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journal homepage: www.elsevier.com/locate/jheLost in the net? Broadband internet and youth mental health[☆]Dante Donati^{a,b}, Ruben Durante^{c,b,d,e}, Francesco Sobbrío^{f,b}, Dijana Zejcirović^g *^a Columbia Business School, United States of America^b CESifo, Germany^c National University of Singapore, Singapore^d IZA, Germany^e CEPR, United Kingdom^f Tor Vergata University of Rome, Italy^g University of Vienna, Austria

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ABSTRACT

How does the internet affect young people's mental health? We study this question using administrative data on the universe of cases of mental disorders diagnosed in Italian hospitals between 2001 and 2013, which we combine with broadband internet availability at the municipal level. Broadband internet access raises the prevalence of mental disorders among younger cohorts (born between 1985 and 1995) by 0.08 standard deviation units, but it does not impact older individuals (1974 and 1984). The adverse effects are driven by individuals who were exposed early in their lives (before the age of 20). These effects persist when examining instances of self-harm and urgent or compulsory hospitalizations, indicating that the negative outcomes are not merely a result of increased awareness and detection of these conditions. The detrimental impacts span across different pathologies, including depression, anxiety, drug abuse, and personality disorders for both genders, in addition to eating disorders for females.

1. Introduction

As of 2019, about 13% of the global population suffered from some form of mental disorder (WHO, 2022). These disorders contribute to both mortality and morbidity, impacting various aspects of life, including decision-making, educational achievement, labor market outcomes, and criminal behavior (Currie and Stabile, 2006; Haushofer and Fehr, 2014; Anderson et al., 2015; BIASI et al., 2019; Shapiro, 2022).¹

The prevalence of mental disorders has sharply increased over the past decades, especially among younger people (Patel et al., 2016). Many commentators have ascribed this trend to the diffusion of the internet and social media, which have dramatically changed the way individuals spend their time and interact with each other (Castellacci and Tveito, 2018; Haidt, 2024). Public

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¹ Bloom et al. (2012) estimate the global cost of mental disorders in 2010 at USD 2.5 trillion. Mental health conditions are among the leading causes of Disability Adjusted Life Years (DALYs) globally and have the highest impact on individuals in early-to-mid-adulthood (Patel et al., 2016).

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concerns about the potentially detrimental effect of digital technologies on mental health are reinforced by information from industry insiders such as Frances Haugen, a former Facebook employee, who, testifying in front of the US Congress, stated that “[Facebook] is generating self-harm and self-hate, especially for vulnerable groups, like teenage girls”.²

The potential impact of the internet on (youth) mental health has also attracted the interest of academics from various fields, from medicine to psychology and, more recently, economics. Yet, empirical evidence in this regard is still limited and rather mixed with some studies documenting a significant negative effect (Allcott et al., 2020; Braghieri et al., 2022) and others finding no clear evidence in this direction (George et al., 2020; Odgers and Jensen, 2020). One of the main limitations of most previous studies is the reliance on self-reported measures of mental well-being, which are potentially problematic for at least two reasons. First, individuals’ perception of their own mental health can be potentially biased and inaccurate (Braghieri et al., 2022). Second, it may be directly influenced by the use of digital technologies, above and beyond the impact of the latter on actual health conditions (Podsakoff et al., 2003).³

Our paper overcomes these limitations using novel administrative data from Italy on the universe of young patients (born between 1974 and 1995) admitted to any Italian hospital between 2001 and 2013 who were diagnosed with a mental health disorder.⁴ Combining this information with data on access to broadband internet at the municipal level over the same period, we can study how the advent of the internet affected mental health outcomes, and how this effect varied by cohort (older vs. younger), gender (males vs. females) and by type of disorder (i.e., depression, anxiety, substance abuse, eating, personality, and sleep disorders).

Our empirical strategy exploits differences across Italian municipalities in the timing of the introduction of broadband technology (ADSL) due to the relative position in the pre-existing voice telecommunications infrastructure.⁵ Specifically, since ADSL-based internet services could only be offered in municipalities connected to high-order telecommunication exchanges (Urban Group Stage, UGS) via optic fiber, we use the distance of a municipality to the closest UGS as a source of variation for the availability of high-speed internet. Because the pre-existing infrastructure was not randomly distributed, our identification strategy – which follows Campante et al. (2017) – relies on interacting this distance with the time variation between the period before and after broadband became available (while also controlling for municipality and region-year fixed effects and for a rich set of observables in Census year 2001 interacted with year dummies). This instrumental variable strategy is based on the assumption that the correlation between the distance from the closest UGS and unobserved municipal characteristics did not change at that point in time other than through the introduction of high-speed internet.

Using this approach, we document no significant impact of the introduction of broadband internet on the overall occurrence of mental disorders. However, when differentiating between age groups, we find that high-speed internet access has harmful and significant effects on the prevalence of mental disorders among younger individuals, i.e., those born between 1985 and 1995, who were 10 to 20 years old in 2005, the first year when broadband data is available. The estimates show that broadband internet leads to a detrimental impact on mental health at the municipal level both along the extensive (i.e., probability of any mental disorders in the resident population) as well as intensive margin (i.e., total occurrences of mental disorders). The effect is rather sizeable: for example, going from 0 to 100% access to broadband internet is associated with 0.08 of a standard deviation (SD) increase in the overall occurrences of mental disorders in the younger cohort. The estimates are fairly similar across genders: for both males and females, annual mental diagnoses increase by almost 0.06 SD units. These magnitudes are comparable to the findings of Braghieri et al. (2022). By contrast, we do not find any significant effect among older individuals (i.e., those born between 1974 and 1984). Further results indicate that these effects are not concentrated among specific birth cohorts, but rather depend on the age at first exposure. Leveraging variation in broadband availability timing, we show that there is a clear relationship between age at first exposure and mental health. Only individuals exposed before the age of 20 experience negative mental health impacts.

Importantly, the main results are robust to several alternative samples and specifications (e.g., adding/removing controls, excluding urban municipalities and provincial capitals), levels of clustering of standard errors (municipal, provincial and regional) and different estimators (e.g., stacked diff-in-diff as in Cengiz et al. 2019). We also present a validation exercise providing suggestive evidence in support of our identification assumption by showing no significant relationship between our instrument (distance to the UGS) and mental health disorders for placebo samples, where no ADSL access was available.

One potential reason behind the observed differential effects may be differences in the use of the internet across birth cohorts. Additionally, early-life internet exposure can be particularly detrimental to mental health as childhood and adolescence are critical stages of cognitive, emotional, and social development. Excessive or inappropriate internet use could negatively impact the development in these formative years (Twenge et al., 2018; Boers et al., 2019), which can lead to long-lasting impacts on mental health.⁶ Children may lack adequate parental supervision in navigating how to use the internet effectively and deciding which content is age-appropriate.

At the same time, our analysis focuses on a period when the use of modern social media was still limited. As such, our findings highlight that the deteriorating impact of the internet on mental health may be driven not only by social media such as Facebook,

² Protecting Kids Online: Testimony from a Facebook Whistleblower, US Senate, Subcommittee on Consumer Protection, Product Safety, and Data Security Hearing, October 5, 2021.

³ For journalistic accounts on how digital platforms may directly affect self-perceived mental health, see <https://www.vox.com/the-goods/2021/9/30/22696338/pathologizing-adhd-autism-anxiety-internet-tiktok-twitter>.

⁴ This is similar to Arenas-Arroyo et al. (2023) who also use administrative hospital-records from Spain from 2007–2019 but do not exploit plausibly exogenous variation in the ADSL roll-out.

⁵ Our identification strategy is comparable to Golin (2021) who, similarly, relies on idiosyncrasies of the voice–telecommunication network in Germany but studies self-reported measures of mental health.

⁶ Depression in adolescence has been linked to, i.a., psychosocial and academic impairment (Meeus, 2016; Verboom et al., 2014).

Instagram or Twitter. In this respect, our results speak to the literature suggesting that access to broadband internet can negatively impact mental health beyond the use of modern social media (Kandell, 1998; Naito, 2007; Carli et al., 2012; Kaess et al., 2014; Haidt and Allen, 2020).

Our rich data allow us to dig deeper to shed light on the potential mechanisms underlying the overall effect. First, we explore whether the effect we document is driven by a mere increase in awareness or also by an actual change in the occurrence of mental disorders. In this regard, we find that access to broadband internet leads to an increase in the probability and number of (i) suicide attempts and episodes of self-harm, and (ii) compulsory hospitalizations due to mental health conditions posing a threat to the patient or others. Unlike for milder disorders, finding an effect on such extreme outcomes can hardly be explained by better access to mental health information. Furthermore, we also find similar effects when looking at urgent hospitalizations (unplanned hospitalizations). Again, this result is inconsistent with an explanation based only on amplified awareness and supports the view that the prevalence of mental disorders in the population actually increased. We also complement this evidence with data on internet use across cohorts and Google searches on different medical conditions, pointing out that awareness is unlikely to be the only mechanism at play. Second, to further elucidate the relationship between age and mental health issues, we examine how the main effects vary across different ages at the point of broadband introduction in the individual's municipality of residence. The evidence shows a clear gradient with respect to the age of first exposure to broadband. The detrimental effects on mental health are present for individuals who were 11 to 19 years old when this technology arrived in their municipality with larger effects for younger individuals. Conversely, those exposed to broadband later in life appear to be less susceptible to its adverse effects. We also explore the mechanisms in terms of broadband technology. In this respect, we document effects similar to the ones present for fixed broadband when looking at mobile internet using 3G data and employing a similar identification strategy. Finally, we look at the impact across specific mental disorders. We find that access to the internet is associated with a higher occurrence of cases of depression/anxiety, drug abuse, and personality disorder across all genders in the younger cohort. We observe an increase in eating disorders only for females.

Our paper contributes to a growing literature in economics and social sciences on the impact of the internet on mental health.⁷ McDool et al. (2020) find that faster internet connection in the UK is associated with children feeling worse about their appearance, an effect that is especially pronounced for girls. In a randomized trial, Allcott et al. (2020) find that individuals who deactivated their Facebook account for a month spent more time with family and friends and experienced a small but significant increase in subjective well-being.⁸ These findings suggest that the use of social media affects actual mental health conditions — and not just individuals' awareness of them. Braghieri et al. (2022) show that access to Facebook is associated with a deterioration in mental health status among college students in the US, arguably due to Facebook facilitating unfavorable social comparisons. Mandile (2025) provides evidence of the negative impact of Instagram's algorithmic feed on teenagers' mental health. Another reason why internet and social media use can be detrimental to mental health is due to their addictive nature (Allcott et al., 2022), also related to the induced "fear of missing out" (Bursztyn et al., 2023). Arenas-Arroyo et al. (2023) investigate the impact of high-speed internet on the mental health of young people in Spain. Similar to our results, they only detect negative health impacts among young children and not for older cohorts, although in their context these effects are only found among girls and not boys. Complementing our results, they document worsened mental health in a later time period than our study (2007–2019). Golin (2021) studies the effect of high-speed internet on mental health in Germany using survey data from the German Socio-Economic Panel. In line with our results, she finds that broadband access negatively affects self-reported mental well-being among female respondents only, and that this effect is larger for younger cohorts. Focusing on young people in Uruguay, Colombo et al. (2025) detect more nuanced results with increases in self-reported feelings of worry and simultaneous decreases in the incidence of loneliness. In line with our findings on the non-negative impact of broadband on mental health for older cohorts, Johnson and Persico (2024) provide correlational evidence showing a negative association between broadband coverage and suicides in US counties in the working age population (age 25–64).

Our study aims to estimate the causal impact of broadband internet on mental health disorders diagnosed by doctors in the entire population of a large country like Italy. As such, it complements, innovates and expands upon previous work in several ways. First, differently from experimental studies, our estimates shed light on the general equilibrium effect on the universe of individuals born between 1974 and 1995 in Italy. These results could be particularly relevant for other countries with universal health care access that introduced broadband internet in a similar time period. Second, we study how being able to access the internet – rather than a specific social media platform – affects mental health not just for college students but for the entire population of children, teenagers, and young adults. This is important since pre-college cohorts (i.e., aged 14 to 17) may be especially vulnerable to the effects of the internet. Third, our data allows us to estimate the effect of the internet on different disorders and types of hospitalizations and for different segments of the population. Such detailed results contribute to a deeper understanding of the various ways in which the internet may affect different groups, and to the design of targeted policy interventions. Fourth, the use of data on doctors' diagnoses strengthens the validity of our findings. Indeed, diagnoses by certified health professionals provide a more objective

⁷ More generally, our paper contributes to a vast literature on the influence of the internet on emotional well-being. In this context, several studies find a positive association between problematic internet use and suicidal behavior, depression/anxiety, personality disorders, and drug abuse (Kaess et al., 2014; Zadra et al., 2016; Ho et al., 2014).

Relatedly, evidence from psychology indicates that adolescents are especially susceptible to problematic internet and mobile phone use since they are developmentally more vulnerable (Sohn et al., 2019). Our results provide empirical support to this correlational evidence by showing a causal impact of broadband internet on mental health disorders for young individuals. The economics literature – with the exception of Johnson and Persico (2024) – is converging to negative effects of internet access on mental health, while studies from other fields show more mixed findings.

⁸ Similar evidence is available from Mosquera et al. (2020).

measure of mental health disorders than those based on self-reported data, which are harder to compare across time and space and are more likely to “suffer from measurement error for reasons related to recall bias and lack of incentive” (Braghieri et al., 2022).⁹ Fifth, with respect to later studies also employing hospital data (Arenas-Arroyo et al., 2023), our analysis relies on more granular units of observation (i.e., 7937 municipalities with a median population of 2353 inhabitants rather than 50 provinces with a median population of more than 600,000 inhabitants). Most importantly, while Arenas-Arroyo et al. (2023) and Johnson and Persico (2024) directly look at the impact of the – endogenous – broadband roll-out on mental health, we instrument the roll-out by exploiting exogenous variations in its cost due to the distance of a municipality to the pre-existing telecommunication infrastructure around the period in which broadband became available (Campante et al., 2017). Lastly, our analysis focuses on an early stage in the diffusion of the internet in Italy, when the use of modern social media was very limited. In this regard, our findings provide intriguing evidence that other online activities, beyond the use of social media, can also have significant implications for mental health.

2. Background and study setting

2.1. Health care provision in Italy

The Italian national healthcare system is funded through general taxation and provides universal and virtually free access to healthcare services to all residents. Patients are only required to pay a fixed access fee for specific services – e.g., non-urgent access to the ER, specialist visits, instrumental and laboratory diagnostic examinations – ranging from ten to a few hundred euros for the most complex tests, which is waived for low-income individuals and for patients with severe medical conditions. Public hospitals account for 80% of total hospital beds and private hospitals for the remainder (ASSS, 2020). The cost of health services to patients does not vary between public and private hospitals. While the key guidelines of the healthcare system are established at the national level, public health provision falls under the jurisdiction of and is managed by regional governments which, among other things, are responsible for setting payment fees, hiring personnel, and investing in infrastructure. Accordingly, municipalities in Italy have no control over healthcare services, such as hospitals, health facilities, doctors, and pediatricians (including their associated costs). This is particularly relevant in our context because our outcome variables vary at the municipal-year level and, therefore, cannot be influenced by changes in the healthcare supply beyond those determined at the regional level. Consequently, as explained in Section 5, we can account for potential confounders related to healthcare supply by including region-year fixed effects in our empirical design, as this allows us to flexibly control for any local trends in mental health service provision.

2.2. Fixed and mobile internet in Italy

Fixed-line broadband internet connection was first introduced in Italy in 1999 through Asymmetric Digital Subscriber Line (ADSL) technology.¹⁰ Yet, the broadband infrastructure experienced a slow development in its early phase. By the end of 2000, only 117 out of 8100 Italian municipalities had ADSL access. As explained in detail by Campante et al. (2017), a key parameter driving the timing of the broadband infrastructure diffusion across Italian municipalities was the distance between the municipality and the closest higher-order telecommunication exchange: the Urban Group Stage (henceforth UGS) whose location was pre-determined long before the advent of the internet. In particular, in order to provide ADSL services in a municipality, telecommunication operators had to bear the cost of connecting the municipality to the closest UGS via optical fiber. Accordingly, all else equal, “the closer a municipality happened to be to a UGS when ADSL came into the picture, the more likely that municipality would get ADSL access earlier on (Campante et al. 2017, p. 1103).¹¹

Mobile internet connections arrived at a later stage. At the end of 2004, only 4% of mobile phones in Italy had a UMTS/3G technology (Between, 2008). By the end of 2006, this percentage increased to around 21%. As for the fixed-line broadband, the mobile internet network also had to be connected to the backbone of the telecommunication infrastructure (*core network*). The distance of a municipality to the higher order nodes of the telecommunication network (Urban Group Stages, UGS, or Optical Packet Backbones, OPB) was therefore also highly relevant in the timing of 3G coverage across Italian municipalities (Guerrieri, 2009; TIM, 2019).

⁹ Doctors' assessment may also be imperfect and may be influenced by implicit biases related to the patient's gender, race, and sexual orientation (Snowden, 2003). In addition, doctors' evaluation of a given disorder may be affected by medical information they can access online, though arguably less so than that of patients who have little or no medical training and are, hence, more impressionable.

¹⁰ Alternative broadband technologies, such as cable and satellite, have been negligible in Italy (OECD, 2001; Between, 2008).

¹¹ Figure A.1 in the Appendix shows the distribution of ADSL availability in 2005 across Italian municipalities (taken from Campante et al. (2017)). Darker shades implies higher coverage.

3. Data

3.1. Health outcomes

Data on patients' mental health diagnoses come from the discharge reports issued by all Italian hospitals, both public and private ("Schede di dimissione ospedaliera", i.e., SDO).¹² For each case, the report includes the diagnosis code(s), and basic socio-demographic information of the patient (i.e., age, gender, municipality of residence). In particular, our dataset covers the universe of individuals born between 1974 and 1995 who were admitted to any Italian hospital between 2001 and 2013, and who were diagnosed with any mental health condition by medical personnel.¹³ Most importantly, the dataset reports the municipality of residence of each patient.

Hospital discharge reports typically contain up to three diagnosis codes, with one being the "primary diagnoses", and the others the "secondary or concomitant" ones. The primary diagnosis refers to the pathology that led to the greatest consumption of medical resources, and does not necessarily coincide with the cause of hospitalization. The secondary or concomitant diagnoses, when present, specify additional pathologies and provide a more complete clinical picture. Some secondary diagnoses qualify as complicating diagnoses, i.e., specific pathologies that, together with the main one, require a greater burden of care.¹⁴

Starting from the individual data, we construct a panel at the municipality-year level for each diagnosis. Specifically, we count, for example, the number of females born in 1974 resident in municipality m who were admitted to a hospital in year t and were later discharged with a diagnosis for mental health condition k (e.g., eating disorders).

When disentangling the effect across different types of mental disorders, we focus on five types of health conditions: (i) depression/anxiety disorders, (ii) drug abuse/addiction, (iii) eating disorders, (iv) personality disorders, and (v) sleep disorders. Specifically, we group diagnoses according to the WHO (2016) classification as follows. The depression/anxiety category includes all diagnoses involving depression, anxieties, or neurotic disorders (ICD-10 codes: F32, F33, F40, F41, F43.21–23). The Drug abuse/addiction category encompasses all drug-related diagnoses (ICD-10 codes: F10-F19). Eating disorders include anorexia, bulimia, and other eating disorders (ICD-10-CM code: F50). Personality disorders include schizophrenia (ICD-10-CM codes: F20, F21, F25) and bipolar disorders (ICD-10-CM code: F31), and other personality disorders (ICD-10-CM code: F60). Finally, sleep disorders correspond to code F51 in the ICD-10-CM classification.¹⁵

3.2. Fixed and mobile internet data

Our dataset on broadband availability provides information on the percentage of households with potential access to ADSL in each Italian municipality for each year between 2005 and 2011. The data were provided by "Osservatorio Banda Larga-Between", a joint venture between the leading Italian telecommunications operators, the Italian Ministry for Telecommunications, and other private and public stakeholders. Specifically, the measure of broadband access is defined on an asymmetric six-point scale corresponding to the following brackets: 0%, 1%–50%, 51%–75%, 76%–85%, 86%–95%, and above 95%. We linearize this measure by considering the midpoint of each interval, to make it comparable with our measures of 3G access defined continuously over the interval 0%–100%. For robustness, we also consider alternative measures of ADSL access such as "Years Since Good Broadband", defined as the number of years since at least 50% of households in a municipality have had ADSL access.

Since 2005 is the first year for which broadband data are available, we set our measure of ADSL equal to zero for all municipalities in the 2001–2004 period in our baseline specification. As shown in Section 7.2, the results are robust to alternative samples such as, for example, focusing on an unbalanced sample where in the 2002–2004 period, we keep only municipalities with no adsl in 2005.¹⁶ Similarly, the results are robust to excluding municipalities that are more likely to have been already covered by broadband before 2005 such as urban municipalities and provincial capitals.

We consider mobile internet, in addition to broadband, to assess whether our results vary depending on the type of connection. Specifically, we use data on 3G coverage as reported by mobile operators (Collins Mobile Coverage Explorer), covering the period 2007–2013.¹⁷ These data come in GIS vector format and assign the value 1 to each 1×1 km-cell that is reached by 3G signal. Following Donati (2023), we use the spatial mean of these values to compute the average share of land covered by 3G for every municipality-year. The resulting measure spans the continuous interval 0–1, where 1 indicates that the entire area in the municipality is covered by 3G. To ease the comparability of 3G and ADSL estimates, we rescale the measure of 3G coverage consistently with the ones for ADSL (e.g., we set it to the midpoint between 0 and 50% if 3G coverage is above zero and less or equal than 0.5). Moreover,

¹² The official data source is: "Archivio Nazionale dati SDO, Ministero della Salute, Direzione Generale delle Programmazione Sanitaria, Ufficio VI".

¹³ We also have data on individuals born in 1973, we decided to focus on the 1974–1995 cohorts to have symmetric cohorts in terms of birth-years span, i.e., 1974–1984 and 1985–1995. Results on the 1973 cohort are in line with the ones on the 1974 cohort and are available upon request to the authors. Unfortunately, given the high sensitivity of this type of data, the Italian Ministry of Health did not allow us to request data on a larger set of cohorts. The original correspondence with the data providers is available upon request to the authors.

¹⁴ Source: http://www.salute.gov.it/portale/p5_1_2.jsp?lingua=italiano&id=126.

¹⁵ It is worth noting that in the period covered by our broadband data (2005–2013), the number of Italian hospitals admitting patients affected by mental health disorders for long-term hospitalization dropped from 1064 to 930. Such reduction affected all Italian regions with only very few exceptions (e.g., in Lombardy, the number of such hospitals increased by 47 units). Source: http://dati.istat.it/Index.aspx?DataSetCode=DCIS_OSPDISTPSICHRIC.

¹⁶ That is, this involves dropping observations in the 2002–2004 period for municipalities that have already broadband access in the first year of our ADSL data, i.e., 2005. This corresponds to a drop of 13% of the baseline sample.

¹⁷ <http://www.collinsbartholomew.com/mobile-coverage-maps/mobile-coverage-explorer/>.

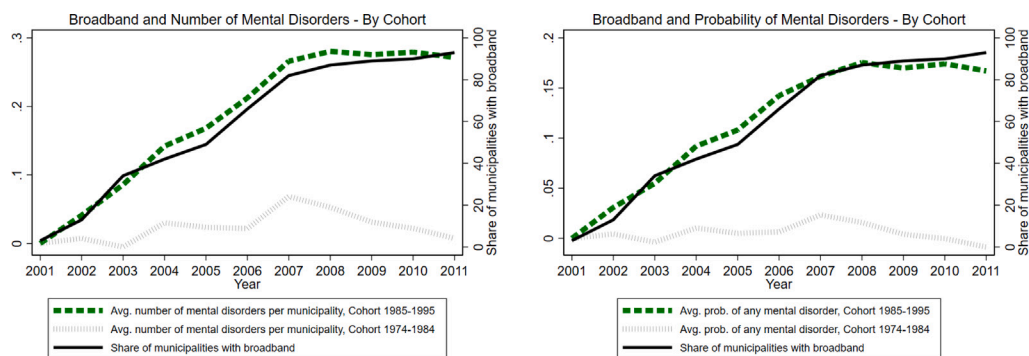


Fig. 1. Broadband access and mental health disorders.

Notes: Evolution of broadband access and average prevalence of mental health disorders at the municipality-level by birth-cohorts over time (gray dotted line: 1974–1984, green dashed line: 1985–1995, solid black line: broadband access). Left-panel measures the average total number of hospitalizations while the right the average probability of at least one hospitalization in the municipality. All mental health measures are standardized with respect to the baseline year 2001. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Data sources: Osservatorio Banda Larga and Archivio Nazionale dati SDO, Ministero della Salute, Direzione Generale delle Programmazione Sanitaria, Ufficio VI.

analogously to ADSL, we set 3G coverage equal to 0 for all municipalities in the years where no data is available (2001–2006). It is important to notice, that there is not a perfect overlap between the two measures. In 2007 (the first year when 3G and ADSL data were both present), 26.16% of the municipalities in our sample were covered by 3G while having no ADSL coverage. In the last year when both 3G and ADSL data are available (2011), the percentage of municipalities in our sample covered by 3G while having no ADSL coverage is 14.71%.

Finally, we collect information on municipal characteristics in the census year 2001 as well as population estimates by age groups between 2002 and 2013 from the Italian National Institute of Statistics (ISTAT). Our final sample consists of 7937 municipalities. Summary statistics on all variables are reported in Table A.1. Appendix Table A.2 provides summary statistics on the prevalence of specific mental disorders by cohort and gender.

4. Descriptive evidence

Fig. 1 shows the evolution of broadband access at the national level and the prevalence of mental disorders across different age groups in Italian municipalities between 2001 and 2011.¹⁸ The left panel reports the average number of total cases of mental health disorders in a municipality, while the right panel shows the average probability of any mental health diagnosis, normalizing the values at zero in 2001. The graph provides *prima-facie* evidence of a positive correlation between broadband access and mental disorders for the younger cohort (individuals born between 1985 and 1995) while there is no discernible pattern for the older cohort (individuals born between 1974 and 1984).¹⁹ Figure A.2 in the appendix presents graphs by cohorts and gender, showing an even stronger correlation for females belonging to the younger cohort.

5. Empirical strategy

Broadband access may be spuriously correlated with the prevalence of mental health disorders. For example, urban municipalities may get access to broadband earlier on due to higher demand factors and, at the same time, may experience a higher incidence of mental health among younger generations. To address this concern, we adopt an instrumental variable approach using cost-level factors to instrument for broadband internet coverage at the municipal level. As explained in Section 2.2, the distance of a municipality from the closest UGS was a key determinant of the cost of providing broadband services in that municipality. From the standpoint of telecommunication operators, connecting a more distant municipality required higher investments. Hence, we can exploit variation in this distance across municipalities to gauge the causal impact of broadband access. However, the pre-existing telecommunication infrastructure was not randomly distributed. To control for time-invariant municipal characteristics correlated with both the distance to the closest UGS and mental disorders, along the lines of Campante et al. (2017), we instrument broadband access with the interaction between the distance and a dummy for the post-2005 period, since this distance should only be relevant at

¹⁸ As discussed in 3.2 there is no broadband data available at the municipal level for Italy prior to 2005. The broadband data presented in Fig. 1 and A.2 is based on national level data from Between (2006, 2008).

¹⁹ Notice that the flattening out of mental disorders after 2008 for the younger cohort is likely to be linked to two factors. First, as also shown in the graph, most municipalities were already covered by broadband in 2008. Accordingly, it is likely that the residual impact of broadband on mental health is limited after that point. Second, as we discuss in Section 8.3 broadband does not have much of an impact on mental health when arriving in a municipality for people that are already 18 or older. The mid-point of the young age cohort (1985–1995) is indeed exactly 1990. Hence, the “mean” individual in this cohort was 18 in 2008 and thus likely, not being affected by the arrival of broadband in her municipality at that point.

the time of broadband roll-out and control for municipality fixed effects.²⁰ The identification assumption is that whatever correlation existed between the distance to the closest UGS and relevant municipality characteristics did not change at the time the ADSL technology was introduced, so any change in the impact of distance on the outcome of interest is only due to the introduction of the broadband internet.

The following two-stage specification summarizes our econometric strategy:

$$Y_{m,t}^k = \gamma \widehat{Broadband}_{m,t} + \beta X_{m,t} + \alpha_m + \tau_t + \epsilon_{m,t} \quad (1)$$

$$\widehat{Broadband}_{m,t} = \phi Distance_UGS_m \times Post - 2005 + \sigma X_{m,t} + \zeta_m + \theta_t + \eta_{m,t} \quad (2)$$

where subscripts m and t indicate respectively municipality and year; $Y_{m,t}^k$ represents the outcome of interest which we measure both in terms of intensive (total occurrences of cases of mental health pathology k in municipality m in year t) or extensive margin (probability of any case of mental health pathology k in municipality m in year t). To account for the non-linearity in the distribution of mental disorders, all the variables relative to the intensive margin are expressed as log of the total number plus one. In a robustness check (Table 3) we show that the results are robust to using an inverse hyperbolic sine transformation or normalizing the occurrence per capita.²¹ α and ζ are municipality fixed effects; τ and θ are region-year fixed effects; and X is a set of municipal controls.²²

Broadband denotes one of the measures of broadband access described in Section 3.2, while *Distance_UGS* is the (time-invariant) distance of a municipality's centroid to the closest UGS.²³ We interact this variable with a dummy (*Post-2005*) that takes value 1 for years after 2005, i.e., after the observed rollout of broadband internet in our data.²⁴

We include municipality fixed effects to rule out the possibility that our results are driven by time-invariant unobserved municipality characteristics. Hence, we exploit variation in broadband access due to the proximity to the telecommunication infrastructure purged from any municipal time-invariant characteristics. The inclusion of region-year fixed effects allows, instead, to control for any time-variant differences across regions. This aspect is especially important since, as mentioned in Section 2, healthcare is managed at the regional level in Italy.

Our identification assumption would be violated by the presence of subjacent trends in the outcomes related to factors correlated with *Distance_UGS* \times *Post* - 2005. This would be the case, for example, if mental health cases were becoming more frequent in municipalities with higher educational attainment, which also happened to be closer to UGS, precisely around the observed rollout of broadband internet. To account for this possibility, we control flexibly for a number of economic and socio-demographic municipal characteristics. Specifically, we include the following variables available at a yearly frequency: log population, shares of the population aged 20 or less, between 20 and 39 year-old, between 40 and 59 year-old, and between 60 and 79 year-old. In addition, we control for a range of other municipal characteristics in the baseline Census year 2001, which we interact with year fixed effects.²⁵ These include: population density, terrain ruggedness, unemployment rate, share of population with a university degree, number of firms per capita, number of non-profit organizations per capita, and distance of the municipality's centroid to the closest provincial capital. It is important to note that, by including population density and distance to the closest provincial capital, we are controlling in multiple ways for the possibility that small, isolated, rural towns, which are more likely to be far from a UGS, may have differential trends relative to larger urban centers. Accordingly, our identification strategy requires that there is no change in the correlation between distance to UGS and the outcomes of interest around the time of broadband rollout, once we account for these potential trends. Importantly, Section 7.3 provides direct evidence in support of this by comparing baseline vs. placebo reduced form estimates. Finally, to account for possible serial correlation in the error terms, we cluster standard errors at the municipality level.²⁶

6. Preliminary evidence

Before showing our main results, we provide evidence in support of our empirical strategy. First, we report the evolution of mental disorders across municipalities that were ex-ante more vs. less likely to be connected to ADSL: i.e., the ones having a distance to UGS below vs. above the median, respectively. Fig. 2 shows such evolution for the older (upper panels) and younger cohort (lower

²⁰ As we have a limited pre-broadband period, differently from Campante et al. (2017) we set to zero broadband in the years where we do not have ADSL data (2002–2004). If anything, this works against finding a significant effect, as it is likely to lead to a downward bias in the estimates. Panel E of Table 4 reports the results of a specification identical to the one of Campante et al. (2018), where the instrument is *de-facto* interacted with a post-2001 dummy. As expected, the magnitudes of the point estimates of this specification are larger with respect to our baseline specification. Moreover, Appendix Table A.4 provides estimates when using as an alternative instrument the interaction between the distance to the closest UGS and a linear time trend.

²¹ The results are also robust to using a linear specification and are available upon request to the authors.

²² Exploiting municipality fixed effects and comparing hospitalization data before and after the arrival of ADSL in the municipality rules out that other pre-determined factors at the municipality-level are explaining our results.

²³ The individual variables, *Distance_UGS_m* and *Post* - 2005, are absorbed by the municipality and year fixed effects.

²⁴ Figure A.3 shows the first stage relationship between our instrument – distance to the telecommunication infrastructure UGS – and our independent variable – access to ADSL – over time. The further the municipality is located from the network, the lower the ADSL coverage. While the predictive power is consistent throughout our study period, it is strongest in the early years of the broadband roll-out. Appendix Table A.3 reports the results of the full first stage specification of Eq. (1).

²⁵ By controlling for observables at baseline interacted with year fixed effects (rather than time-varying controls) we avoid the issue of including potentially endogenous controls in our analysis.

²⁶ For the purpose of robustness, in Table 5 we also present estimates when clustering by province or by region-year.

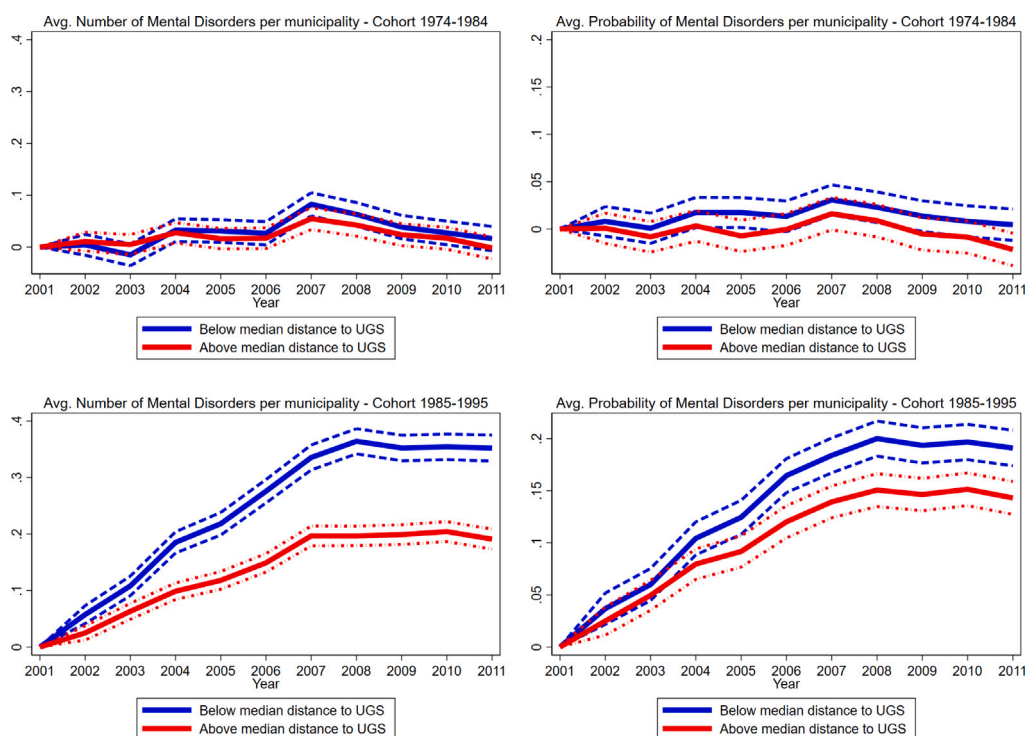


Fig. 2. Distance to UGS and mental health disorders.

Notes: Evolution of average prevalence of mental health disorders by distance to the closest urban group stage (UGS). The blue lines report the average prevalence of mental health disorders for municipalities with a distance to the closest UGS below the median. The red lines report the average prevalence of mental health disorders for municipalities with a distance to the closest UGS above the median. The dashed lines represent 95% confidence intervals. The left-panels report the average total number of mental health disorders per municipality. The right panels report the average probability of having at least one case of mental health disorders in the municipality. The upper panel illustrates the patterns for the 1974–1984 cohort. The bottom panel illustrates the patterns for the 1985–1995 cohort. All mental health measures are standardized to the baseline year 2001. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

panels) in terms of the average number of total cases (left panels) and the average probability of any mental disorder (right panels), with 95% confidence intervals.²⁷ While no discernible pattern across municipalities emerges for the older cohort, when it comes to the younger cohort (born between 1985 and 1995) there is a larger increase in mental health disorders in municipalities that were closer to a UGS (below median distance) relative to the more distant ones. Moreover, this gap intensifies over time, as broadband access increases (see Fig. 1).

Fig. 3 provides a corresponding picture when excluding from the sample municipalities that were likely to be already connected to broadband between 2001 and 2004, i.e., provincial capitals and urban municipalities.²⁸ Accordingly, it is possible to split more clearly the sample into a pre-period (2001–2004) and a post-period (2005–2011) with respect to broadband coverage. Therefore, Fig. 3 allows to look more directly at the evolution of mental disorders pre vs. post broadband.

The bottom panels show how municipalities with higher probability to be connected after 2004 (i.e., those below median distance to a UGS), before the arrival of broadband were not on a differential path in terms of youths' mental health outcomes compared to the “control” group (municipalities with a distance to a UGS above the median). At the same time, once broadband started being rolled out these two groups of municipalities took different trajectories in terms of mental health of their young resident population. Moreover, the upper panels show the absence of pre-trend as well as no clearly significant pattern in terms of post-trends for the older cohort.

²⁷ The total cases in a municipality and probability of any case are normalized to the 2001 baseline.

²⁸ All provincial capitals and 96% of urban municipalities were indeed already connected in the first year of available ADSL data, i.e., in 2005.

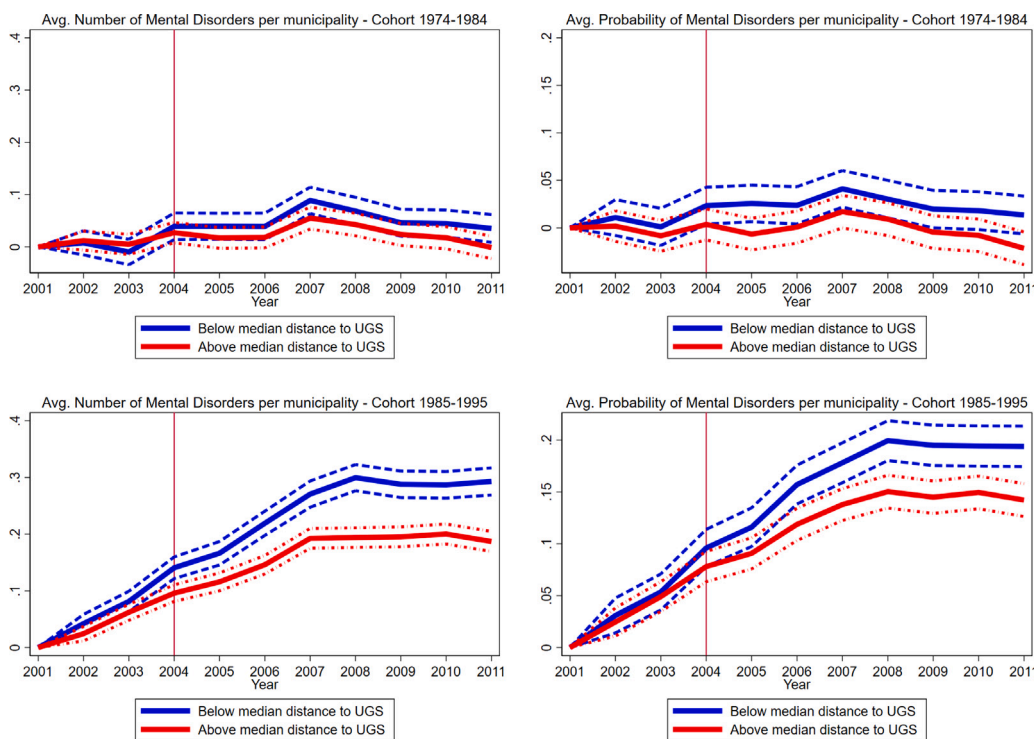


Fig. 3. Distance to UGS and mental health disorders — pre vs. post broadband.

Notes: Evolution of average prevalence of mental health disorders by distance to the closest urban group stage (UGS) excluding provincial capitals and urban municipalities. The blue lines report the average prevalence of mental health disorders for municipalities with a distance to the closest UGS below the median. The red lines report the average prevalence of mental health disorders for municipalities with a distance to the closest UGS above the median. The dashed lines represent 95% confidence intervals. The left panels report the average total number of mental health disorders per municipality. The right panels report the average probability of having at least one case of mental health disorder in the municipality. The upper panel illustrates the patterns for the 1974–1984 cohort. The bottom panel illustrates the patterns for the 1985–1995 cohort. All mental health measures are standardized to the baseline year 2001. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

7. Broadband internet and mental health

7.1. Baseline results

Table 1 shows how broadband connection impacted the overall number of mental disorders in a municipality (Column 1) and on the occurrence (probability) of any case of mental disorders in a given municipality-year (Column 2).²⁹

Panel A presents the results for all individuals in our sample. Panels B and C present results when looking at the older and younger cohort, respectively. The first stage works in the expected direction: the distance to the UGS is significantly negatively correlated with broadband coverage (see Figure A.3) and we have a strong first stage, as shown by the large F-stat of the excluded instrument (62.40).³⁰ Panels B and C present the results by splitting the sample into two equally large birth cohorts. For the cohort of individuals born between 1985 and 1995, the estimates suggest a significant positive effect of broadband internet on the overall number of mental disorders as well as in terms of the probability of any mental disorder in the municipality. By contrast, we do not find any impact on the older cohort, for which estimates coefficients are closer to zero and statistically insignificant. In Appendix Table A.5, we pooled the data from both cohorts and interacted broadband coverage with an indicator for the younger cohort. The coefficients on the interaction terms (columns 1 and 2) confirm a significant difference in the impact of broadband on mental health disorders for the younger cohort compared to the older cohort, which showed no significant effect. Fig. 4 presents a breakdown of the main estimates by year of birth. The figure validates that the detrimental impact of broadband internet on mental health is confined to the younger cohorts.

The relative effects appear rather sizeable. For example, Column 1 of Table 1 suggests that a unitary increase in municipal broadband coverage (i.e., going from zero to hundred percent penetration) increases the overall prevalence of annual mental

²⁹ The total number of mental disorders, as well as the other variables on the intensive margin of mental disorders, are expressed as log of the total number plus one. The results are robust to using a linear specification and are available upon request to the authors. Table 3 also shows that the results are robust to using an inverse hyperbolic sine transformation rather than the logarithmic one, and normalizing occurrences per capita.

³⁰ Appendix Table A.3 reports the results of the first stage specification of Eq. (1).

Table 1
Internet and mental disorders.

	Total occurrences	Any occurrence
Panel A: All		
Broadband	0.192 (0.139)	-0.040 (0.082)
Mean	3.55	0.52
SD	32.19	0.50
Panel B: Cohort 1974–1984		
Broadband	0.007 (0.125)	0.041 (0.089)
Mean	2.65	0.45
SD	20.34	0.50
Panel C: Cohort 1985–1995		
Broadband	0.752*** (0.142)	0.201** (0.099)
Mean	0.90	0.25
SD	12.48	0.43
Observations	87,307	87,307
F-stat (Excluded instrument)	62.40	62.40
Municipality controls	Y	Y
Municipality FE	Y	Y
Region-Year FE	Y	Y

Notes: The dependent variable in Column 1 is equal to the logarithm of one plus the total occurrences of mental health disorders in a municipality-year (for the corresponding cohort). The dependent variable in Column 2 is equal to a dummy variable indicating the occurrence of any mental health disorders in a municipality-year (for the corresponding cohort). Contemporaneous municipality controls include: population size, share of age groups (0–19, 20–39, 40–59, 60–79, >80 residual category). Baseline characteristics at the municipal level (in census year 2001) interacted with year dummies are: population density, distance to closest provincial capital, ruggedness, unemployment rate, share of university graduates, number of firms per capita, and number of non-profits organizations per capita. Column 1 reports the means and standard deviations of the (linear) number of total occurrences of mental disorders (for the corresponding cohort). All means and standard deviations are reported at baseline (i.e., for municipality-years with no broadband coverage). * Significant at 10%, ** significant at 5%, and *** significant at 1%.

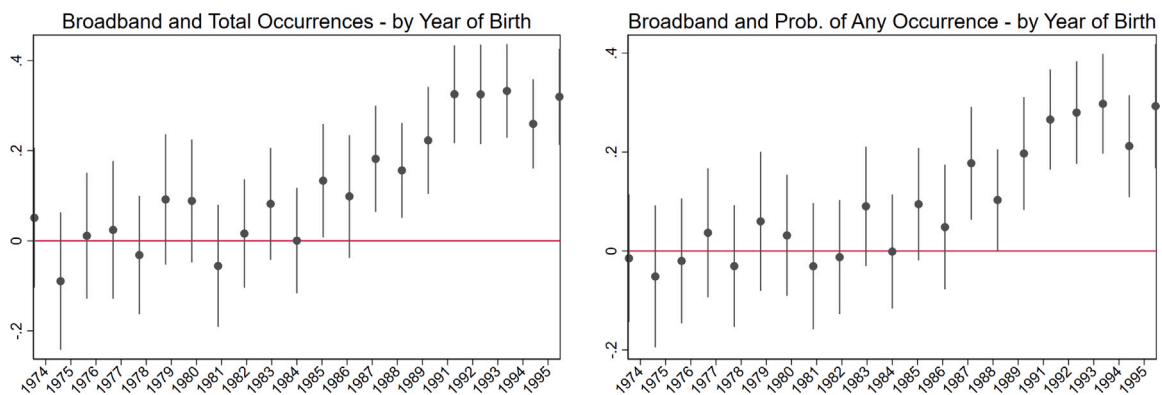


Fig. 4. Broadband and mental disorders — By year of birth.

Notes: The graph illustrates IV estimates of Eq. (2) (with 95% confidence intervals) by birth cohort. The dependent variable in the left panel is equal to the logarithm of one plus the total occurrences of mental health disorders in a municipality-year (for the corresponding cohort group). The dependent variable in the right panel is equal to a dummy variable indicating the occurrence of any mental health disorders in a municipality-year (for the corresponding cohort group).

disorders in the younger cohort by 111% ($e^{0.75} - 1$).³¹ For the sake of interpretation, the table reports the mean and standard deviation of the outcomes in municipalities-years with no broadband. Considering the mean of the dependent variable (0.9), the relative effect for the young cohort translates into an average absolute increase of 1 case per year, corresponding to 0.08 standard deviation (SD) units. In terms of probability of any occurrence (i.e., the extensive margin) of mental disorders, the absolute effect is equal to 20 percentage points. Our results are comparable to those of Braghieri et al. (2022), who estimate that the Facebook

³¹ More generally, the percent change in y due to a unitary increase in x is $e^{\beta} - 1$.

roll-out led to an increase by 0.085 standard deviation units in the index of poor mental health among US college students. At the same time, our setting is different across several dimensions. First, we look at the overall number of mental health disorders rather than a composite index. Second, [Braghieri et al. \(2022\)](#) look at the roll-out of a single social media platform with limited features (at the time of their study) over a limited period of time (2004–2006). Our effect is over seven years of access to an entirely new technology that encompasses several platforms, websites, etc.³²

In Table A.6, we test the sensitivity of our findings to different specifications and estimators. First, we report the results of a two-way fixed effects (TWFE) model for the total number of mental disorders and the probability of any mental disorder in a municipality. We consider the case where the treatment variable is continuous (i.e., broadband coverage) as well as where it is measured with a dummy (any broadband in the municipality-year). Second, we report estimates using the stacked diff-in-diff approach by [Cengiz et al. \(2019\)](#) to account for the staggered nature of broadband access.³³ Finally, we show the IV results replicating the diff-in-diff specification, instrumenting any broadband access in the municipality. The signs and significance of the TWFE and Stacked diff-in-diff regression results are in line with the ones of the IV, with larger magnitudes in the 2SLS regressions. The magnitude differences between the OLS (and related TWFE and Stacked diff-in-diff specifications) and the 2SLS may be explained by: (a) the OLS likely suffering from omitted variable bias; (b) the unevenness of our measure of broadband coverage and related measurement error associated with the OLS estimates; (c) the IV measuring the Local Average Treatment Effect.³⁴

Our dataset also allows us to investigate how such results may vary across genders within each cohort. [Table 2](#) provides further evidence that the younger cohort drives the detrimental impact of broadband internet on mental disorders. It is also possible to detect an increase in both the extensive and intensive margin for males and females born between 1985 and 1995. At the intensive margins, the effects appear quite similar across genders. For example, annual mental diagnoses increase by 85% for males and by 75% for females. These correspond to an absolute annual increase of 0.3 male cases (0.056 SDs) and 0.4 female cases (0.055 SDs). Effects at the extensive margin are slightly larger for males than for females.

In Appendix Table A.5, we pooled the data for the younger cohort across both genders and interacted broadband coverage with an indicator for female cases. This specification further shows that broadband coverage affects both males and females belonging to the younger cohort. The coefficients on the interaction terms (columns 3 and 4) indicate that impact on the intensive margin is larger for males, while there is no statistically significant difference on the extensive margins. [Section 8.4](#) further decomposes the heterogeneous effects across males and females by type of mental disorder.

All in all, these findings highlight that the deteriorating impact of the internet on mental health may be driven not only by modern social media, as it precedes the advent of these platforms. Accordingly, our estimates bring causal support to the literature suggesting that access to broadband internet can negatively impact mental health beyond the use of modern social media ([Haidt and Allen, 2020](#)). People may become addicted to being online, be exposed to harmful content, sleep less, engage less in physical activity, or engage in fewer face-to-face interactions ([Castellacci and Tveito, 2018](#)). The arrival of broadband internet also provided an easy escape from real-life problems, which could reinforce avoidance behavior. This might prevent individuals from facing and resolving personal issues, potentially exacerbating mental health conditions.³⁵ Broadband internet access can accelerate addictions by providing constant and easy access to addictive activities, paired with the anonymity of the user. Accordingly, our estimates

³² Importantly, our unit of observation is the municipality rather than individuals. As such, the effect on the intensive margin may capture at the same time: (1) the impact of broadband internet on triggering mental disorders in individuals who previously had not experienced these disorders or, at least they did not had to resort to a hospitalization; (2) the impact of broadband internet on triggering more episodes of mental disorders in individuals who had a pre-existing condition. Finally, the probability of observing any episodes of mental disorders in a municipality (i.e., the extensive margin) encompasses the aggregate effect across all individuals resident in a municipality and thus it is mechanically larger of individual measures on the probability of experiencing any mental health issue.

³³ Following [Cengiz et al. \(2019\)](#), the stacked diff-in-diff estimates the following equation

$$Y_{h,m,t} = \beta D_{h,m,t} + \sigma X_{m,t} + \delta_{h,m} + \delta_{h,t} + \varepsilon_{h,m,t} \quad (3)$$

where $Y_{h,m,t}$ is the observed outcome in municipality m at time to event t in the event-level h . Furthermore, $D_{h,m,t} = \mathbb{1}\{t \geq G_{h,m}\}$, where $G_{h,m}$ is time when municipality m is connected to broadband in the event-level h . $X_{h,m,t}$ represents controls at the event-municipality-time level analogously to our baseline [Eq. \(2\)](#). Finally, $\delta_{h,m}$ and $\delta_{h,t}$ represent municipality-event and time-event fixed effects, respectively. Standard errors are clustered at the municipality level. [Appendix Figure A.4](#) presents the corresponding event-study estimates of the dynamic version of [Eq. \(3\)](#) with six leads and six lags.

³⁴ Municipalities covered by broadband internet earlier or more intensively are likely to be systematically different from those that do not in ways that could also be correlated with mental health outcomes. The municipality fixed effect accounts for time-invariant differences in this respect (with municipal-level controls in the baseline year 2001 interacted with year-fixed effects capturing any non-parametric trends in those specific observable variables). Yet, earlier adopting municipalities might have unobservable characteristics or embed other unobservable attenuating factors that are positively correlated with mental disorders. There might be underlying trends in unobservable positive attributes that could bias the OLS estimates downward, attenuating the negative effect of broadband internet on mental health. Moreover, our measure of broadband access is rather coarse as it gives us information on the percentage of households covered by broadband internet on a six-point (asymmetric) scale. As such, this might lead to a classical measurement error, which tends to attenuate OLS estimates toward zero. The IV estimation approach can correct this particular attenuation bias, yielding larger estimates. Finally, while the OLS regressions reflect the impact of the internet on mental health outcomes across all localities (in the absence of omitted variable bias and measurement error), the IV reflects the LATE. That is, it measures the effect of broadband on the subset of municipalities where the arrival of this technology was induced by closer proximity to existing telecommunication infrastructure. Mental health outcomes in these two sets of municipalities are likely to respond differently to internet arrival (e.g., higher technology adoption in places closer to old infrastructure), and this could contribute to explaining the sizes of the coefficients.

³⁵ Internet Addictive Disorders were discussed in the 1990s, long before the widespread use of social media ([Kandell, 1998](#)). [Kandell \(1998\)](#) mentions gaming and chat rooms among the more addictive online activities in that time period. Chat rooms or instant messaging services (like AOL Messenger) share many similarities with social media platforms that were popularized in the last decade. They facilitated real-time conversations and users could (anonymously) join discussions with others who shared similar interests. Exchanges on these platforms mostly occurred in text-based form, while the content shared in modern social media platforms also includes images and videos.

Table 2
Internet and mental disorders by cohort and gender.

	(1) Total occurrences Males	(2) Total occurrences Females	(3) Any occurrence Males	(4) Any occurrence Females
Panel A: Cohort 1974–1984				
Broadband	−0.066 (0.107)	0.034 (0.111)	−0.068 (0.086)	0.029 (0.084)
Mean	1.22	1.43	0.30	0.33
SD	8.89	11.67	0.46	0.47
Panel B: Cohort 1985–1995				
Broadband	0.618*** (0.113)	0.558*** (0.118)	0.288*** (0.097)	0.181** (0.088)
Mean	0.35	0.54	0.14	0.17
SD	5.32	7.25	0.34	0.38
Observations	87,307	87,307	87,307	87,307
F-stat (Excluded instrument)	62.40	62.40	62.40	62.40
Municipality controls	Y	Y	Y	Y
Municipality FE	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y

Notes: The dependent variable in Columns 1 and 2 is equal to the logarithm of one plus the total occurrences of mental health disorders in a municipality-year (for the corresponding cohort-gender group). The dependent variable in Columns 3 and 4 is equal to a dummy variable indicating the occurrence of any mental health disorders in a municipality-year (for the corresponding cohort-gender group). Contemporaneous municipality controls include: population size, share of age groups (0–19, 20–39, 40–59, 60–79, >80 residual category). Baseline characteristics at the municipal level (in census year 2001) interacted with year dummies are: population density, distance to closest provincial capital, ruggedness, unemployment rate, share of university graduates, number of firms per capita, and number of non-profits organizations per capita. Columns 1–2 report means and standard deviations of the (linear) number of total occurrences of mental disorders (for the corresponding cohort-gender group). All means and standard deviations are reported at baseline (i.e., for municipality-years with no broadband coverage). * Significant at 10%, ** significant at 5%, and *** significant at 1%.

provide causal evidence supporting correlational studies showing that problematic internet use is positively associated with a range of mental health disorders, such as depression/anxiety, conduct problems, personality disorder, and suicidal behavior (Naito, 2007; Carli et al., 2012; Kaess et al., 2014).³⁶

7.2. Robustness

We perform a variety of robustness checks to show that our results do not depend on the choice of the specification or sample. Panel A of Table 3 shows that our results are robust to implementing the inverse hyperbolic sine (IHS) transformation to the total occurrences of mental disorders. Panel B provides estimates when normalizing total occurrences per 1000 resident population. These alternative specifications confirm the baseline results and yield more conservative effect estimates. Specifically, we can interpret the IHS results in a similar fashion to the log-lin estimates (Bellemare and Wichman, 2020).³⁷ Hence, Panel A indicates a rise in annual mental diagnoses of 52% (0.18 cases or 0.034 SDs) for males and of 40% (0.22 cases or 0.030 SDs) for females. Coefficients in Panel B point out a 10% increase in males hospitalized per 1000 people, and a 9.3% rise for females. These estimates imply that annual prevalence per Million inhabitants increased by 5.2 young-male cases and 7.9 young-female cases. Considering the 7-year period with internet availability covered by our data (2005–2011), the average population in the municipality (7168) and the total number of municipalities included in the sample (7937), back-of-the-envelope calculations suggest that broadband internet is responsible for the occurrence of 2070 young-male hospitalizations and 3148 young-female hospitalizations.³⁸ Again, we only detect higher numbers of mental health disorders among the younger cohort, while the effects on the older population are much smaller and statistically insignificant. Appendix Table A.7 provides corresponding estimates for the entire sample.

Table 4 provides further robustness checks. While our main specification captures the immediate effect of internet availability on mental health, it is plausible that such effect takes time to fully materialize. To explore this aspect, in Panel A we define our independent variable as the total number of years since the municipality had good coverage, which we define as more than 50% of the population with access to the internet. We observe that an additional year of good internet coverage in the municipality increases both the total number and the probability of any episode of mental health disorders for the young cohort.³⁹ Panel B and D assess

³⁶ Consistent with this, Bhuller et al. (2013) find that internet use is associated with increases in reported sex crimes, using Norwegian administrative data from 2000 until 2008 (similar to our studied time period). One mechanism explaining the increase proposed by Bhuller et al. (2013) is that people are more exposed to pornographic content online, due to lower pecuniary and non-pecuniary costs.

³⁷ The percent change in y due to a unitary increase in x is approximately $e^{\beta} - 1$.

³⁸ For males: $2,070 = 0.10 \times 0.052 \times 7 \times 7,168 \times 7,937$. For females: $3,148 = 0.093 \times 0.085 \times 7 \times 7,168 \times 7,937$.

Table 3
Internet and mental health — Robustness (1).

	(1)	(2)	(3)	(4)
	Cohort 1974–1984		Cohort 1985–1995	
	Total occurrences		Total occurrences	
	Males	Females	Males	Females
Panel A: IHS Transformation				
Broadband	−0.067 (0.083)	0.021 (0.083)	0.421*** (0.088)	0.336*** (0.088)
Observations	87,307	87,307	87,307	87,307
Mean	1.22	1.43	0.35	0.54
SD	8.89	11.67	5.32	7.25
Panel B: Per capita hospitalizations ('000 inh.)				
Broadband coverage	−0.060 (0.051)	0.044 (0.058)	0.095*** (0.035)	0.089** (0.043)
Observations	87,307	87,307	87,307	87,307
Mean	0.185	0.224	0.052	0.085
SD	0.608	0.791	0.285	0.472
Municipality controls	Y	Y	Y	Y
Municipality FE	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y

Notes: The dependent variable in Panel A is the Inverse Hyperbolic Sine transformation of the total occurrences of mental health disorders in a municipality-year (for the corresponding cohort). The dependent variable in Panel B the logarithm of the number of total occurrences of mental health disorders normalized per 1000 residents population. Baseline characteristics at the municipal level (in census year 2001) interacted with year dummies are: population density, distance to closest provincial capital, ruggedness, unemployment rate, share of university graduates, number of firms per capita, and number of non-profits organizations per capita. Panel A also includes contemporaneous municipality population controls: population size, and share of age groups (0–19, 20–39, 40–59, 60–79, >80 residual category). Means and standard deviations are reported in terms of the (linear) number of total occurrences of mental disorders. All means and standard deviations are reported at baseline (i.e., for municipality-years with no broadband coverage). * Significant at 10%, ** significant at 5%, and *** significant at 1%.

the robustness of our results to alternative samples. Namely, in Panel B we drop provincial capitals and urban municipalities. These estimates show that our results are not driven by urban areas/main cities only.⁴⁰ These findings speak against the interpretation that our results are driven by differential trends in urban areas, such as, for example, a higher supply of mental health treatment facilities. Moreover, Panel C provides a further robustness check by weighting observations by population size. Similarly, in Panel D we exclude municipality-years with potential measurement error in the 2002–2004 period (i.e., municipalities that were already connected to broadband in 2005, the first year of our ADSL data). Finally, in Panel E, we exclude altogether the 2002–2004 period for all municipalities.⁴¹ Although the coefficient estimates exhibit some variations across the above subsamples, they are always in line with the baseline specification. In all cases, broadband internet has a negative impact on the mental condition of the younger cohort, while the older one is not affected.

Table 5 provides additional robustness checks to different clustering and model specifications. Panel A and B present estimates when clustering the standard errors at a higher geographic unit than municipalities. Namely, province and region-years, respectively. The estimates do not lose statistical precision despite the higher level of clustering. In our main specification, we define our dependent variable using the presence of mental disorders in any of the three diagnoses reported in the hospital records. As explained in Section 3.1, the first diagnosis does not need to coincide with the cause of hospitalization. The order in which diagnoses are reported reflects which pathology requires the highest resource consumption. As a robustness check, we also investigate whether we observe similar patterns in the youngest cohort when we construct our outcome variables by focusing on the primary diagnosis only (i.e., including a case of mental disorder only if recorded as the primary diagnosis). Panel C indicates that the results focusing on the primary diagnosis are very similar to those of our main specification. Furthermore, we provide evidence suggesting that the results are not driven by a general association between early internet access and the likelihood of being hospitalized (e.g., for physical problems). Panel D shows that the results omitting any physical diagnosis from the sample (i.e., keeping only those cases where all three diagnoses refer to mental disorders) are indistinguishable from the baseline coefficients depicted in Table 2. Finally,

³⁹ Appendix Figure A.4 provides complementary evidence on the timing occurring between the broadband coverage of the municipality and the materialization of its detrimental effects in terms of mental health of the young cohort. When focusing on the sample where there is no measurement error regarding the initial year of good broadband coverage (i.e., excluding municipalities already covered by ADSL in the first year when broadband data is available), we see quite clearly that broadband has a significant impact on mental health disorders starting from two or three years with respect to the first year when the municipality started having good coverage in terms of broadband (above 50%). Notice, however, that the evidence provided by Figure A.4 should be taken with caution as, differently from our instrumental variable estimates, it takes the timing of ADSL coverage at face value and thus it may reflect endogenous drivers of broadband coverage.

⁴⁰ The urbanization index is provided by ISTAT. All municipalities with the highest urbanization index in 2001 (3) are excluded in this analysis.

⁴¹ In this specification, the instrument is *de facto* equivalent to the interaction of the distance to the closest UGS and a post 2001 dummy.

Table 4
Internet and mental health — Robustness (2).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Cohort 1974–1984				Cohort 1985–1995			
	Total occurrences		Any occurrence		Total occurrences		Any occurrence	
	Males	Females	Males	Females	Males	Females	Males	Females
Panel A: Years since good broadband								
Years of good broadband	−0.022 (0.035)	0.011 (0.036)	−0.022 (0.029)	0.009 (0.028)	0.204*** (0.038)	0.184*** (0.039)	0.095*** (0.032)	0.060** (0.029)
Observations	87,307	87,307	87,307	87,307	87,307	87,307	87,307	87,307
Mean	1.22	1.43	0.30	0.33	0.35	0.54	0.14	0.17
SD	8.89	11.67	0.46	0.47	5.32	7.25	0.34	0.38
F-stat (Excluded instrument)	53.27	53.27	53.27	53.27	53.27	53.27	53.27	53.27
Panel B: Exclude provincial capitals and urban municipalities								
Broadband	−0.117 (0.153)	0.048 (0.160)	−0.082 (0.127)	0.053 (0.122)	0.363** (0.153)	0.349** (0.163)	0.253* (0.141)	0.154 (0.127)
Observations	76,736	76,736	76,736	76,736	76,736	76,736	76,736	76,736
Mean	0.68	0.77	0.27	0.29	0.18	0.28	0.11	0.15
SD	1.89	2.04	0.44	0.45	0.73	1.01	0.31	0.35
F-stat (Excluded instrument)	37.97	37.97	37.97	37.97	37.97	37.97	37.97	37.97
Panel C: Weight by population								
Broadband	−0.119 (0.164)	−0.130 (0.169)	−0.172 (0.107)	0.027 (0.105)	2.649*** (0.211)	2.356*** (0.210)	0.331*** (0.123)	0.070 (0.118)
Observations	87,307	87,307	87,307	87,307	87,307	87,307	87,307	87,307
Mean	1.22	1.43	0.30	0.33	0.35	0.54	0.14	0.17
SD	8.89	11.67	0.46	0.47	5.32	7.25	0.34	0.38
F-stat (Excluded instrument)	450.1	450.1	450.1	450.1	450.1	450.1	450.1	450.1
Panel D: Drop municipality-years with potential measurement error								
Broadband	−0.004 (0.119)	−0.096 (0.122)	−0.008 (0.102)	−0.058 (0.104)	0.511*** (0.099)	0.459*** (0.108)	0.249*** (0.086)	0.125 (0.090)
Observations	75,451	75,451	75,451	75,451	75,451	75,451	75,451	75,451
Mean	0.62	0.75	0.23	0.25	0.17	0.25	0.09	0.12
SD	5.03	7.15	0.42	0.43	3.18	3.94	0.29	0.32
F-stat (Excluded instrument)	78.88	78.88	78.88	78.88	78.88	78.88	78.88	78.88
Panel E: Drop 2002–2004 period								
Broadband	0.034 (0.157)	−0.082 (0.159)	−0.071 (0.125)	−0.029 (0.131)	0.887*** (0.136)	0.771*** (0.141)	0.475*** (0.114)	0.248** (0.109)
Observations	63,496	63,496	63,496	63,496	63,496	63,496	63,496	63,496
Mean	0.80	0.96	0.25	0.27	0.22	0.32	0.11	0.14
SD	6.35	9.06	0.43	0.44	4.03	5.00	0.31	0.34
F-stat (Excluded instrument)	63.97	63.97	63.97	63.97	63.97	63.97	63.97	63.97
Municipality controls	Y	Y	Y	Y	Y	Y	Y	Y
Municipality FE	Y	Y	Y	Y	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y	Y	Y	Y	Y

Notes: The dependent variable in Columns 1–4 is equal to the logarithm of one plus the total occurrences of mental health disorders in a municipality-year (for the corresponding cohort-gender group). The dependent variable in Columns 5–8 is equal to a dummy variable indicating the occurrence of any mental health disorders in a municipality-year (for the corresponding cohort-gender group). Contemporaneous municipality controls include: population size, share of age groups (0–19, 20–39, 40–59, 60–79, >80 residual category). Baseline characteristics at the municipal level (in census year 2001) interacted with year dummies are: population density, distance to closest provincial capital, ruggedness, unemployment rate, share of university graduates, number of firms per capita, and number of non-profits organizations per capita. Columns 1–4 report means and standard deviations of the (linear) number of total occurrences of mental disorders (for the corresponding cohort-gender group). All means and standard deviations are reported at baseline (i.e., for municipality-years with no broadband coverage).

* Significant at 10%, ** significant at 5%, and *** significant at 1%.

Panel E shows that our estimates are robust to the exclusion of the municipality controls. The results are quantitatively similar to our preferred specification with slightly higher precision.⁴²

⁴² Appendix Table A.8 provides a further robustness exercise showing that the estimates are robust to the inclusion of linear and quadratic time trends at the provincial level. Moreover, Appendix Table A.9 shows that our results are robust to controlling for Mediaset signal strength in 1985, interacted with year fixed effects, which account for exposure to entertainment-focused TV content broadcast by Mediaset channels (Durante et al., 2019).

Table 5
Internet and mental health — Robustness (3).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Cohort 1974–1984				Cohort 1985–1995			
	Total occurrences		Any occurrence		Total occurrences		Any occurrence	
	Males	Females	Males	Females	Males	Females	Males	Females
Panel A: Cluster at province level								
Broadband	−0.066 (0.122)	0.034 (0.095)	−0.068 (0.097)	0.029 (0.087)	0.618*** (0.137)	0.558*** (0.128)	0.288*** (0.108)	0.181** (0.091)
Mean	1.22	1.43	0.30	0.33	0.35	0.54	0.14	0.17
SD	8.89	11.67	0.46	0.47	5.32	7.25	0.34	0.38
F-stat (Excluded instrument)	27.64	27.64	27.64	27.64	27.64	27.64	27.64	27.64
Panel B: Cluster at the region-year level								
Broadband	−0.066 (0.091)	0.034 (0.098)	−0.068 (0.076)	0.029 (0.086)	0.618*** (0.105)	0.558*** (0.088)	0.288*** (0.080)	0.181*** (0.064)
Mean	1.22	1.43	0.30	0.33	0.35	0.54	0.14	0.17
SD	8.89	11.67	0.46	0.47	5.32	7.25	0.34	0.38
F-stat (Excluded instrument)	100	100	100	100	100	100	100	100
Panel C: Primary diagnosis only								
Broadband	−0.095 (0.101)	0.057 (0.108)	−0.082 (0.086)	0.035 (0.079)	0.538*** (0.102)	0.533*** (0.110)	0.253*** (0.085)	0.190** (0.082)
Mean	0.95	1.06	0.26	0.27	0.26	0.41	0.11	0.14
SD	6.95	9.20	0.44	0.44	3.94	5.66	0.31	0.35
F-stat (Excluded instrument)	62.40	62.40	62.40	62.40	62.40	62.40	62.40	62.40
Panel D: Exclude physical diagnoses								
Broadband	−0.063 (0.107)	0.036 (0.111)	−0.064 (0.086)	0.026 (0.084)	0.618*** (0.113)	0.557*** (0.118)	0.288*** (0.097)	0.178** (0.088)
Mean	1.22	1.42	0.30	0.33	0.35	0.54	0.14	0.17
SD	8.88	11.62	0.46	0.47	5.32	7.24	0.34	0.38
F-stat (Excluded instrument)	62.40	62.40	62.40	62.40	62.40	62.40	62.40	62.40
Panel E: No municipality controls								
Broadband	0.091** (0.046)	0.068 (0.046)	0.027 (0.036)	0.032 (0.034)	0.593*** (0.049)	0.638*** (0.054)	0.244*** (0.038)	0.201*** (0.035)
Mean	1.22	1.43	0.30	0.33	0.35	0.54	0.14	0.17
SD	8.89	11.67	0.46	0.47	5.32	7.25	0.34	0.38
F-stat (Excluded instrument)	134.5	134.5	134.5	134.5	134.5	134.5	134.5	134.5
Observations	87,307	87,307	87,307	87,307	87,307	87,307	87,307	87,307
Municipality FE	Y	Y	Y	Y	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y	Y	Y	Y	Y

Notes. The dependent variable in Columns 1, 2, 5 and 6 is equal to the logarithm of one plus the total occurrences of mental health disorders in a municipality-year (for the corresponding cohort-gender group). The dependent variable in Columns 3, 4, 7, and 8 is equal to a dummy variable indicating the occurrence of any mental health disorders in a municipality-year (for the corresponding cohort-gender group). Estimates in Panels A-D include municipality controls. Contemporaneous municipality controls include: population size, share of age groups (0–19, 20–39, 40–59, 60–79, >80 residual category). Baseline characteristics at the municipal level (in census year 2001) interacted with year dummies are: population density, distance to closest provincial capital, ruggedness, unemployment rate, share of university graduates, number of firms per capita, and number of non-profits organizations per capita. Columns 1, 2, 5 and 6 report means and standard deviations of the (linear) number of total occurrences of mental disorders (for the corresponding cohort-gender group). All means and standard deviations are reported at baseline (i.e., for municipality-years with no broadband coverage). * Significant at 10%, ** significant at 5%, and *** significant at 1%.

7.3. Reduced form and placebo regressions

This section conducts a series of exercises to provide evidence supporting our identifying assumption, namely that the instrumental variable $Distance_{UGS} \times Post - 2005$ affects the outcomes only through its impact on broadband internet availability, and not through any other channels.⁴³

To assess the plausibility of the exclusion restriction, we examine the reduced-form relationships between our IV and the outcomes under different scenarios. First, as a benchmark for our placebo exercises, we present the reduced-form results estimated on the same sample used in the main analysis (i.e., all municipalities from 2001 to 2011). Panel A of Table 6 shows that the number and frequency of mental disorders in the younger cohort increase after 2005 in municipalities closer to the UGS. Combined with the 2SLS estimates in Table 2 and the year-by-year first-stage relationship illustrated in Figure A.3, these results suggest that the

⁴³ We focus only on the younger cohort as we have shown before that the statistically significant effects are limited to this cohort. For completeness, the appendix reports the corresponding analysis for the older cohort.

Table 6
Reduced form estimates: Baseline.

	(1)	(2)	(3)	(4)
	Cohort 1985–1985			
	Total occurrences		Any occurrence	
	Males	Females	Males	Females
Panel A: Baseline sample (2001–2011)				
Distance to closest UGS × Post 2005	−0.302*** (0.046)	−0.273*** (0.059)	−0.140*** (0.039)	−0.088** (0.041)
Observations	87,307	87,307	87,307	87,307
Panel B: Drop municipality-years with no broadband (2001–2011)				
Distance to closest UGS × Post 2005	−0.367*** (0.079)	−0.338*** (0.105)	−0.166*** (0.060)	−0.112* (0.064)
Observations	59,863	59,863	59,863	59,863
Municipality FE	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y
Municipality controls	Y	Y	Y	Y

Notes. The dependent variable in Columns 1 and 2 is equal to the logarithm of one plus the total occurrences of mental health disorders in a municipality-year (for the corresponding cohort). The dependent variable in Columns 3 and 4 is equal to a dummy variable indicating the occurrence of any mental health disorders in a municipality-year (for the corresponding cohort). Contemporaneous municipality controls include: population size, share of age groups (0–19, 20–39, 40–59, 60–79, >80 residual category). Baseline characteristics at the municipal level (in census year 2001) interacted with year dummies are: population density, distance to closest provincial capital, ruggedness, unemployment rate, share of university graduates, number of firms per capita, and number of non-profits organizations per capita.

Table 7
Reduced form estimates: Placebo.

	(1)	(2)	(3)	(4)
	Cohort 1985–1995			
	Total occurrences		Any occurrence	
	Males	Females	Males	Females
Panel A: Only municipality-years with no broadband (2001–2011)				
Distance to closest UGS × Post 2005	−0.045 (0.050)	0.005 (0.063)	−0.056 (0.056)	0.004 (0.065)
Observations	27,186	27,186	27,186	27,186
Panel B: Only municipalities with no broadband in 2005 (2001–2005)				
Distance to closest UGS	0.038 (0.031)	0.045 (0.039)	0.047 (0.036)	0.038 (0.041)
Observations	19,925	19,925	19,925	19,925
Region-Year FE	Y	Y	Y	Y

Notes. The dependent variable in Columns 1 and 2 is equal to the logarithm of one plus the total occurrences of mental health disorders in a municipality-year (for the corresponding cohort). The dependent variable in Columns 3 and 4 is equal to a dummy variable indicating the occurrence of any mental health disorders in a municipality-year (for the corresponding cohort). Estimates in Panels A also include municipality fixed effects. Contemporaneous municipality controls include: population size, share of age groups (0–19, 20–39, 40–59, 60–79, >80 residual category). Baseline characteristics at the municipal level (in census year 2001) interacted with year dummies are: population density, distance to closest provincial capital, ruggedness, unemployment rate, share of university graduates, number of firms per capita, and number of non-profits organizations per capita.

effect of proximity to the UGS changes over time and that ADSL availability is likely the mediating factor. Second, we replicate the reduced-form regressions by excluding all municipality-years between 2005 and 2011 without broadband access. This allows us to eliminate observations where distance to a UGS should not affect the outcomes. The results in Panel B of Table 6 confirm that our instrument influences mental health disorders only in municipalities where broadband access is present. Appendix Table A.10 provides corresponding estimates for the 1974–1984 cohort, showing no significant effects and further supporting our main results.

We then perform placebo exercises by replicating the previous analyses for observations without broadband connections, i.e., municipality-years where our instrument should not matter. If the exclusion restriction holds, we would expect the interaction between distance to the UGS and the post-2005 dummy to have no impact on mental health outcomes in municipality-years without ADSL during the post-2005 period (i.e., until ADSL becomes available in that municipality). Reassuringly, the estimates in Panel A of Table 7 are insignificant and much smaller in magnitude compared to those in Table 6. Additionally, Panel B of Table 7 presents another placebo exercise, showing no significant relationship between the distance to the UGS and mental health during the 2001–2005 period in a balanced sample of “late adopter” municipalities (those not covered by ADSL in 2005). Overall, these results support the exclusion restriction, suggesting that ADSL access is a necessary condition for the instrument to influence the outcomes. Appendix Table A.11 provides corresponding estimates for the 1974–1984 cohort.

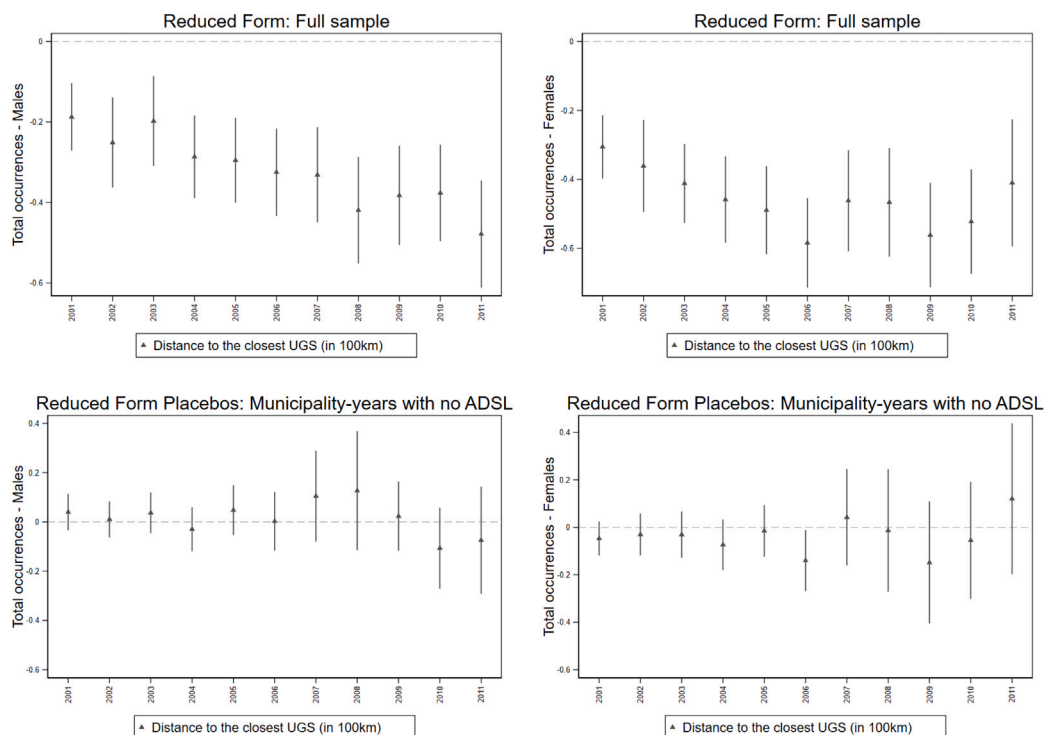


Fig. 5. Reduced form: distance to UGS and mental disorders by year — Cohort 1985–1995.

Notes: The upper panel presents estimates for the full sample, while the bottom panel shows estimates for municipality-years without an ADSL connection. The dependent variable is the logarithm of one plus the total occurrences of mental health disorders in a municipality-year, separately for males (left panel) and females (right panel) in the 1985–1995 cohort. The independent variable is the distance to the closest UGS, measured in 100 km.

Finally, to provide more detailed evidence supporting the validity of our instrument, Fig. 5 presents year-by-year estimates of the reduced-form relationship between mental disorders and distance to the UGS for the entire sample (upper panel) and the subset of municipality-years without ADSL (lower panel). Our findings corroborate the exclusion restriction of the instrument. In the entire sample, the reduced-form relationship shows a clear gradient, with the (negative) impact of distance to UGS on mental disorders increasing over time and stabilizing once most municipalities are connected. In contrast, for the subset of municipality-years without ADSL, no such gradient is observed, especially in the earlier years of our sample.⁴⁴

8. Mechanisms

In this section, we exploit the richness of our data to shed light on the potential mechanisms underlying our results. In particular, we aim to answer the following questions. First, is the impact of mobile broadband on mental health different from the one observed for fixed broadband? Second, are the results driven by a higher general awareness of mental disorders or by an actual increase in the incidence of mental disorders beyond any possible awareness channel? Third, is the detrimental impact of broadband internet on mental health mediated by the age of individuals at the time of first exposure to this technology? Finally, what is the impact of broadband internet on specific types of mental disorders across gender and cohorts?

8.1. Mobile internet

Whether or not internet access influences well-being may depend on how people use it. For example, having access on smartphones rather than on fixed devices may further increase the risk of addictive behaviors due to the portability of the technology. We use data on 3G coverage to explicitly investigate the relationship between mobile internet and mental health.

In this analysis, we use the minimum distance to the UGS or OPB network as an instrument for mobile coverage (see Section 2). Table 8 reports the results. The first stage is strong and indicates the further a municipality centroid is from one of these networks, the lower the municipality's 3G coverage. Despite focusing on a different broadband technology, different time-span (2001–2013), and

⁴⁴ See Figure A.5 in the appendix for corresponding estimates for the older cohort, which show no gradient of the impact of distance to UGS on mental disorders over time.

Table 8
Mobile internet and mental disorders — by cohort and gender.

	(1) Cohort 1974–1984 Males	(2) Cohort 1974–1984 Females	(3) Cohort 1985–1995 Males	(4) Cohort 1985–1995 Females
Panel A: Total occurrences				
Mobile Broadband	−0.112 (0.086)	0.098 (0.094)	0.560*** (0.082)	0.345*** (0.097)
Mean	1.44	1.68	0.41	0.62
SD	9.89	12.99	5.92	8.07
Panel B: Any occurrence				
Mobile Broadband	−0.078 (0.068)	0.068 (0.068)	0.258*** (0.064)	0.064 (0.068)
Mean	0.33	0.36	0.15	0.18
SD	0.47	0.48	0.35	0.39
Observations	103,181	103,181	103,181	103,181
F-stat (Excluded instrument)	119.6	119.6	119.6	119.6
Municipality controls	Y	Y	Y	Y
Municipality FE	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y

Notes: The dependent variable in Panel A is equal to the logarithm of one plus the total occurrences of mental health disorders in a municipality-year (for the corresponding cohort-gender group). The dependent variable in Panel B is equal to a dummy variable indicating the occurrence of any mental health disorders in a municipality-year (for the corresponding cohort-gender group). Contemporaneous municipality controls include: population size, share of age groups (0–19, 20–39, 40–59, 60–79, >80 residual category). Baseline characteristics at the municipal level (in census year 2001) interacted with year dummies are: population density, distance to closest provincial capital, ruggedness, unemployment rate, share of university graduates, number of firms per capita, and number of non-profits organizations per capita. Panel A reports means and standard deviations of the (linear) number of total occurrences of mental disorders (for the corresponding cohort-gender). All means and standard deviations are reported at baseline (i.e., for municipality-years with no broadband coverage). * Significant at 10%, ** significant at 5%, and *** significant at 1%.

different final sample of municipality-years sample (see Section 3), the coefficients are fairly comparable to our main specification (Table 2).⁴⁵ The coefficients on the intensive margins suggest that a unitary increase in 3G coverage (i.e., going from 0 to 100% of the municipality area covered by the signal) leads to a 75% rise in mental diagnoses for males (corresponding to 0.30 cases, or 0.052 SDs), and a 41% increase for females (corresponding to 0.26 cases, or 0.032 SDs). The only difference (with respect to the results on fixed broadband) is that mobile broadband does not significantly affect the extensive margin of mental disorders for females belonging to the younger cohort. Appendix Table A.12 provides estimates when including both ADSL coverage and 3G coverage at once (using the two instruments at once: the distance to the UGS and the minimum of distance to the UGS or OPB network). Access to either type of technology increases mental disorders for the younger cohort.

8.2. Awareness vs. prevalence

One way to interpret our results is that internet availability increases information access about mental health diagnoses and resources. Instead of causing these disorders, internet could enable users to better understand their problems and seek help.⁴⁶ While this may partially explain our results, several observations speak against this interpretation.

First, we only observe a detrimental effect on mental health for individuals born between 1985–1995 but not for the cohorts born before. This would imply that only the younger generation exploits internet as source of medical information. Instead, using survey data from ISTAT, we observe the opposite pattern. The older cohort is more likely to seek health advice on the internet in the study period (see Figure A.6). By contrast, the younger cohort is more likely to participate in social networks, play or download games, films, or music. We further analyze patterns in internet usage for searching health information over time. In Figure A.7, we present trends regarding the use of internet for seeking health information across cohorts (left panel) and regions with lower vs. higher broadband internet access (right panel). We clearly see that the younger cohort is less likely to search for health information than the older cohort, with similar trends in search behavior observed across both groups. Additionally, trends in searches are comparable across regions with higher and lower broadband access. These results suggest that the impact of the internet on the younger cohort is unlikely to be driven by their increased awareness of mental health disorders only.

Second, we gather data on Google searches on mental health conditions. Google searches for these terms could reflect both increased awareness and higher prevalence of mental disorders. To control for the awareness channel, we gather data on searches on other medical issues that might have been triggered by a higher awareness driven by broadband internet, but whose incidence should not increase with the arrival of the broadband internet: c-sections (Amaral-Garcia et al., 2022) and celiac disease. Appendix

⁴⁵ The results remain unchanged when we harmonize the time-spans of the two analyses. Results are available upon request.

⁴⁶ Similarly, doctors may now be better informed and more likely to diagnose a mental disorder.

Table 9
Self-harm & compulsory hospitalizations.

	(1)	(2)	(3)	(4)
	Cohort 1985–1995			
	Total occurrences		Any occurrence	
	Males	Females	Males	Females
Panel A: Self-harm				
Broadband	0.051*** (0.012)	0.028* (0.015)	0.073*** (0.015)	0.032 (0.020)
Mean	0.002	0.005	0.001	0.004
SD	0.048	0.092	0.038	0.066
Panel B: Compulsory hospitalization				
Broadband	0.084*** (0.026)	0.031* (0.016)	0.123*** (0.029)	0.042** (0.017)
Mean	0.005	0.002	0.004	0.002
SD	0.078	0.050	0.065	0.043
F-stat (Excluded instrument)	62.40	62.40	62.40	62.40
Observations	87,307	87,307	87,307	87,307
Municipality controls	Y	Y	Y	Y
Municipality FE	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y

Notes: The dependent variable in Columns 1 and 2 is equal to the logarithm of one plus the total occurrences of mental health disorders in a municipality-year (for the corresponding cohort-gender-type of hospitalization). The dependent variable in Columns 3 and 4 is equal to a dummy variable indicating the occurrence of any mental health disorders in a municipality-year (for the corresponding cohort-gender-type of hospitalization). Contemporaneous municipality controls include: population size, share of age groups (0–19, 20–39, 40–59, 60–79, >80 residual category). Baseline characteristics at the municipal level (in census year 2001) interacted with year dummies are: population density, distance to closest provincial capital, ruggedness, unemployment rate, share of university graduates, number of firms per capita, and number of non-profits organizations per capita. Columns 1 and 2 report means and standard deviations of the (linear) number of total occurrences of mental disorders (for the corresponding cohort-gender-type of hospitalization). All means and standard deviations are reported at baseline (i.e., for municipality-years with no broadband coverage) * Significant at 10%, ** significant at 5%, and *** significant at 1%.

Table A.13 report the results of an analysis where we look at the impact of broadband at the region-year level (the most granular level allowed by Google trends data) on Google searches.⁴⁷ Panel A looks at searches for specific mental disorders (Anorexia, Bulimia, Depression). In Panel B, we also control for the relative volume of searches on c-sections and celiac disease. The results show a positive impact of the broadband internet on searches on mental disorders. Importantly, if anything, after controlling for searches of other conditions the estimates relative to “Anorexia” and “Depression” become more precisely estimated. All in all, these estimates provide suggestive evidence that – while the awareness about all these conditions and treatments could have increased with the arrival of the internet – spending more time online additionally appears to deteriorate mental health directly.

Third, we find increases in the prevalence of certain episodes that are hardly connected with a simple awareness mechanism.⁴⁸ Specifically, Table 9 shows the impact of broadband internet on instances of self-harm (Panel A) or compulsory hospitalization (Panel B). Self-harm refers to cases where hospital doctors registered the presence of suicide attempts or self-inflicted trauma. Expanding the ADSL coverage from 0 to 100%, increases the cases of self-harm by 5.2% for males and almost 3% for females. The observed increase in the prevalence of self-inflicted trauma cannot be rationalized with better access to resources and mental health information only. Similarly, we observe an increase (by 8.8% for males and 3% for females) in the occurrence of compulsory hospitalizations (i.e., forced hospitalization due to the possible threat that a patient posed to herself or others).⁴⁹ As in the case of self-inflicted trauma, it is difficult to explain an increase in compulsory hospitalization simply based on an information mechanism. Appendix Table A.14 provides corresponding estimates for the older cohort, showing that also for these outcomes there is no significant impact of broadband on the 1974–1984 cohort.

Finally, we can leverage details about whether hospitalizations in our dataset were scheduled in advance or necessitated by emergencies. We repeat our main exercise splitting the sample into urgent vs. planned hospitalizations. We hypothesize that if

⁴⁷ As Google trends data are available only from 2004 and only at the regional level, we cannot replicate our baseline specification. The econometric model is thus an instrumental variable where we aggregate broadband coverage and distance to the closer UGS at the regional level by taking the mean of these variables at the region-year level weighted by municipal population. Accordingly, we adopt the following two-stage specification:

$$Y_{r,t}^k = \gamma \widehat{Broadband}_{r,t} + \tau_r + \epsilon_{r,t} \quad (4)$$

$$\widehat{Broadband}_{r,t} = \phi Distance_{UGS_m} + \theta_t + \eta_{r,t} \quad (5)$$

where subscripts r and t indicate respectively region and year; $Y_{r,t}^k$ represents the normalized value of Google searches regarding term k (e.g., Anorexia) in region r in year t . τ and θ are year fixed effects. Standard errors are clustered at the region level.

⁴⁸ We focus only on the younger cohort as we have shown before that the statistically significant effects are limited to this cohort. For completeness, the appendix reports also parallel tables for the older cohort.

⁴⁹ In Italy compulsory hospitalizations are defined as TSO (“Trattamento Sanitario Obbligatorio”) by Law 833/1978.

Table 10
Planned vs. urgent hospitalizations.

	(1)	(2)	(3)	(4)
	Cohort 1985–1995			
	Total occurrences		Any occurrence	
	Males	Females	Males	Females
Panel A: Planned hospitalizations				
Broadband	0.342*** (0.081)	0.385*** (0.097)	0.253*** (0.082)	0.213*** (0.080)
Mean	0.23	0.39	0.08	0.12
SD	4.72	6.39	0.27	0.33
Panel B: Urgent hospitalization				
Broadband	0.482*** (0.084)	0.445*** (0.086)	0.239*** (0.070)	0.210*** (0.073)
Mean	0.12	0.15	0.07	0.09
SD	0.80	1.06	0.26	0.28
F-stat (Excluded instrument)	62.40	62.40	62.40	62.40
Observations	87,307	87,307	87,307	87,307
Municipality controls	Y	Y	Y	Y
Municipality FE	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y

Notes: The dependent variable in Columns 1 and 2 is equal to the logarithm of one plus the total occurrences of mental health disorders in a municipality-year (for the corresponding cohort-gender-type of hospitalization). The dependent variable in Columns 3 and 4 is equal to a dummy variable indicating the occurrence of any mental health disorders in a municipality-year (for the corresponding cohort-gender-type of hospitalization). Contemporaneous municipality controls include: population size, share of age groups (0–19, 20–39, 40–59, 60–79, >80 residual category). Baseline characteristics at the municipal level (in census year 2001) interacted with year dummies are: population density, distance to the closest provincial capital, ruggedness, unemployment rate, share of university graduates, number of firms per capita, and number of non-profits organizations per capita. Columns 1 and 2 report means and standard deviations of the (linear) number of total occurrences of mental disorders (for the corresponding cohort-gender-type of hospitalization). All means and standard deviations are reported at baseline (i.e., for municipality-years with no broadband coverage). * Significant at 10%, ** significant at 5%, and *** significant at 1%.

using the internet only improves information access and the matching between patients and providers, only planned hospitalizations should be growing with early internet access. Instead, we can see in [Table 10](#) that the increases are fairly similar in urgent compared to planned hospitalizations. If anything, the effect on the intensive margin is even larger when looking at urgent hospitalizations. Appendix Table A.15 provides corresponding estimates for the older cohort, showing that both for planned and urgent hospitalization there is no significant impact of broadband on the 1974–1984 cohort.

Overall, the observed use of the internet to look for health information, the Google trend data, the impact of broadband on self-harm, compulsory and urgent hospitalizations all provide evidence of broadband internet causing an increase in the actual prevalence of mental health disorders in the younger cohort (rather than a mere increase in the rates of reporting and detection).

8.3. Age of first broadband internet exposure

The findings discussed in Section 7 underscore the age-specific impact of broadband internet on mental health, revealing that its adverse effects are particularly severe for younger cohorts. This evidence suggests that engaging in potentially addictive or alienating online activities at an early age may heighten the risk of developing mental disorders. To further elucidate the relationship between age and mental health issues, this section delves into the dynamics by examining the main effects across different ages at the point of broadband introduction in the individual's municipality of residence. By leveraging the variation in broadband availability timing across municipalities, we observe that individuals from different birth cohorts and municipalities, experienced broadband exposure at the same age. For instance, a person born in 1989 and living in a municipality that adopted ADSL in 2005, and another born in 1990 in a municipality that followed suit in 2006, both encountered broadband at age 16.

[Fig. 6](#) provides a detailed analysis of the impact based on the age at first exposure to broadband. It illustrates a discernible trend: the younger the age at initial broadband exposure, the more negative the impact on mental health. Conversely, those exposed to broadband later in life appear to be less susceptible to its adverse effects.⁵⁰ These findings provides causal evidence in support of the recent correlational studies on the topic ([Twenge, 2017](#); [Boers et al., 2019](#); [Patel et al., 2016](#); [Haidt, 2024](#)).

⁵⁰ There is an important caveat when considering the estimates obtained for an age of exposure below 16 years old. Our dataset comprises individuals born between 1995 and 1973, meaning the analyses for age groups 11 to 15 cover a narrower range of municipalities and birth cohorts (more so for the younger age groups). For example, the group of 11-year-olds includes only those born in 1994 and residing in municipalities reached by ADSL in 2005, and those born in 1995 in municipalities connected to ADSL in 2006. For transparency, Tables A.16 and A.17 present the estimates – for the total number of mental disorders and the probability of any mental disorders, respectively – for each age of exposure. The Tables also report the number of observations for each estimate along with the other relevant statistics.

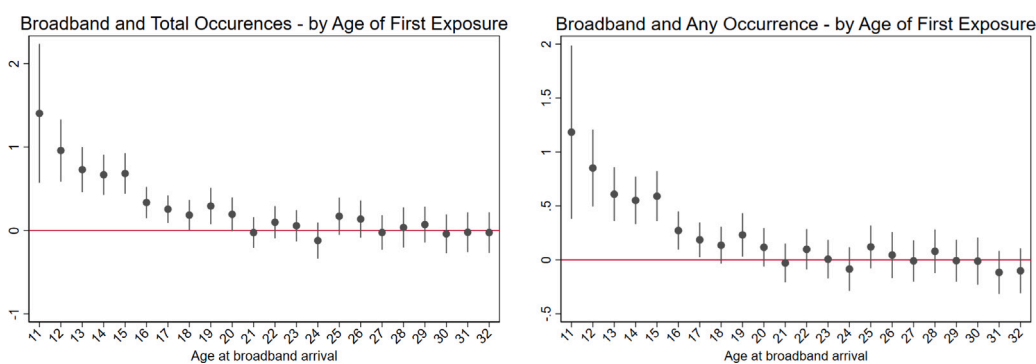


Fig. 6. Broadband and mental disorders — By Age of first broadband exposure.

Notes: The graph illustrates IV estimates of Eq. (2) (with 95% confidence intervals) by age at the arrival of broadband in the municipality of residence. The dependent variable in the left panel is equal to the logarithm of one plus the total occurrences of mental health disorders in a municipality-year (for the corresponding age of first broadband exposure group). The dependent variable in the right panel is equal to a dummy variable indicating the occurrence of any mental health disorders in a municipality-year (for the corresponding age of first broadband exposure group).

8.4. Type of mental disorders

The richness of our data allows us to dig deeper looking at the impact across cohort-gender-specific groups of mental disorders. Fig. 7 provide a visual representation of the estimates by gender-disorder for the younger cohort.⁵¹ The above results show a detrimental effect of broadband internet on the younger cohort across different types of mental disorders: depression, anxiety, addiction and personality disorders. We find no significant effect on sleep disorders. Moreover, for women it also has a detrimental effect in terms of eating disorders. One possible reason for why we detect an effect on eating disorders on girls only is that the prevalence is much larger among girls than boys (Van Eeden et al., 2021).⁵² In addition, girls are more likely victims of cyberbullying than boys (OECD, 2019). They may also be more vulnerable to online comparisons regarding their body image and self-esteem.

9. Conclusions

While the advantages of digital technologies are undisputed, studies providing causal evidence on the harmful effects on mental health remain rare. This paper provides the first causal estimation of the relationship between internet access and specific mental disorders diagnosed by doctors.

We document statistically significant increases in both the intensive and extensive margin of mental disorders at the municipality level among patients born after 1985. We complement these results by showing that individuals who were exposed to this technology earlier in life were more affected. We show that the detrimental effects on mental health are present for individuals who were 11 to 19 years old when this technology arrived in their municipality, with larger effects for younger individuals. Conversely, those exposed to broadband later in life appear to be less susceptible to its adverse effects. Our results speak in favor of a true increase in mental disorder prevalence – rather than just increased awareness – as we also identify a rise in self-inflicted harm and compulsory and urgent mental health hospitalizations. In terms of connection technology, we show that mobile and fixed broadband lead to similar increases. Finally, we provide evidence on the specific disorders triggered by broadband internet across genders. We document economically and statistically significant increases in depression/anxiety disorders, drug abuse/addiction, and personality disorders among patients belonging to the younger cohort (born between 1985 and 1995). In addition, we find significant raises in eating disorders among female patients in the same cohort.

From a conceptual standpoint, access to the internet can influence mental health in various ways, both positively and negatively (Castellacci and Tveito, 2018). On the positive side, the internet makes it easier for individuals experiencing mental disorders to access information about these pathologies, learn about potential treatments, and seek the help of health professionals (Powell and Clarke, 2006). Such increased awareness could, on the one hand, lead to a higher number of diagnoses even if the underlying prevalence of the disorders remains unchanged. On the other hand, better information can allow patients to treat their disorders earlier on, preventing more severe symptoms, and reducing the need for hospitalization. Moreover, internet might also indirectly improve mental health by improving economic conditions (Johnson and Persico, 2024). On the negative side, internet use can crowd out activities that are beneficial to mental health, such as spending time with family and friends, exercising, or sleeping (Twenge, 2017; Giuntella et al., 2021). Also, certain online activities, such as the use of social media or gambling, can lead to addictive behavior (Allcott et al., 2022; WHO, 2018; Zastrow, 2017) and may induce related “fear of missing out” (Bursztyjn et al., 2023).

⁵¹ See Figure A.8 in the Appendix for a corresponding figure for the 1974–1984 cohort.

⁵² The same is true in our dataset. While 16% of all municipalities have at least one hospitalizations of a female patient due to an eating disorder, only 2.6% have at least one male patient with an eating disorder.

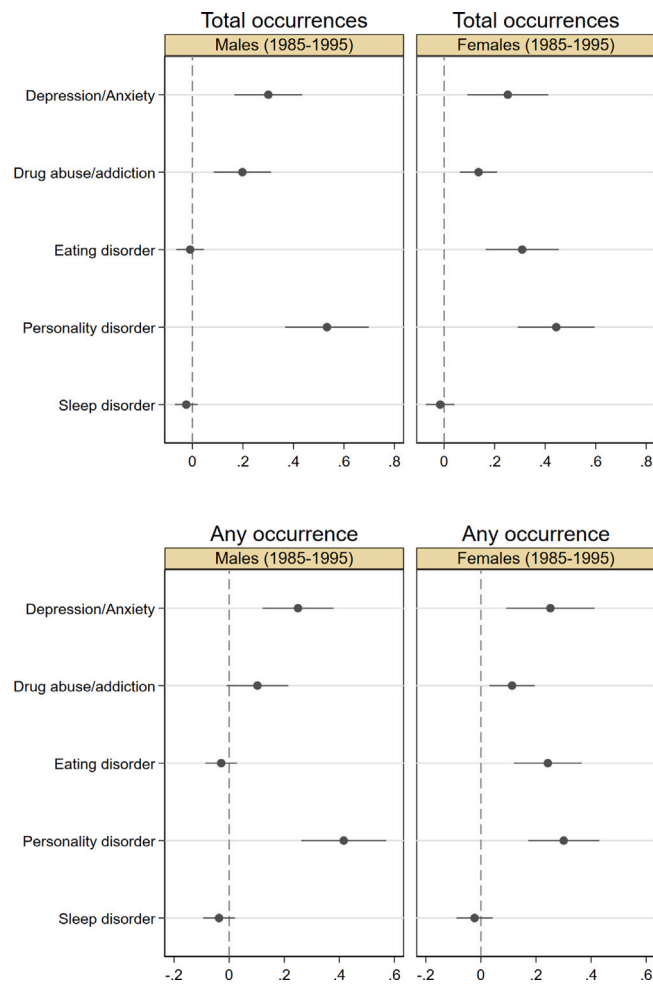


Fig. 7. Internet and mental health disorders — Cohort 1985–1995.

Notes: The graph illustrates 2SLS estimates of Eqs. (1) and (2) (with 95% confidence intervals) by gender and type of mental disorder for the 1985–1995 cohort. The dependent variable in the upper panel is equal to the logarithm of one plus the total occurrences of mental health disorders in a municipality-year (for the corresponding cohort-gender group). The dependent variable in the bottom panel is equal to a dummy variable indicating the occurrence of any mental health disorders in a municipality-year (for the corresponding cohort-gender group). The left panels report estimates for males while the right panels report estimates for females.

Repeated media exposure to collective traumas can trigger psychological distress (Holman et al., 2014). People may also behave in more impulsive, narcissistic, and aggressive ways when they are online (Suler, 2004), which can translate into worse socializing behavior offline (Aboujaoude, 2016). Importantly, Internet Addictive Disorders were discussed in the 1990s, long before the widespread use of modern social media (Kandell, 1998).

Overall, our results point to a net negative effect on the younger cohorts while no discernible pattern emerges for the older one. As we focus on a period of early penetration of social media, our findings highlight that the deteriorating impact of the internet on mental health may be driven by several factors that happened beyond and before the rise of these specific digital platforms.

CRediT authorship contribution statement

Dante Donati: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ruben Durante:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Francesco Sobbrío:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Dijana Zejčirović:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

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

Appendix A. Supplementary data

Supplementary material related to this article can be found online at <https://doi.org/10.1016/j.jhealeco.2025.103017>.

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