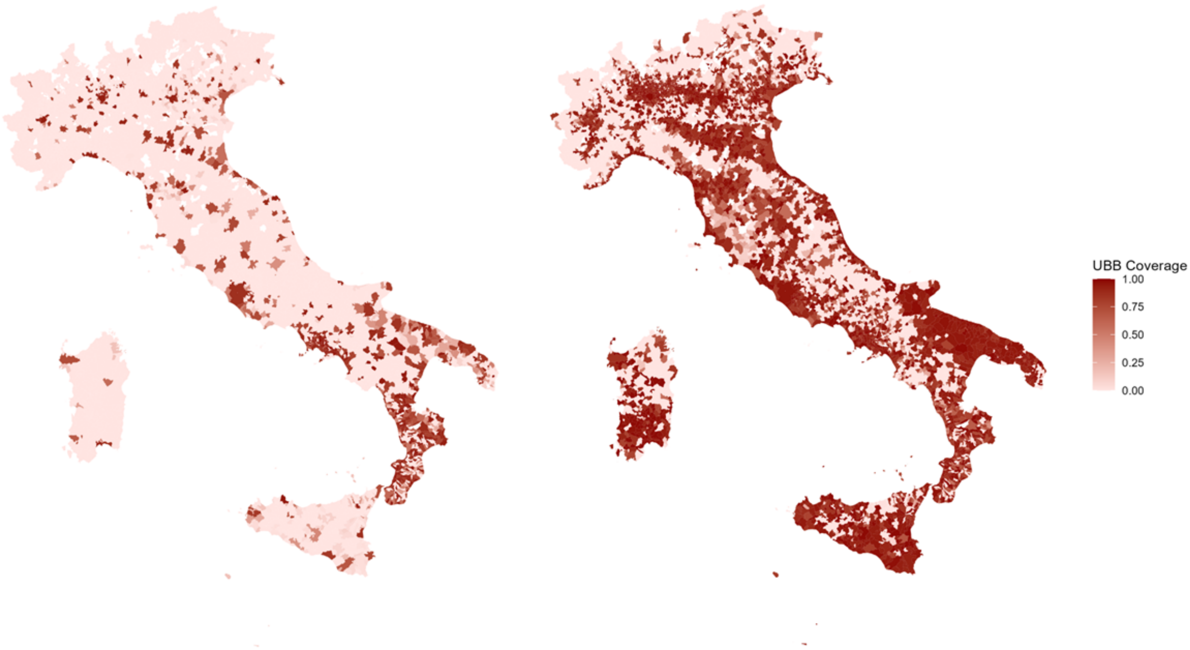


Figure 1. Ultra-broadband coverage in Italian municipalities (2015, left graph; 2019, right graph)

[1]In more detail, the several technologies for internet connection are: *I)* DSL (ADSL): technology using the traditional copper telephone line from the central office to the user; distance strongly affects the speeds of connection. *II)* VDSL: an evolution of DSL that still based on copper but achieves higher performance, frequently combined with fiber up to the street cabinet. *III)* Fiber to the Cabinet (FTTC): fiber arrive at the street cabinet, while the final stretch to the home is copper; provides intermediate speeds. *IV)* Fiber to the Building (FTTB): fiber reaches the building, then internal cabling distributes the connection to individual apartments. *V)* Fiber to the Home (FTTH): fiber arrive directly inside the home, offering very high connection speeds. *VI)* Fiber to the Premises (FTTP): a general term covering all fiber connections up to the customer premises, including FTTH and FTTB.

Figure 1 highlights the evolution of UBB coverage over the period under study, focusing on two benchmark years: 2015 and 2019. The maps show a substantial expansion in coverage, measured by share of households covered by UBB across Italian municipalities. In 2015, coverage was generally limited, with many areas remaining below 40%. By 2019, coverage levels were high across most of the country, with several municipalities surpassing 80%.

This change reflects the action taken by the Italian government to resolve the uneven development of UBB with the *National Ultra-Broadband Strategy* launched in 2015.

Between 2015 and 2019, although the general progress recorded in Italy, the beat and extent of this progress varied noticeably across macro-regions. The share of municipalities covered by UBB increased nationally from about 8% in 2015 to more than 42% in 2019. In the Southern regions, this share raised from 17% to nearly 52%, while the North-West remained the most disadvantaged area, improving from roughly 3% to 32%. A similar pattern appear when considering population-weighted broadband coverage: national access increased from 40% to 80% of residents, with the Center and South reaching the highest levels by 2019.[2]

Zooming on Lombardy, which is the region of interest for our empirical analysis, UBB diffusion in 2015 was characterized by marked disparities across municipalities although overall the region outperformed the national average. In 2015, about 6% of municipalities was covered by UBB, covering 42% of total population in Lombardy. Indeed, urban centers, particularly Milan and provincial capitals, benefited from early deployment of FTTH, while smaller municipalities in mountain valleys (e.g. Como, Lecco, and Sondrio) were still uncovered by 2015.

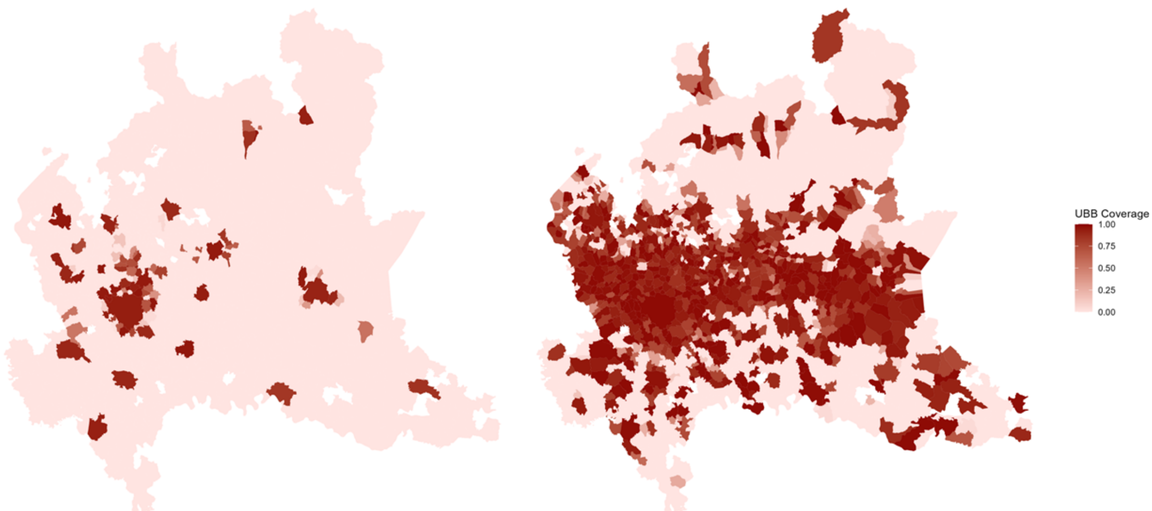


Figure 2. Ultra-broadband coverage in Lombardy municipalities (2015, left graph; 2019, right graph)

[2]Supplementary information on these shares can be found in Table A1 in the Appendix.

By 2019, UBB coverage in Lombardy had reached nearly universal levels: the share of municipalities covered by UBB jumped up to 54%, while 89% of the population was covered (Figure 2).

When examining the share of households covered by UBB in each municipality, we observe significant variation over time. Figure 3 plots the histogram of the change in the share of families covered by UBB in each municipality between 2015 and 2019. While 46% of municipalities displayed no change, because the share of households covered remained equal to zero between 2015 and 2019, the rest of the municipalities displayed a positive increase. On the other extreme, about 20% of municipalities passed from zero to virtually the entire population covered by UBB. Conditioning on having a positive change, the share of households covered by UBB increased, on average, by 77 percentage points.

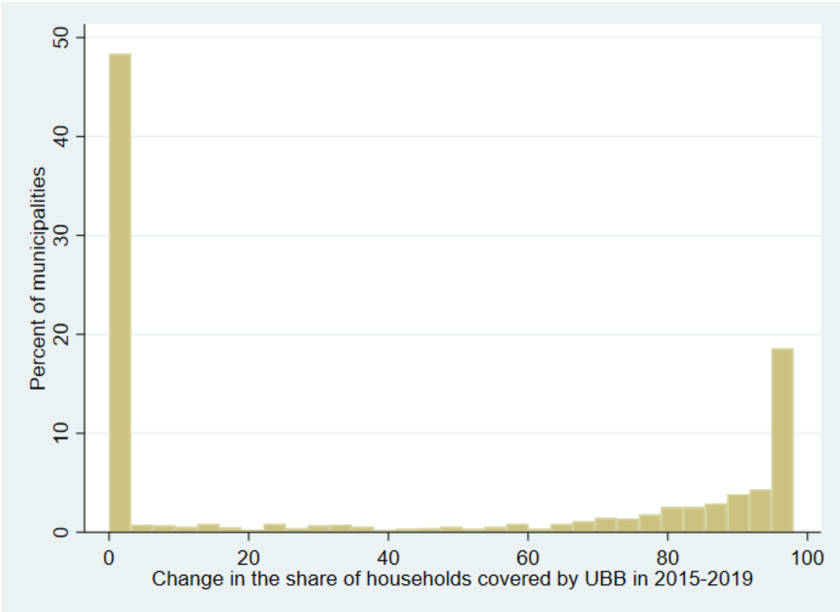


Figure 3. UBB coverage in Lombardy 2015-2019

Overall, the period 2015–2019 saw Lombardy achieve very high levels of UBB coverage. However, by 2019 there was still pronounced variability, separating urban and peri-urban centers from rural and mountain areas, which remained substantially uncovered, possibly due to the combined influence of geography, infrastructure investment patterns, and demand-side constraints.

3.1 Ultra-Broadband and Online Symptoms Search

To empirically assess whether improved digital connectivity translates into greater online health information seeking, we exploit data from Google Trends (GT), a freely available tool that reports the relative popularity of search queries over time. GT provides a Search Volume Index, which measures the share of searches for a specific term relative to all searches in a given location and period, normalized on a 0–100 scale. This metric captures population-level interest rather than absolute search counts, making it particularly suitable for comparative analysis across time and regions.

GT has been widely adopted in the empirical literature as a proxy for individual attention and information demand, including applications in finance, labor markets, tourism, and more recently during the COVID-19 pandemic (Da et al., 2011; Choi and Varian, 2012; Costola et al., 2021; Cebrián and Domenech, 2023; Manacorda et al., 2024). In the health domain, Google Trends has been extensively used to monitor disease outbreaks and symptom searches, and to proxy population health concerns. A systematic review by Nuti et al. (2014) documents its application in epidemiology, public health surveillance, and healthcare utilization, including studies on influenza, mental health, and chronic diseases. More recent contributions confirm its usefulness for tracking real-time health information seeking and behavioral responses to health shocks, particularly during the COVID-19 pandemic. These findings demonstrate the relevance of Google Trends for studying how individuals respond to changes in information access and perceived health risks (Nuti et al., 2014).

Importantly, GT data have some limitations. First, they only reflect behavior of individuals with internet access and who use Google as their search engine, implying potential coverage bias. Second, GT reports data only when search volumes exceed a minimum threshold; low-frequency queries are suppressed and displayed as " Not enough search volume to show results." For this reason, several candidate symptom-related terms could not be included in the analysis due to insufficient observations[3].

Since GT data are available only at the regional level[4], we construct a region-level indicator of UBB coverage by computing a population-weighted average of municipal UBB coverage for each region and year. To construct our indicator of online symptom search, we selected a set of common symptoms (e.g., pain and fever) that consistently generated sufficient search volume over time. Yearly search data from January 2007 to December 2019 were downloaded from GT.

We then examine the correlation between UBB coverage and online search activity. Figure 4 displays scatter plots relating GT scores to UBB coverage for two representative symptoms: "Pain" (Panel a) and "Fever" (Panel b). together with fitted linear regression lines and the associated 95% confidence intervals. In both cases, we observe a positive and statistically significant correlation between UBB coverage and online symptom search intensity.

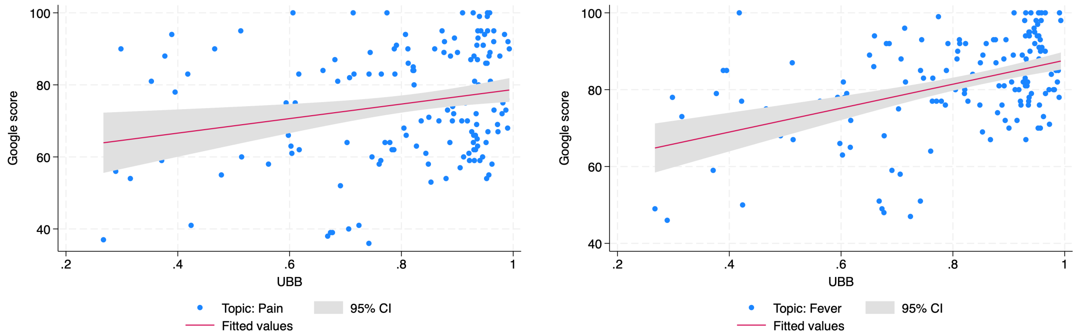
These results suggest that faster and more reliable internet access increases individuals' propensity to seek health-related information online, consistent with the "Dr Google" mechanism. More broadly, the findings indicate that UBB diffusion may influence online health-related search behavior and, in turn, patterns of healthcare utilization and service provision.

[3]Several additional symptom-related terms (e.g., dizziness, nausea, chest pain, headache, cough, fatigue) were initially considered but excluded due to insufficient search volume, as GT suppresses low-frequency queries.

[4]There are 20 administrative regions in Italy.

Overall, these results provide a sanity check for our main empirical strategy: if UBB diffusion truly affects healthcare utilization through an information channel, we should observe higher symptom-related searches in better-connected areas. The strong correlation documented here confirms that UBB expansion is indeed associated with more intensive online health information seeking, which plausibly mediates subsequent healthcare demand.

Figure 4. Correlation between online search and UBB coverage



(a) Search topic: Pain **(b)** Search topic: Fever

The figure shows the correlation between UBB coverage and Google Trends' scores, together with the fitted values from a linear regression and the associated 95% robust confidence interval. Data are at the province and year levels. UBB is the weighted average of UBB coverage within a province-year, weighted by municipality population.

4 Data

4.1 UBB Data

Data on UBB diffusion derive from two main sources. The first one comes from Telecom Italia Mobile (TIM), the Italian telecommunication incumbent. For each municipality, we observe the % of households with access to UBB connections from the beginning of UBB deployment plan in 2015. The second source of broadband data comes from OpenFiber and collects additional information on the municipalities covered by the unique alternative UBB operator, entering the market in 2017. That is, we also observe the % of households with access to ultra-fast connections supplied by OpenFiber, which gives us the full picture of UBB deployment in Lombardy.[5]

Therefore, consistent with prior studies (Campante et al., 2018), we use UBB coverage as our main explanatory variable. This choice is justified by the fact that UBB penetration is intrinsically endogenous, as it depends on individual decisions to adopt the technology. Using

[5]The UBB deployment plan has been implemented through a combination of public and private investments. There are only two distinct networks that supply UBB services to final consumers. The first one is owned by the telecommunication incumbent TIM, which leverages on the pre-existing telecommunication facilities used for voice telephone and ADSL connections. As a consequence, TIM has been the first in investing in UBB infrastructures throughout Italy since 2015. The second one is owned by Open Fiber, a wholesale operator currently owned by Cassa Depositi e Prestiti – the investment branch of the Ministry of Treasury – and two international private investment funds. Open Fiber entered the market in 2017 by acquiring Metroweb, a private telecom company covering a few large cities (e.g. Milan, Bologna, and Turin).

data from TIM and OpenFiber , we observe which municipalities in Lombardy have access to the UBB for each year of observation, from 2015 to 2019.

4.2 Healthcare Data

The empirical analysis relies on two comprehensive administrative healthcare datasets covering the entire population of the Lombardy region over the period 2015–2019.

The first dataset contains detailed records of all outpatient (ambulatory) services provided to Lombardy residents. Each observation corresponds to a single outpatient service, with more than 150 million prescriptions recorded annually. For each service, the dataset reports the patient's anonymized unique identifier, the date of provision, and the specific diagnostic or specialist procedure performed. Additional information includes the number of services delivered, the associated reimbursement cost, the provider organization, the facility where the service was carried out, and the amount of patient co-payment. This rich set of variables allows us to capture both the volume and the composition of outpatient diagnostic activity across areas and over time.

The analysis focuses on overall diagnostic procedures and a subset of them: namely computed tomography scans, MRI, and ultrasound, identified through detailed service descriptions. These procedures are particularly relevant for our research question, as their utilization is relatively discretionary and may be influenced by patients' perceptions and concerns as well as by GPs referral decisions.

Starting from the individual-level records, we construct an aggregated dataset at the municipality–year level by summing the total number of each diagnostic procedure performed. This aggregation enables us to match healthcare utilization outcomes with municipality-level measures of UBB coverage and to conduct area-level causal analyses.

The second dataset covers ER utilization and includes all ER visits by Lombardy residents over the same period. For each access, the data report the date of admission, the patient's age and municipality of residence, and the clinical triage code assigned at entry. Using this information, we construct two main outcomes at the municipality–year level: the total number of ER visits and the number of inappropriate ER visits.

Inappropriate ER visits are defined following the classification proposed by Rosano et al. (2011), which identifies non-urgent accesses that could have been appropriately managed in primary or outpatient care settings. Specifically, these include visits classified as low-severity at triage and not resulting in hospitalization or urgent medical intervention.

Taken together, the combination of detailed outpatient and emergency care data provides a comprehensive view of healthcare utilization patterns. This allows us to study not only changes in the intensity of diagnostic activity, but also potential reallocations between planned outpatient care and emergency services in response to increased UBB coverage.

The empirical analysis is conducted separately for two age groups: individuals aged 25–55 and those aged over 65. This stratification captures systematic differences in both exposure to and use of online health information. Several studies document substantial age differences in online health information–seeking behavior. While older adults face barriers related to digital skills, trust, and usability, they actively seek health information online and consult multiple internet sources for symptom and disease-related information (Zhao et al., 2022; Chaudhuri et al., 2013; Medlock et al., 2015). Comparative research further suggests that although older adults are less likely than younger individuals to adopt online health searches overall, when they do engage, their searches tend to focus more strongly on health management and symptom-related queries (Barreda Gutiérrez et al., 2024).

Younger adults, by contrast, are more likely to be active broadband users and thus more frequently exposed to digital content, including health-related misinformation, which may fuel precautionary demand for discretionary diagnostic procedures (Starcevic and Berle, 2013; Powell et al., 2011; D'Andrea et al., 2023; Di Novi et al., 2024). Older adults also exhibit a higher prevalence of chronic conditions and interact more frequently with the healthcare system, making them a key group for assessing whether broadband access amplifies utilization among populations already at elevated health risk (McMullan et al., 2019; Tan and Goonawardene, 2017). Examining these cohorts separately therefore allows us to disentangle healthcare demand driven by digital engagement from demand linked to underlying health status and age-related healthcare needs.

Beyond differences in digital engagement and health status, the two age groups also differ markedly in their interaction with physicians, which is crucial for understanding healthcare utilization. Access to outpatient visits and diagnostic procedures is largely mediated by physicians through referrals, and medical advice also plays an important role in shaping emergency department utilization. Older adults typically maintain more frequent and continuous contact with their GPs, which may both attenuate the direct influence of online health information and increase the likelihood that perceived health risks are translated into formal medical encounters and diagnostic testing. In contrast, younger adults interact less regularly with physicians, making their healthcare demand potentially more sensitive to online information and less filtered by professional assessment.

A distinctive feature of our data is the ability to link individual-level diagnostic prescriptions with detailed information on both patients and their GPs. This enables a rich heterogeneity analysis. In addition to stratifying by patient age group, we examine whether the effect of UBB varies across patient gender and GP characteristics, including physician workload and duration of patient-physicians relationship. This extension is particularly relevant given prior evidence that patient–doctor interactions and healthcare utilization are shaped not only by patient characteristics but also by physicians' attributes (Starcevic and Berle, 2013; McMullan et al., 2019).

The number of patients registered with a GP represents a key dimension of heterogeneity. there are several studies on overtesting and undertesting in primary care (O'Sullivan et al., 2018). In this context it is very important to understand the GP's approach which, on the one hand, physicians with larger patient panels may be more experienced and therefore better able to resist patient-driven demand for unnecessary diagnostic procedures. On the other hand, high patient loads may weaken effective oversight by regional health authorities regarding compliance with appropriateness guidelines, and more experienced physicians may also be better provided to explain deviations when exceeding diagnostic prescription targets. In addition, we explore heterogeneity by GP switching behavior, which captures the duration and stability of the patient–doctor relationship and allows us to assess how continuity of care mediates the impact of digital health information on healthcare utilization. Exploring these dimensions enables us to capture how digital health information interacts not only with patient behavior but also with physician-level incentives and institutional constraints.

5 Methods

Recent methodological advances in causal inference have addressed the limitations of traditional DiD estimators in settings involving continuous treatments and the absence of untreated or "stayer" units (de Chaisemartin et al., 2024).

In this context, de Chaisemartin et al. (2024) introduced a DiD framework specifically designed for continuous treatments, where treatment levels change for all units over time. Traditional two-way fixed effects (TWFE) models often perform poorly in such settings because they assume linear treatment effects and require untreated comparison groups and which can produce biased estimates in the presence of heterogeneous effects. The new framework overcomes these limitations by exploiting the presence of "quasi-stayers" units whose treatment levels change only minimally between periods. This approach, based on a weighted average of marginal treatment effects accommodates both nonlinear and heterogeneous responses to treatment.

In our study, we apply this framework to estimate the effects of UBB coverage across Lombardy's municipalities between 2015 and 2019. We treat UBB coverage as a continuous variable, noting that all municipalities experienced some degree of change during this period, so there are no untreated units or "stayers." This context fits well with the assumptions of the estimator, which is explicitly designed for settings with continuous treatments and universal variation. By exploiting differences in the intensity of UBB availability and conditioning on quasi-stayers municipalities where coverage changed only slightly we are able to compute a weighted average of marginal treatment effects. This approach not only captures heterogeneous treatment effects but also avoids the biases typical of standard fixed-effects estimators when interventions are nonlinear and continuous. As a result, our implementation provides credible evidence of the causal impact of UBB expansion on diagnostic utilization at the municipal level.

Our empirical strategy is formulated following de Chaisemartin et al. (2024). We assume the representative unit is observed for $T \geq 2$ periods, from 2015 to 2019 so that $T = 5$. Let $(D_1, \ldots, D_T)$ denote the unit's treatments and let $\mathcal{D}_t = \text{Supp}(D_t)$ for all $t \in \{1, \ldots, 5\}$. For any $t \in \{1, \ldots, 5\}$, and for any $d \in \bigcup_{t=1}^{T} \mathcal{D}_t$, let $Y_t(D_d)$ denote the unit's potential outcome at period t with treatment d, while Y_t denotes the observed outcome at period t. Define $\Delta Di, t = D_{i,t} - D_{i,t-1}$ as the change in treatment between periods t and $t-1$.

This setup allows us to define our main estimator based on treatment changes over time:

$$Y_{i,t} - Y_{i,t-1} = \alpha + \beta_1 D_{i,t-1} + \beta_2 \Delta D_{i,t} + \beta_3 D_{i,t-1} \Delta D_{i,t} + \beta_4 (\Delta D_{i,t})^2 + \varepsilon_{it}, \tag{1}$$

where the interaction term $D_{i,t-1}\Delta D_{i,t}$ and the quadratic term $(\Delta D_{i,t})^2$ allow the effect of treatment change to depend on the initial level of treatment and to capture potential non-linearities in the treatment response.

After estimating equation (1), we can identify the causal effect of the treatment on the outcome. To this end, we introduce the estimator θ, defined as:

$$\theta = \frac{E[\text{sgn}(\Delta D_{i,t})(Y_{i,t}(D_{i,t}) - Y_{i,t}(D_{i,t-1}))]}{E(|\Delta D_{i,t}|)}, \tag{2}$$

where the numerator corresponds to the expected change in the potential outcome associated with a unit increase in treatment, and the denominator corresponds to the expected change in treatment.

By definition, $\text{sgn}(\Delta D_{i,t}) = 1$ if $\Delta D_{i,t} > 0$ and -1 otherwise. Hence, the estimator θ is a weighted average of the slopes of units' potential-outcome functions across treatment changes from period $t-1$ to t. This measure is also referred to as Weighted Average of Slopes of Switchers (WAOSS) in de Chaisemartin et al. (2024).

In this paper, $Y_{i,t}$ represents one of the six outcomes of interest: number of prescriptions, sonograms, tomographs, MRIs, ER accesses and inappropriate ER accesses for municipality i in period t, while $D_{i,t}$ measures the extent of UBB availability in municipality i and period t. In our empirical application, we focus on the change between the first and last periods (2015 and 2019), effectively using $\Delta D_{i,T} = D_{i,2019} - D_{i,2015}$ and $\Delta Y_{i,T} = Y_{i,2019} - Y_{i,2015}$ to compute the estimator θ.

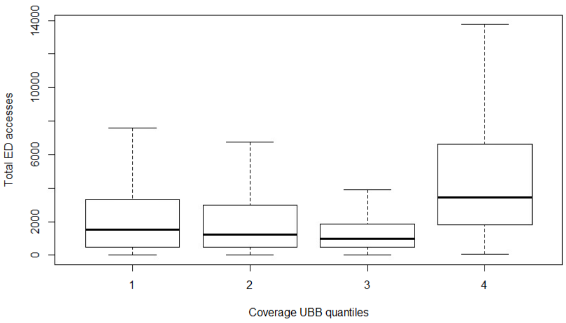
As previously discussed, our setting corresponds to a DiD design with continuous treatments in a two-period panel. All units are treated to varying degrees, and there are no untreated ("stayer") units. This implies that

$$\Pr(\Delta D = 0) = 0 \quad \text{or} \quad \Pr(|\Delta D| < \eta) > 0 \quad \forall \eta > 0,$$

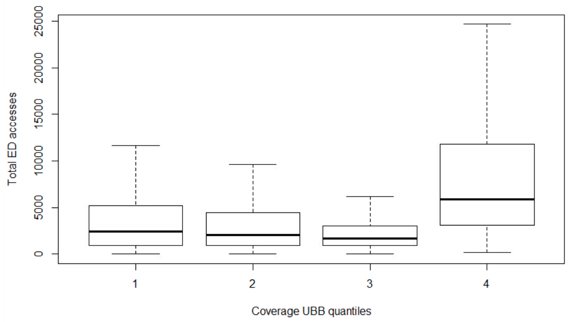
which is the Assumption 4 in de Chaisemartin et al. (2024).

6 Descriptive Statistics

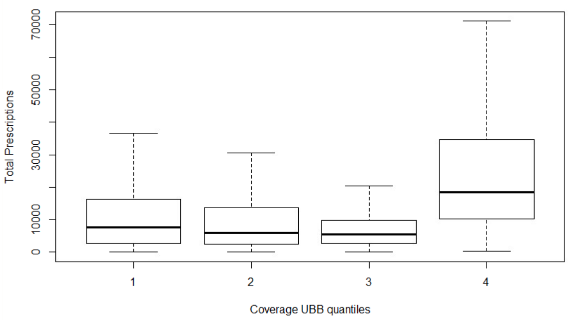
To explore the relationship between Coverage UBB and healthcare utilization, we first conducted a descriptive analysis of key indicators across quartiles of Coverage UBB. Boxplots were used to summarize the distribution of ER utilization, including total ER accesses and inappropriate ER, as well as outpatient care utilization. Other descriptive boxplots for other healthcare services are reported in the Appendix.



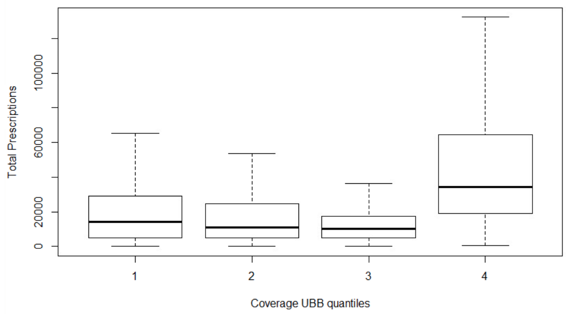
(a) Total ER accesses (25-55).



(b) Total ER accesses (65+).



(c) Total outpatient prescriptions (25-55).



(d) Total outpatient prescriptions (65+)

Figure 5. Distribution of Emergency Department and outpatient care utilization across quartiles of Coverage UBB

Descriptive analysis indicates a positive association between Coverage UBB and healthcare utilization. Across increasing quartiles of Coverage UBB, both ER and outpatient utilization exhibit progressively higher median values, with the highest coverage quartile characterized by a marked upward shift in the distribution and greater variability. By contrast, the first three quartiles display relatively similar distributions. These patterns are consistent with a positive correlation between Coverage UBB and healthcare utilization, which is formally assessed in subsequent analyses.

7 Results

Tables 1 and 2 report the estimates of the WAOSS for a range of healthcare utilization outcomes among individuals aged 25–55, under the hypothesis that increased UBB coverage, measured as the percentage of households with access to UBB, affects health-related behaviors through greater exposure to online medical information. Across both tables, the empirical specification and presentation are consistent: each row corresponds to a separate estimated model, with point estimates reported alongside standard errors and 95% confidence intervals.

Table 1 focuses on outpatient diagnostic services. The results reveal a large and statistically significant increase in the overall volume of diagnostic procedures associated with higher UBB coverage. Specifically, a one–percentage-point increase in the share of households covered by UBB leads to an increase of approximately 310 diagnostic procedures per year. This finding suggests that improved internet access substantially intensifies individuals' engagement with diagnostic healthcare services.

At the same time, the effects are heterogeneous across diagnostic technologies. While greater UBB coverage is associated with a statistically significant increase in the use of tomographs, it is linked to a reduction in MRI prescriptions and sonograms. This pattern indicates that UBB expansion does not uniformly raise demand for all diagnostic tools, but rather reshapes the composition of diagnostic activity, potentially reflecting changes in patients' concerns, physicians' responses, or both.

Complementary evidence emerges from Table 2, which examines emergency room utilization. In municipalities experiencing greater growth in UBB coverage, ER visits decline sharply. A one–percentage-point increase in household UBB coverage is associated with a reduction of approximately 661 total ER visits. Importantly, the decrease is also evident for inappropriate ER visits: those not requiring urgent care which fall by about 40 visits. These results suggest that increased access to online information may improve individuals' ability to assess the severity of health conditions or to seek alternative forms of care, thereby reducing unnecessary reliance on emergency services.

Taken together, the findings across diagnostic and ER outcomes are consistent with a behavioral mechanism through which UBB coverage affects healthcare utilization via information channels. Greater exposure to online medical content, potentially including symptom checkers, health news, and discussions of diseases, appears to increase precautionary behavior and diagnostic demand in outpatient settings, while simultaneously reducing inappropriate or excessive use of emergency care. Rather than simply increasing overall healthcare utilization, UBB expansion seems to reallocate healthcare demand toward planned diagnostic services and away from emergency interventions.

Table 3 reports the WAOSS estimates of the effect of UBB coverage on diagnostic service utilization among individuals aged over 65. The results indicate a large and statistically

	Estimate	SE	LB CI	UB CI
Diagnostic procedures	309.81	123.06	68.61	551.02
MRI	-7.47	3.23	-13.80	-1.14
Sonograms	-78.49	18.91	-115.55	-41.43
Tomographs	10.37	1.72	6.90	13.75

Table 1. WAOSS Estimation for coverage on yearly diagnostic procedures – Individuals aged 25–55

	Estimate	SE	LB CI	UB CI
Total ER visits	-661.48	139.69	-935.26	-387.69
Inappropriate ER visits	-39.51	13.69	-66.33	-12.68

Table 2. WAOSS Estimation for coverage on ER outcomes – Individuals aged 25–55

significant increase in the overall volume of diagnostic procedures. A one–percentage-point increase in UBB coverage is associated with approximately 2,335 additional diagnostic services per year, pointing to a strong behavioral response to increased digital access in older populations. The magnitude of the estimated effect is considerably larger than that observed among younger individuals, pointing to a particularly strong responsiveness of healthcare utilization to digital access in older populations.

Disaggregating by diagnostic technology reveals heterogeneous effects. UBB expansion is associated with a statistically significant increase in the use of technologically intensive procedures, such as MRIs and tomographs. In contrast, sonogram utilization declines significantly. This pattern suggests that greater access to online health information may lead older individuals, possibly in interaction with healthcare providers to substitute toward more advanced diagnostic technologies, rather than uniformly increasing demand across all procedures.

Table 4 complements this evidence by examining ER utilization. Higher UBB coverage is associated with a reduction in total ER visits, with an estimated decrease of 495 visits per year for each additional percentage point of coverage. The effect on inappropriate ER visits is negative but not statistically significant. Taken together, these results suggest that improved digital access among older individuals may facilitate better health management and more appropriate use of outpatient diagnostic services, thereby reducing reliance on emergency care.

Comparing these findings with those for individuals aged 25–55 reveals important age-related differences in how UBB coverage affects healthcare utilization. In both age groups, higher UBB coverage is associated with a significant increase in overall diagnostic activity, supporting the hypothesis that increased exposure to online health information raises health awareness and engagement with the healthcare system. However, the magnitude of the effect is substantially larger among individuals aged over 65, indicating a stronger responsiveness of older cohorts to digital health information. This pattern aligns with the institutional features described in the data section, whereby access to diagnostic services is largely physician-mediated. Older individuals' more frequent interaction with general practitioners facilitates the conversion of online health information into diagnostic prescriptions, amplifying the effect of UBB coverage. Younger adults, who are less embedded in regular physician–patient relationships, display a weaker translation of digital exposure into observed utilization.

Differences also emerge in the composition of diagnostic services. While UBB coverage increases the use of tomographs in both age groups, the effect on MRIs is positive and statistically significant only among the over-65 population. Conversely, younger individuals exhibit a reduction in MRI use alongside declining sonogram utilization, whereas older individuals show a clearer shift toward more technologically intensive diagnostics. This divergence may reflect differences in baseline health risk, physician decision-making, or the perceived relevance of online medical information across age groups.

Finally, the effects on emergency care utilization point to a potentially beneficial reallocation of healthcare use, particularly among older individuals. While increases in UBB coverage are associated with reductions in total ER visits in both age groups, the effect is more clearly identified for individuals aged over 65. This pattern suggests that improved digital access may facilitate substitution away from emergency services toward planned and scheduled forms of care, such as outpatient diagnostics, especially among older cohorts.

Importantly, age-related differences emerge in the nature of this adjustment. Among individuals aged 25–55, higher UBB coverage leads to statistically significant decrease not only in total ER visits but also in inappropriate ER use, indicating improved self-triage or more efficient navigation of healthcare options. In contrast, for individuals aged over 65, the estimated effect on inappropriate ER visits is negative but imprecise and not statistically significant. This suggests that, in this age group, UBB expansion primarily operates through broad reductions in emergency care utilization rather than through selective decreases in inappropriate access.

Overall, these findings highlight that the behavioral impact of UBB coverage on healthcare utilization is not uniform across age groups. Instead, it varies both in magnitude and in composition, with older individuals exhibiting particularly strong responses in terms of overall healthcare reallocation, but less evidence of fine-tuned adjustments in the appropriateness of emergency care use.

	Estimate	SE	LB CI	UB CI
Diagnostic procedures	2335.33	363.59	1622.70	3047.96
MRI	6.35	2.96	0.54	12.15
Sonograms	-78.77	20.44	-118.84	-38.71
Tomographs	35.51	5.35	25.02	45.99

Table 3. WAOSS Estimation for coverage on yearly diagnostic procedures – Individuals aged over 65

	Estimate	SE	LB CI	UB CI
Total ER visits	-494.84	249.37	-983.61	-6.07
Inappropriate ER visits	-52.76	31.73	-114.95	9.42

Table 4. WAOSS Estimation for coverage on ER outcomes – Individuals aged over 65

8 Heterogeneity Analysis

8.1 By patient sex

This section explores heterogeneity in the effects of UBB coverage by patient sex. Table 5 report WAOSS estimates separately for females and males, distinguishing between individuals aged 25–55 and those aged over 65, and considering both ambulatory diagnostic services and emergency room utilization.

Among females aged 25–55, higher UBB coverage causes with a sizeable and statistically significant increase in the overall volume of diagnostic procedures. A one–percentage-point increase in household UBB coverage leads to approximately 611 additional diagnostic services per year. Disaggregated results reveal a clear increase in the use of technologically intensive diagnostics, such as MRIs and tomographs, alongside a reduction in sonogram utilization. This pattern suggests that improved access to online health information may increase health awareness and precautionary behavior among younger women, while also affecting the composition of diagnostic demand toward more advanced technologies.

For females aged over 65, the effects are even more pronounced. UBB expansion is associated with a very large increase in overall diagnostic activity: over 2,000 additional procedures per year per percentage point of coverage and statistically significant increases across all diagnostic modalities, including MRIs, sonograms, and tomographs. These results point to a strong responsiveness of older women to improved digital access, potentially reflecting higher baseline health risks combined with increased engagement with online medical information and healthcare providers.

In contrast, the patterns for males differ markedly. Among males aged 25–55, higher UBB coverage is associated with a statistically significant reduction in overall diagnostic procedures, as well as declines in MRI and sonogram use. The effect on tomographs is negative but imprecisely estimated. This finding suggests that, for younger men, improved access to online information may reduce diagnostic utilization, possibly by improving self-assessment of symptoms or reducing unnecessary precautionary testing.

For males aged over 65, the estimates indicate a weaker relationship. While the effect on total diagnostic procedures is not statistically significant, UBB coverage is associated with significant increases in MRIs and tomographs. This suggests a reallocation toward more technologically intensive diagnostics rather than an overall expansion in diagnostic volume, pointing to sex-specific differences in how older individuals translate digital information into healthcare demand.

Sex-based heterogeneity is also evident in ER outcomes. Among females aged 25–55, UBB coverage does not affect either total or inappropriate ER visits, suggesting limited adjustment in emergency care use in this group.

For females aged over 65, higher UBB coverage is associated with a statistically significant increase in total ER visits, while the effect on inappropriate ER use is not statistically significant. This pattern may reflect increased health awareness or perceived urgency triggered by online information, leading older women to seek emergency care more frequently rather than substituting toward outpatient services.

Among males aged 25–55 , UBB expansion is associated with a significant reduction in total ER visits, with a negative but borderline-significant effect on inappropriate visits. This suggests that improved digital access may help younger men better triage health conditions and avoid unnecessary emergency care.

Finally, for males aged over 65, UBB coverage is associated with a statistically significant increase in total ER visits, while the effect on inappropriate ER use remains imprecisely estimated. As with older females, this finding suggests that increased digital exposure may raise perceived health risks or urgency among older men, leading to greater reliance on emergency services.

Overall, the heterogeneity analysis reveals substantial differences by sex in how UBB coverage affects healthcare utilization. Women, especially those aged over 65, exhibit strong increases in diagnostic activity in response to UBB expansion, consistent with heightened health awareness and precautionary behavior. Men, by contrast, display more muted or even negative responses in diagnostic utilization at younger ages, alongside clearer reductions in ER use.

These results suggest that the behavioral channels linking digital access to healthcare demand are strongly mediated by gender and age. Differences in health information-seeking behavior, risk perception, baseline health status, and interactions with healthcare providers likely play an important role in shaping these heterogeneous responses.

Table 5. Effect of Ultra-Broadband Coverage on Healthcare Utilization by Gender and Age

	Ages 25–55			Ages 65+		
	Estimate	SE	CI	Estimate	SE	CI
Females						
OUTPATIENT SERVICES						
Diagnostic procedures	611.26	113.69	[388.42, 834.10]	2057.14	269.20	[1529.51, 2584.77]
MRI	11.20	1.40	[8.45, 13.94]	18.82	2.49	[13.94, 23.71]
Tomographs	3.85	1.14	[1.61, 6.08]	20.53	4.39	[11.93, 29.13]
Sonograms	-16.79	5.08	[-26.74, -6.83]	16.44	2.69	[11.16, 21.72]
EMERGENCY SERVICES						
Total ER visits	-6.75	4.22	[-15.03, 1.52]	7.60	3.35	[1.03, 14.16]
Inappropriate ER visits	-0.46	0.32	[-1.09, 0.18]	0.39	0.55	[-0.70, 1.47]
Males						
OUTPATIENT SERVICES						
Diagnostic procedures	-620.80	251.17	[-1113.09, -129.51]	254.92	440.56	[-608.56, 1118.41]
MRI	-5.39	2.18	[-9.67, -1.11]	5.31	2.50	[0.42, 10.92]
Tomographs	-1.34	1.07	[-3.43, 0.75]	18.57	3.64	[11.43, 25.70]
Sonograms	-5.05	1.86	[-8.69, -1.41]	4.31	2.76	[-1.09, 9.72]
EMERGENCY SERVICES						
Total ER visits	-11.70	3.95	[-19.45, -3.95]	14.22	2.92	[8.50, 19.94]
Inappropriate ER visits	-0.50	0.27	[-1.01, 0.02]	1.01	0.60	[-0.15, 2.18]

8.2 GP workload

This subsection explores heterogeneity in the effect of UBB coverage by the size of the patient list served by primary care physicians. We distinguish between practices with fewer than 1,500 registered patients and those with more than 1,500 patients, a threshold commonly used to capture differences in physicians' workload, organizational capacity, and intensity of patient–provider interaction.

Tables 6 reports results for physicians by patient lists. In the group of GP with a small workload, higher UBB coverage is associated with a strong and statistically significant increase in outpatient diagnostic activity across both age groups. Among individuals aged 25–55, a one–percentage-point increase in UBB coverage leads to approximately 551 additional diagnostic procedures per year, alongside significant increases in MRI and tomograph use, and a reduction in sonograms. The pattern is even more pronounced among individuals aged over 65, for whom the same increase in UBB coverage is associated with over 3,000 additional diagnostic procedures annually (95% CI: [2,081.50, 4,055.03]), as well as sizable and statistically significant increases across all advanced diagnostic technologies.

These findings suggest that when physicians face lower patient loads, increased exposure to online health information among patients may translate more easily into diagnostic demand. In such settings, physicians may have greater capacity to accommodate patient concerns, respond to information-driven requests, or engage in precautionary diagnostic practices prompted by heightened health awareness.

The corresponding ER outcomes for physicians with fewer than 1,500 registered patients reveal a different pattern. For individuals aged 25–55, the estimated effects on total and inappropriate ER visits are negative but imprecisely estimated and not statistically significant. In contrast, among individuals aged over 65, higher UBB coverage is associated with a statistically significant increase in both total ER visits and inappropriate ER visits. This suggests that for older patients served by smaller practices, increased access to online health information may generate additional demand for urgent care, possibly reflecting heightened anxiety or difficulties in appropriately navigating healthcare options.

A markedly different picture emerges for physicians with more than 1,500 registered patients. In these high-load practices, increased UBB coverage is associated with either negligible or negative effects on outpatient diagnostic activity. For individuals aged 25–55, a one–percentage-point increase in UBB coverage leads to a small but statistically significant reduction in total diagnostic procedures, while effects on specific diagnostic technologies are generally close to zero. A similar pattern is observed among individuals aged over 65, with a modest decline in overall diagnostic volume and largely insignificant effects across diagnostic categories.

ER utilization in high-load practices also displays muted responses. Among individuals aged 25–55, UBB coverage has no statistically significant effect on either total or inappropriate ER visits. Among those aged over 65, higher UBB coverage is associated with a small but statistically significant reduction in total ER visits, while the effect on inappropriate ER access remains imprecisely estimated.

Taken together, these results highlight the central role of provider capacity in mediating the behavioral effects of UBB access on healthcare utilization. When physicians serve smaller patient populations, increased access to online health information appears to translate into substantial increases in diagnostic activity, particularly among older individuals, while potentially generating additional pressure on emergency services. Conversely, in more congested practices, physicians' limited capacity may constrain the extent to which information-driven demand can be accommodated, thereby dampening both diagnostic expansion and emergency room responses. Moreover, under a capitation-based remuneration system, GPs with high workload face weaker incentives to satisfy marginal patient demand, as they have already achieved the desired number of patients.

To further characterize heterogeneity by GP patient load, we examine descriptive differences between physicians with fewer and more than 1,500 registered patients. Clear and systematic patterns emerge across demographic and professional characteristics. Physicians serving smaller patient lists are on average older, with a markedly higher concentration in cohorts born before 1945, whereas those with larger patient lists tend to be younger and more strongly represented in post-1960 birth cohorts. This pattern is consistent with differences in career stage and workload choices, with senior physicians more likely to operate smaller practices as they approach retirement, while younger physicians expand their patient base.

Table 6. Effect of Ultra-Broadband Coverage on Healthcare Utilization by GP Patient Load

	Ages 25–55			Ages 65+		
	Estimate	SE	CI	Estimate	SE	CI
GP Patient Load < 1,500						
OUTPATIENT SERVICES						
Diagnostic procedures	551.31	185.26	[188.21, 914.42]	3069.27	503.45	[2081.50, 4055.03]
MRI	12.82	1.71	[9.47, 16.16]	29.31	4.39	[20.70, 37.92]
Tomographs	5.89	1.49	[2.97, 8.81]	42.19	8.64	[25.25, 59.13]
Sonograms	-23.44	6.02	[-35.23, -11.66]	17.34	3.83	[9.83, 24.84]
EMERGENCY SERVICES						
Total ER visits	-13.81	7.99	[-29.47, 1.85]	19.31	7.97	[3.70, 34.92]
Inappropriate ER visits	-0.75	0.49	[-1.72, 0.22]	3.07	1.19	[0.74, 5.41]
GP Patient Load > 1,500						
OUTPATIENT SERVICES						
Diagnostic procedures	-37.48	16.76	[-70.33, -4.64]	-68.86	33.57	[-134.65, -3.08]
MRI	-0.15	0.15	[-0.44, 0.14]	-0.21	0.13	[-0.46, 0.04]
Tomographs	0.05	0.17	[-0.29, 0.39]	-0.71	0.38	[-1.46, 0.04]
Sonograms	-0.98	0.45	[-1.87, -0.09]	-0.61	0.36	[-1.32, 0.11]
EMERGENCY SERVICES						
Total ER visits	-1.21	0.73	[-2.63, 0.21]	-1.79	0.88	[-3.51, -0.07]
Inappropriate ER visits	0.02	0.05	[-0.07, 0.11]	-0.20	0.11	[-0.41, 0.01]

In addition, female physicians are disproportionately represented among practices with fewer than 1,500 registered patients, in line with existing evidence documenting lower average patient loads and stronger preferences for work–life balance. This gender composition may further contribute to observed differences in prescribing behavior and responsiveness to patient demand.

Taken together, these descriptive patterns indicate that variation in patient load captures meaningful heterogeneity in GP characteristics, including age, gender, and career stage. These supply-side differences help interpret our main results. Indeed, our findings highlight the central role of provider capacity in mediating the behavioral effects of UBB access on healthcare utilization. When physicians serve smaller patient populations, increased access to online health information appears to translate into substantial increases in diagnostic activity, particularly among older individuals, while potentially generating additional pressure on emergency services.

This pattern is consistent with institutional features of the Italian National Health Service, where GPs are primarily remunerated through capitation payments. Under this system, physicians receive a fixed payment per registered patient, implying weaker financial incentives to satisfy marginal patient demand once their patient list is filled. As a result, GPs with smaller workloads may be more responsive to patient requests and concerns, either because they have greater available time or because they are younger physicians seeking to build patient trust and retention, which may translate into higher prescribing intensity. Conversely, in more congested practices, physicians' limited capacity constrains the extent to which information-driven demand can be accommodated, thereby dampening both diagnostic expansion and emergency room responses.

Overall, heterogeneity by the number of registered patients suggests that the impact of UBB coverage on healthcare utilization is shaped not only by patients' exposure to online information but also by supply-side constraints and provider incentives. Broadband-induced behavioral responses are strongest in settings where physicians have greater scope to respond to patient concerns, underscoring the importance of healthcare system organization in moderating the effects of digital access.

Table 7. Characteristics of General Practitioners by Patient Load

	< 1,500 patients	**> 1,500 patients**
Demographics		
Female (%)	35.8	36.0
Male (%)	64.2	64.0
Born before 1945 (%)	11.4	0.5
Geographic distribution		
ATS represented (count)	10	10
Max ATS share (%)	≈6	≈6
Sample size		
Number of GPs	9,250	16,768
Share of total GPs (%)	35.6	64.4

Notes: The table reports descriptive characteristics of general practitioners by patient load. Physicians are classified according to whether they serve fewer or more than 1,500 registered patients. Percentages are computed within patient-load groups. All regression specifications include physician fixed effects; differences reported here are descriptive and intended to aid interpretation of heterogeneous effects.

8.3 By GP switch

Finally, Tables 8 distinguish individuals who remain with the same GP throughout the period from those who switch GP at least once between 2015 and 2021. This distinction captures differences in continuity of care and in the strength of the physician–patient relationship, which may affect both physicians' referral behavior and the extent to which patient driven health concern, potentially shaped by online information, are translated into observed healthcare utilization.

Among individuals who do not change GP, UBB expansion is associated with sharply divergent age-specific effects. For those aged 25–55, higher UBB coverage leads to significant reductions in outpatient diagnostic procedures and ER visits, consistent with more efficient use of healthcare services within stable patient–physician relationships. In this group, improved access to online health information may complement professional medical advice, enabling better self-triage and reducing unnecessary utilization.

In contrast, for individuals aged over 65, UBB coverage is associated with very large increases in diagnostic utilization across all technologies, as well as increases in both total and inappropriate ER visits. This pattern is consistent with an amplification mechanism whereby digital health information reinforces perceived health risks among older patients and, within stable and trust-based GP relationships, lowers the threshold for precautionary referrals and emergency care. For this group, UBB access appears to intensify engagement with the healthcare system rather than substitute for it.

Among individuals who change GP, the effects of UBB coverage are generally smaller in magnitude and less precisely estimated. For younger individuals, diagnostic and ER outcomes show no statistically significant responses, suggesting that in the absence of continuity of care, increased digital exposure does not systematically translate into observed utilization. For older individuals, we observe evidence of increased diagnostic activity, particularly for MRIs and tomographs, alongside a decline in inappropriate ER visits. This result suggests that while GP switching may affect trust-based and relational channels, improved access to information may still facilitate more appropriate navigation of the healthcare system among older patients, shifting utilization away from low-value emergency care toward planned diagnostic services.

Overall, these findings highlight the central role of physician continuity in mediating the impact of UBB access on healthcare utilization. Stable GP relationships appear to act as a key transmission channel through which digital health information affects patient behavior, amplifying utilization among older individuals while promoting more efficient care use among younger cohorts.

Table 8. Effect of Ultra-Broadband Coverage on Healthcare Utilization by GP Continuity

	Ages 25–55			Ages 65+		
	Estimate	SE	CI	Estimate	SE	CI
Individuals with the Same GP						
OUTPATIENT SERVICES						
Diagnostic procedures	-825.84	365.98	[-1543.17, -108.51]	2022.51	490.69	[1060.77, 2984.26]
MRI	-6.67	3.34	[-13.21, -0.12]	9.63	3.51	[2.75, 16.51]
Tomographs	0.30	0.99	[-1.64, 2.25]	34.21	7.12	[20.26, 48.16]
Sonograms	-17.12	3.98	[-24.92, -9.32]	28.46	4.73	[19.19, 37.72]
EMERGENCY SERVICES						
Total ER visits	-18.77	5.02	[-28.61, -8.94]	40.24	8.03	[24.51, 55.97]
Inappropriate ER visits	-0.58	0.30	[-1.17, 0.01]	2.35	0.69	[1.01, 3.69]
Individuals with a GP Change						
OUTPATIENT SERVICES						
Diagnostic procedures	206.42	250.11	[-283.79, 696.64]	812.43	298.82	[226.75, 1398.12]
MRI	4.51	2.37	[-0.14, 9.16]	13.27	1.80	[9.74, 16.80]
Tomographs	1.23	1.11	[-0.94, 3.41]	4.97	2.31	[0.44, 9.51]
Sonograms	-6.19	2.59	[-11.27, -1.11]	-0.82	3.57	[-7.82, 6.19]
EMERGENCY SERVICES						
Total ER visits	0.62	3.35	[-5.95, 7.19]	-10.99	6.37	[-23.47, 1.50]
Inappropriate ER visits	-0.47	0.32	[-1.10, 0.15]	-1.38	0.69	[-2.73, -0.03]

8.4 Over 75

	Estimate	SE	LB CI	UB CI
Diagnostic procedures	2846.935	348.602	2163.675	3530.194
MRI	8.799	2.554	3.795	13.804
Sonograms	38.583	7.240	24.392	52.774
Tomographs	63.790	13.230	37.859	89.722

Table 9. WAOSS Estimation for coverage on yearly diagnostic procedures – Individuals aged over 75

	Estimate	SE	LB CI	UB CI
Total ER visits	-387.795	181.152	-750.693	-24.896
Inappropriate ER visits	-42.110	21.343	-83.943	-0.278

Table 10. WAOSS Estimation for coverage on ER outcomes – Individuals aged over 75

To further explore age-related heterogeneity in behavioral responses to UBB coverage, we extend our analysis to individuals aged over 75. This age group is of particular interest because older adults tend to be less digitally literate and rely more heavily on traditional physician-mediated channels for health information and care. As a result, the mechanisms linking UBB access to healthcare utilization may differ from those observed among younger seniors (65–74).

Tables 9 and 10 report the WAOSS estimates for individuals aged over 75. The results indicate that UBB coverage continues to significantly influence healthcare utilization even among the oldest seniors. Increased UBB coverage is associated with a substantial rise in total diagnostic procedures, with an estimated 2,847 additional procedures per percentage-point increase in coverage. This effect is slightly larger than that observed for the broader over-65 group. However, this difference in magnitude likely reflects higher baseline utilization among individuals aged over 75, who already receive more diagnostic services on average, rather than stronger behavioral responsiveness to digital information.

All diagnostic categories exhibit positive and statistically significant effects. Specifically, MRIs increase by approximately 9 procedures, tomographs by 64 procedures, and sonograms by nearly 39 procedures per percentage-point increase in coverage. Importantly, sonograms increase in this age group, in contrast to the decline observed in the overall over-65 sample. This pattern points to a generalized expansion of diagnostic activity rather than substitution across technologies, suggesting that UBB access amplifies demand across both routine and technologically intensive procedures.

At the same time, higher UBB coverage is associated with reductions in emergency care utilization. Total ER visits decline by approximately 388 visits per percentage-point increase in coverage, while inappropriate ER visits decrease by about 42 visits. These findings suggest improved triage and more appropriate use of emergency services among the oldest seniors.

Taken together, these results support the behavioral mechanism identified for the over-65 population, demonstrating that even the oldest individual, despite lower digital literacy, respond to improved access to online health information. This response may operate either directly or indirectly through caregivers and physicians, resulting in increased engagement with diagnostic services and reduced reliance on emergency care. The composition of diagnostic responses highlights age-specific patterns, with individuals over 75 exhibiting a more generalized increase across both routine and technologically intensive procedures, reflecting both higher clinical needs and mediated use of digital information.

These findings are consistent with existing evidence documenting age differences in online health information–seeking behavior and with an elasticity mechanism: fewer older individuals use the internet, but among users the marginal propensity to search for symptoms and to request diagnostic procedures is higher, reflecting greater morbidity, symptom prevalence, and more frequent interactions with the healthcare system.

Moreover, older individuals are more likely to suffer from multiple chronic conditions, which increases the probability that online symptom searches translate into medical consultations and diagnostic demand. By contrast, younger adults, despite being more digitally active primarily access the internet through smartphones and mobile applications, which are less sensitive to UBB expansion compared to fixed home connections. As a result, improvements in fixed UBB infrastructure may have weaker behavioral effects among younger cohorts, whose internet usage is already saturated through mobile technologies.

Taken together, these patterns imply that UBB expansion is more likely to affect health-related behavior among older adults, not only because they face higher baseline health risks, but also because their online activity is more elastic to improvements in connection quality and more strongly oriented toward diagnostic information seeking.

9 Robustness Analysis

9.1 Exclusion of Milan

Tables 11–14 report the WAOSS estimates obtained by excluding the municipality of Milan from the main sample. Milan represents a distinctive context within the region, as UBB coverage was already largely in place at the beginning of the observation period (2015), and the local healthcare system exhibits structural characteristics that differ markedly from the rest of the territory. For these reasons, excluding Milan allows us to assess whether the baseline results are driven by this outlier context or instead reflect broader behavioral responses to UBB diffusion.

Overall, the results remain qualitatively consistent with the main findings, supporting the robustness of the baseline estimates. Among individuals aged 25–55, higher UBB coverage continues to be associated with a significant increase in overall diagnostic activity, accompanied by heterogeneous effects across diagnostic technologies. As in the main analysis, sonogram utilization declines sharply, while tomograph use increases significantly. The estimated effect on MRI prescriptions is smaller in magnitude and no longer statistically significant, suggesting that the MRI response observed in the baseline results may be partly driven by large urban settings with more intensive diagnostic capacity.

For individuals aged over 65, excluding Milan does not alter the central pattern of results. UBB expansion remains associated with a large and precisely estimated increase in total diagnostic procedures, as well as with increased use of MRIs and tomographs and a reduction in sonograms. While the magnitudes are somewhat attenuated relative to the baseline estimates, the direction and statistical significance of the effects are preserved, indicating that the strong responsiveness of older individuals to UBB diffusion is not driven by Milan alone.

Turning to emergency room outcomes, the negative association between UBB coverage and ER utilization among individuals aged 25–55 remains large and highly significant. A one–percentage-point increase in UBB coverage is associated with a reduction of approximately 461 total ER visits and a sizable decline in inappropriate ER visits. These effects are slightly smaller than in the full sample but remain economically meaningful, reinforcing the interpretation that improved access to online health information reduces unnecessary reliance on emergency care among younger cohorts.

For individuals aged over 65, the estimates for ER outcomes become less precise once Milan is excluded. While point estimates remain negative for both total and inappropriate ER visits, they are no longer statistically significant. This loss of precision likely reflects reduced statistical power and greater heterogeneity in ER utilization patterns outside large metropolitan areas, rather than a substantive change in the underlying relationship.

Taken together, the robustness analysis excluding Milan confirms that the main conclusions of the paper are not driven by this unique urban context. The key patterns—namely, increased diagnostic activity, reallocation across diagnostic technologies, and reduced emergency care utilization among younger individuals—persist when Milan is removed from the sample. At the same time, the attenuation of some estimates suggests that large urban centers may amplify the magnitude of broadband-related behavioral responses, without overturning their qualitative nature.

	Estimate	SE	LB CI	UB CI
Diagnostic procedures	363.66	118.58	133.25	598.06
MRI	-3.20	1.76	-6.65	0.25
Sonograms	-55.45	8.87	-72.83	-38.08
Tomographs	9.57	1.71	6.21	12.93

Table 11. WAOSS Estimation excluding Milan – Diagnostic procedures (25–55)

	Estimate	SE	LB CI	UB CI
Diagnostic procedures	1932.42	253.21	1436.13	2428.71
MRI	9.39	2.55	4.39	14.39
Sonograms	-55.55	10.37	-75.88	-35.22
Tomographs	29.57	3.29	23.12	36.02

Table 12. WAOSS Estimation excluding Milan – Diagnostic procedures (Over 65)

	Estimate	SE	LB CI	UB CI
Total ER visits	-460.70	69.19	-596.31	-325.09
Inappropriate ER visits	-26.08	6.91	-39.62	-12.54

Table 13. WAOSS Estimation excluding Milan – ER outcomes (25–55)

	Estimate	SE	LB CI	UB CI
Total ER visits	-127.74	98.22	-320.25	64.77
Inappropriate ER visits	-18.80	19.02	-56.09	18.48

Table 14. WAOSS Estimation excluding Milan – ER outcomes (Over 65)

9.2 Placebo test: randomized coverage

To assess whether our main result could be driven by spurious correlations or generic features of the data, we conduct a randomization-based placebo test.

Specifically, we generate 1,000 placebo treatments by replacing the observed continuous treatment variable with a randomly generated variable drawn from a normal distribution with the same mean and standard deviation as the original coverage measure. This procedure preserves the scale of the treatment while breaking any systematic relationship with the outcome and the panel structure.

For each placebo treatment, we re-estimate the baseline specification using the same identification

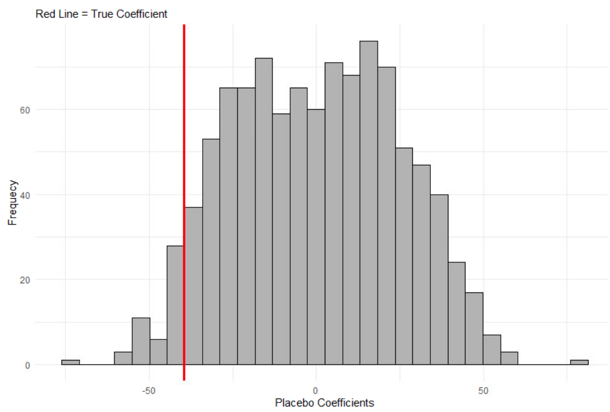


Figure 6. Placebo distributions for ACSC emergency department visits for individuals aged 25-55. The red vertical line indicates the coefficient estimated using the observed coverage.

strategy and sample as in the main analysis. We then compare the estimated coefficient obtained with the true treatment to the empirical distribution of coefficients obtained under random assignment.

Figure 6 reports the placebo distribution for ACSC emergency department visits among individuals aged 25-55. The estimated coefficient using the observed coverage lies far in the tail of the placebo distribution, in several cases outside the support generated under random assignment. Placebo results for all other outcomes and age groups are reported in Appendix and display qualitatively consistent patterns.

10 Discussion and Conclusion

This study provides causal evidence on the impact of UBB diffusion on healthcare utilization in Lombardy between 2015 and 2019. Our results show that improved internet access leads to a substantial increase in outpatient diagnostic activity while simultaneously reducing ER use. These findings support the hypothesis that access to online health information, whether accurate or misleading, can influence real world healthcare decisions and health care use.

The effects, however, are highly heterogeneous across population groups and physician characteristics. Among younger individuals, for emergency care the Dr Google effect reduces both total and inappropriate ER visits. In contrast, for older individuals, internet access amplifies healthcare engagement, leading to significant increases in diagnostic procedures across all technologies and, in some cases, higher ER utilization.

We also investigate how supply-side characteristics mediate these effects. We show that physician workload plays a central role in shaping how information-driven demand translates into healthcare utilization. In practices with lower patient loads, increased exposure to online health content leads to higher diagnostic activity, suggesting that physicians have greater capacity to accommodate patient concerns. Conversely, in high workload practices, UBB coverage is associated with muted or even negative effects on diagnostic prescribing, indicating that capacity constraints may limit the translation of patient demand into service provision.

We also document important differences related to the stability of the patient–doctor relationship. For younger individuals with a stable GP relationship, higher UBB coverage is associated with lower diagnostic use and fewer ER visits, suggesting improved self-triage and more efficient healthcare navigation. By contrast, among older patients with continuous GP relationships, internet access is associated with increased diagnostic utilization and ER visits, highlighting the role of trust-based relationships in amplifying precautionary care.

In Italy, reducing the number of GP prescriptions is an issue that has become topical in public debate on health care spending. For example, the Emilia-Romagna region has reduced the set of services that general practitioners can directly prescribe, moving over 2,100 diagnostic tests from GP authority to specialist referral in an effort to increase prescription appropriateness and better manage access to specialist appointments (Regione Emilia-Romagna Dipartimento Salute, 2025). This policy has generated debate in local media, with many arguing that reducing GP prescription rights hinders patients' access to health care services and extends waiting times (Ugolini, 2025). In Modena, the local health authority has introduced incentives for GPs who keep diagnostic prescriptions within predefined thresholds (Emilia-Romagna, 2025).

Taken together, these findings suggest that UBB expansion heightens patient demand for healthcare services, but its impact on utilization is shaped by both patient characteristics and institutional factors. Digital access does not uniformly increase healthcare use but rather reallocates demand across care settings and population groups.

From a policy perspective, our findings point to the double-edged role of digital health information. On the one hand, wider internet access can empower patients and reduce avoidable access to emergency care. On the other hand, it may also encourage excessive diagnostic testing, increasing pressure on publicly funded health systems. These considerations suggest that investment in digital infrastructure should be followed by measures to improve online health literacy, including access to transparent, reliable, evidence-based information sources. Our results investigating how the Dr Google phenomenon affects GP with different workload suggest that policies aimed at supporting appropriate prescriptions and referral practices, as well as supporting GPs in managing information-driven patient demand, may help contain unintended consequences.

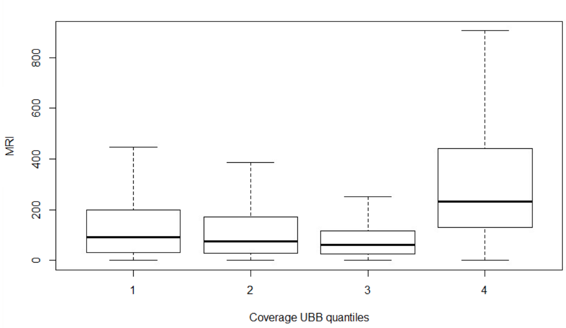
Future research should further investigate the psychological mechanisms underlying online health information seeking and explore how digital literacy can mitigate overuse. In addition, examining individual responses to specific types of online content and regional policy experiments would help better understand how information environments and health governance interact to shape healthcare behavior. As digital infrastructure continues to expand, understanding its interaction with healthcare systems will remain crucial for designing policies that maximize benefits while limiting inefficiencies.

Appendix

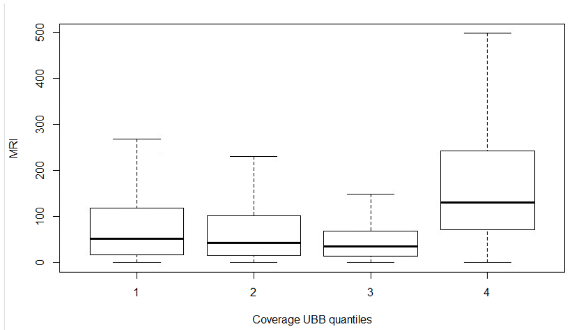
	(1)	(2)	(3)	(4)
	UBB coverage		UBB coverage (population weighted)	
	2015	2019	2015	2019
Italy	0.081	0.422	0.401	0.801
Center	0.050	0.484	0.437	0.835
North-East	0.050	0.423	0.317	0.747
North-West	0.027	0.319	0.355	0.769
South & Islands	0.171	0.517	0.461	0.838

This table shows mean coverage rates (overall and by Italian macro-areas) in 2015 and 2019. The first two columns display the unweighted average rate across municipalities, while columns 3 and 4 relate to UBB coverage weighted by municipalities' population.

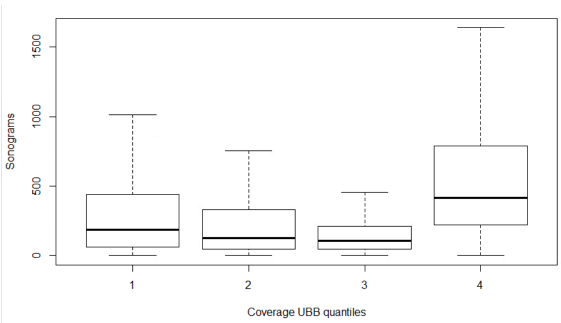
Table A1. UBB coverage: 2015-2019



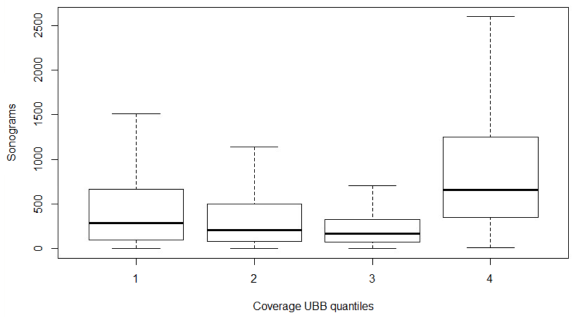
(a) Total outpatient MRI (65+)



(b) Total outpatient MRI (25-55).

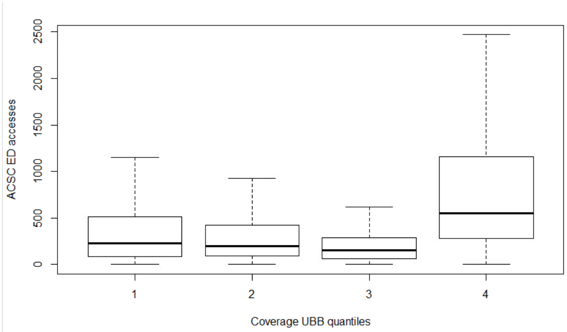


(c) Total outpatient sonograms (25-55).

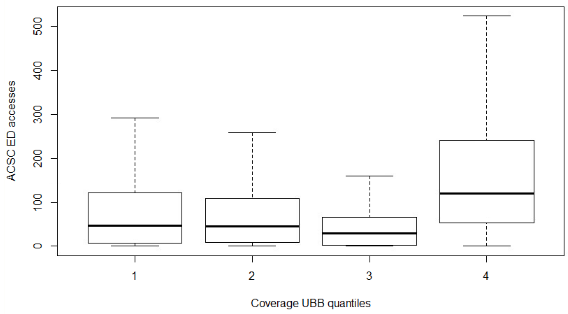


(d) Total outpatient sonograms (65+)

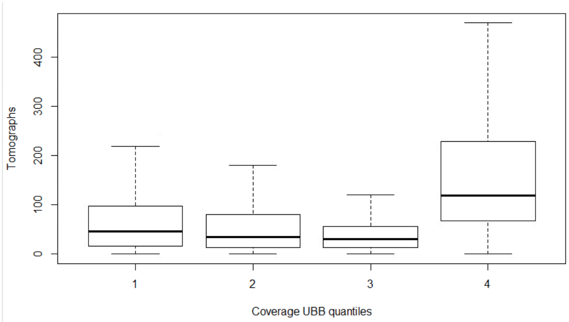
Figure A1. Distribution of Emergency Department and outpatient care utilization across quartiles of Coverage UB



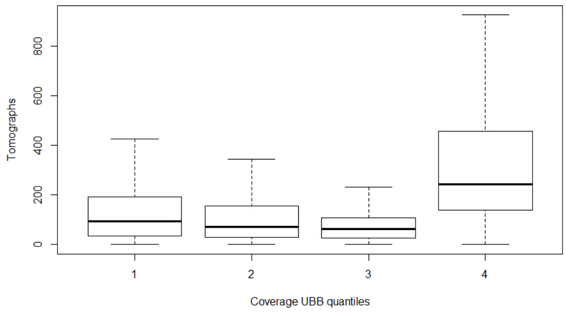
(a) ACSC ED accesses (65+).



(b) ACSC ED accesses (25-55).

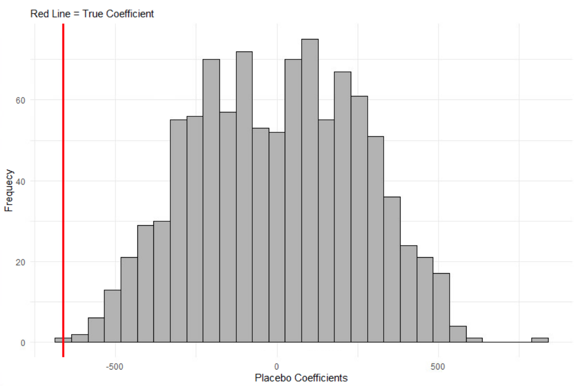


(c) Total outpatient tomographs (25-55).

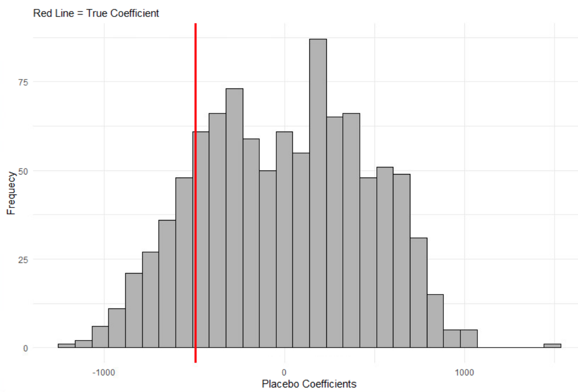


(d) Total outpatient tomographs (65+)

Figure A2. Distribution of Emergency Department and outpatient care utilization across quartiles of Coverage UB

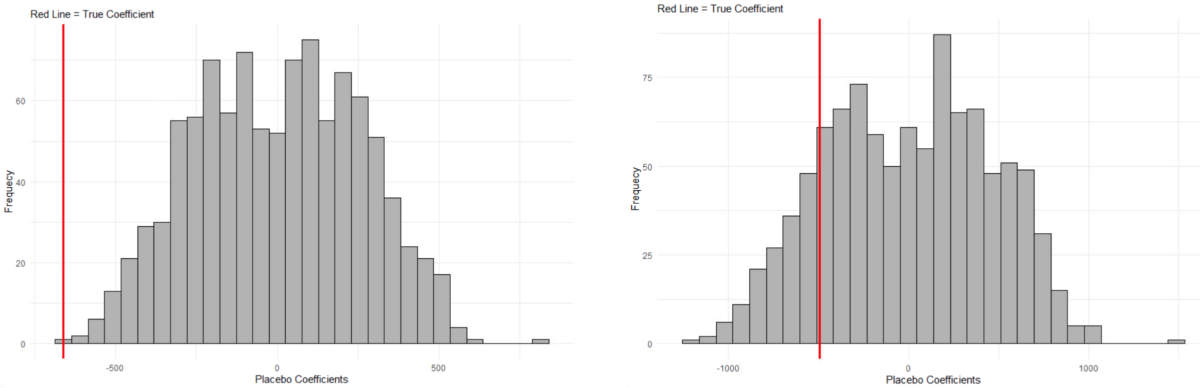


(a) Ages 25–55



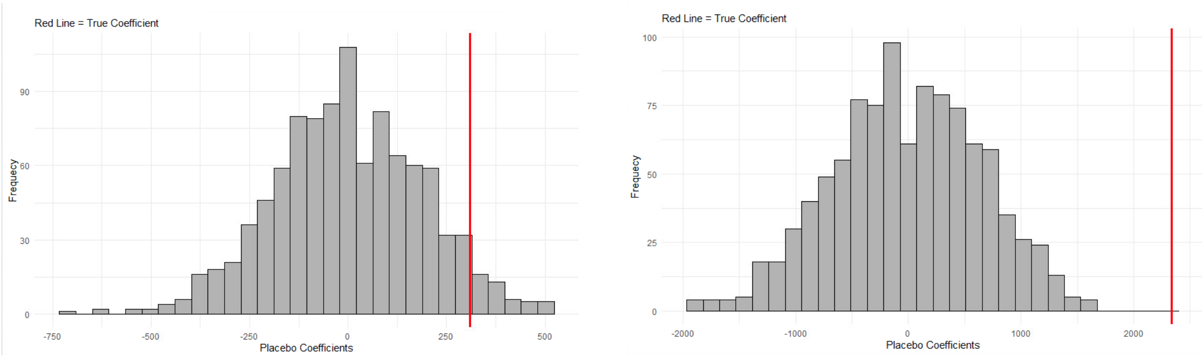
(b) Ages 65+

Figure A3. Placebo distributions for total emergency department visits. The red vertical line indicates the coefficient estimated using the observed coverage.



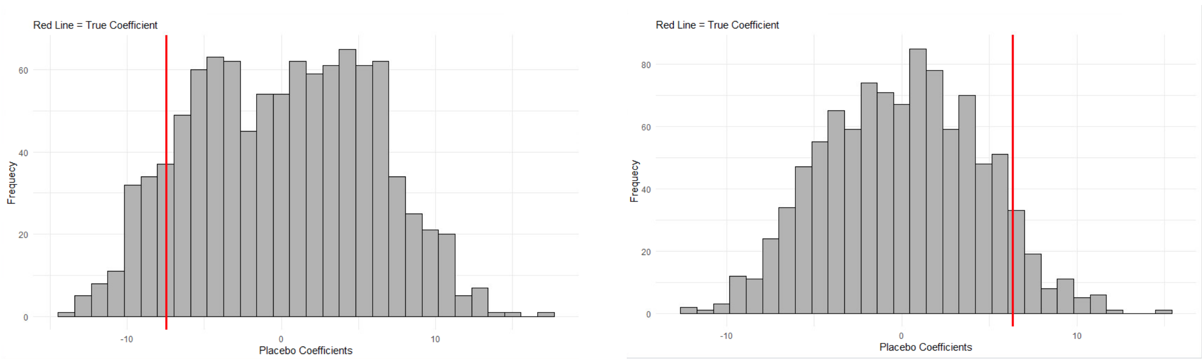
(a) Ages 25–55 **(b)** Ages 65+

Figure A4. Placebo distributions for total emergency department visits. The red vertical line indicates the coefficient estimated using the observed coverage.



(a) Ages 25–55 **(b)** Ages 65+

Figure A5. Placebo distributions for total prescriptions. The red vertical line indicates the coefficient estimated using the observed coverage.



(a) Ages 25–55 **(b)** Ages 65+

Figure A6. Placebo distributions for MRI. The red vertical line indicates the coefficient estimated using the observed coverage.

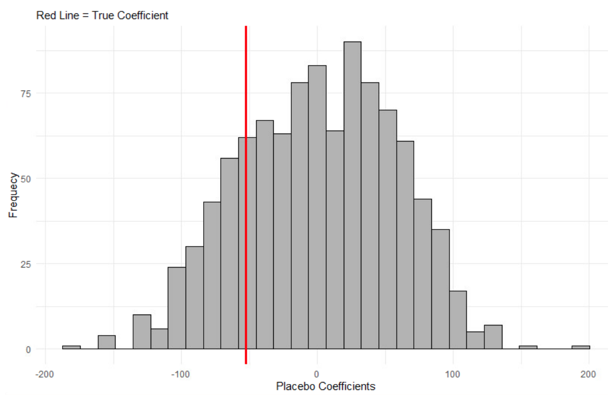
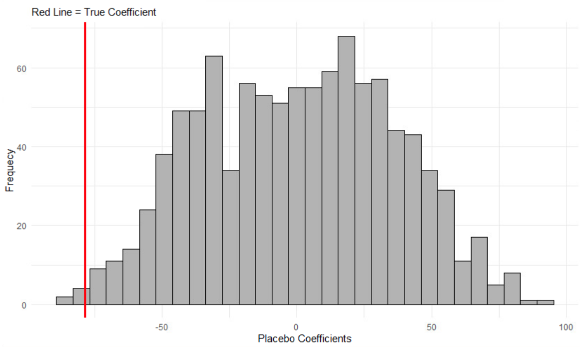
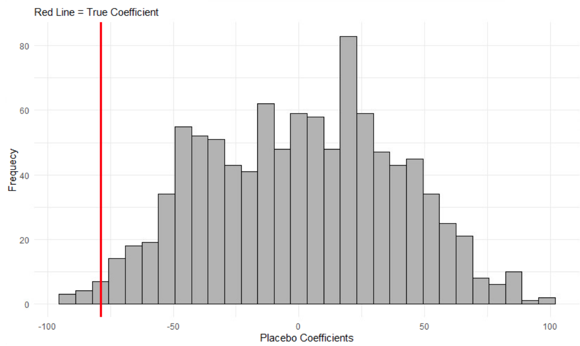


Figure A9. Placebo distributions for ACSC emergency department visits for individuals aged 65 and over. The red vertical line indicates the coefficient estimated using the observed coverage

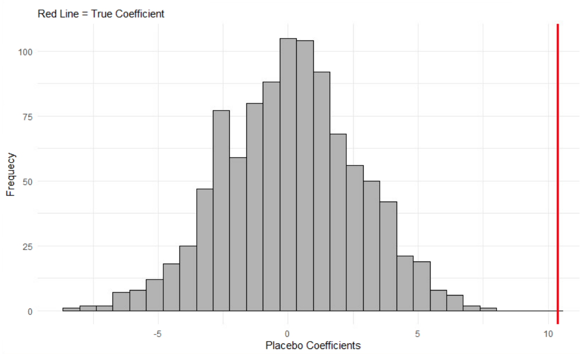


(a) Ages 25–55

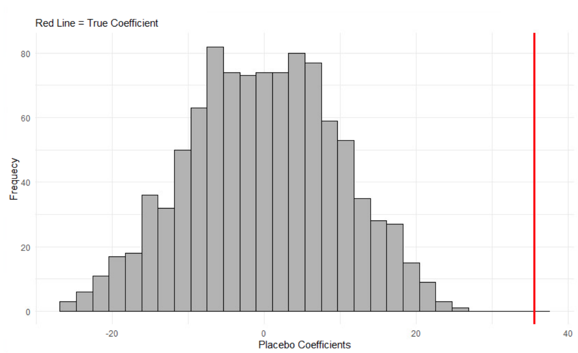


(b) Ages 65+

Figure A7. Placebo distributions for sonograms. The red vertical line indicates the coefficient estimated using the observed coverage.



(a) Ages 25–55



(b) Ages 65+

Figure A8. Placebo distributions for tomography. The red vertical line indicates the coefficient estimated using the observed coverage.

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