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ABSTRACT

Education, Information, and COVID-19 Excess Mortality

We study the role of education during the COVID-19 epidemic in Italy. We compare the trends of mortality rates between municipalities with different shares of educated residents between 2012 and 2020, by means of a continuous event study model and controlling for many confounders. We find that education played a protective role against the pandemic, significantly reducing mortality rates, during the first wave of the pandemic (between March and May 2020), but not during the second wave (between October and December 2020). We interpret this finding as the outcome of the interplay between education and the quality of information about preventive strategies, which was available at the different phases of the epidemic.

JEL Classification: I14, I18, I26, R00

Keywords: COVID-19, education, information, excess mortality, municipality, parallel trend

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Introduction

COVID-19 mainly spreads through close contact from person to person. Hence, people may have a great deal of control over the risk of being infected. For instance, they can keep social distancing, reduce mobility, use face masks and adopt specific hygiene practices.

However, adopting these protective strategies requires a profound change of long-established and deeply interiorised social behaviours. Changing is difficult because of inertia (Ornaghi and Tonin, 2018), and because these strategies limit social interactions and freedom of movement. The decision to adopt protective strategies depends on their perceived costs and benefits, and individuals comply if perceived benefits exceed perceived costs. The balance between costs and benefits is influenced by several factors, including gender, age, occupation, income, trust in the government and beliefs (Galasso et al. 2020, and Desmet and Wacziargm 2021, among others). Several papers also show that compliance is stronger in areas richer in social capital (Barrios et al. 2021, Durante et al. 2021, Brodeur et al. 2020), where social benefits are more likely to be factored in individual decisions.

Assessing the size of the benefits crucially depends on one's ability to acquire and process information, to judge the effectiveness of alternative strategies, the level of own risk of infection, the credibility of alternative information providers, the ability to discriminate between evidence-based and fake news. Quite obviously education is crucial in this respect, as individuals with higher education enjoy higher numeracy, literacy, cognitive and analytical abilities. Hence, they are less likely to believe in conspiration theory, or fake news (Freeman et al. 2020) and are able to take better decisions in the health domain (Reyna et al. 2009).

It is surprising that so little attention has been spent studying the role of education in determining the spread and intensity of the COVID-19 pandemic. Many studies control for education, but very few focus primarily on education, despite it is a determinant of many of the factors that have been analysed in the literature.

There is also an interesting interplay between education and information, which is worth exploring. Consider for instance the discussion about wearing face masks, which was fierce at the beginning of the pandemic. At that time, several prominent commentators argued against using face masks, on the grounds of their ineffectiveness and side effects. Later on, especially during the second wave of the epidemic, most agreed on the importance of face masks. We argue that when information is abundant and univocal, people can easily ascertain the benefits of a strategy, independently of their education. When instead information is contradictory, the more educated are better able to discriminate among different opinions and are more likely to take the right side.

In this paper we test such interplay between education and information by analysing 1) how excess mortality varied across Italian municipalities depending on their level of education, specifically the proportion of residents with at least an upper secondary degree, while controlling for a broad spectrum of confounders; 2) how the role of education changed between the first wave of the epidemic, when information was more contradictory, and the second wave, when guidelines were rather aligned.

We exploit the mortality data provided by the Italian National Statistics (ISTAT), by municipality, date of death, and age, from 2011 to 2020. These data are rather unique because they allow us to examine (excess) mortality in 2020 compared to the previous years in detail. All-cause mortality captures mortality both directly and indirectly related to COVID-19, the latter being the one caused by possible disruptions of the healthcare system at the peak of the epidemic, the delay in programmed treatments, surgery and screening. We believe that all-cause mortality is a more accurate account for the intensity of the COVID-19 epidemic compared to the number of COVID-19 cases, the number of COVID-19 hospitalizations or the number of COVID-19 fatalities.

We consider mortality in the population aged 60 and over, which is the age group that almost exclusively suffered the worst consequences of COVID-19, and we distinguish four periods in the epidemic, January and February 2020, which is essentially pre-COVID-19; March to May, which corresponds to the first COVID-19 wave; June to September, which corresponds to the fading out of the first wave and the ease of mobility restrictions; and, finally October to December, which corresponds to the rise of the second wave. This way we shall compare the role of education during the first wave, when information about prevention strategies was contradictory, and during the second wave, when established preventive strategies and guidelines were generally agreed upon. We also distinguish between Northern and Central-Southern Italy, because the former experienced both waves while the latter was spared between March and May.

For each period and each area, we estimate a continuous event study model to establish if and to what extent the increase in mortality rates registered in 2020 compared to the period between 2012 and 2019 depends on the proportion of municipality residents with at least an upper secondary school diploma. To credibly identify the differential effect due to education, we control for confounding variables in a manner that is more comprehensive compared to what has been done in the literature. Specifically, we ran a principal component analysis over a battery of municipality characteristics likely to be correlated with education, ranging from employment, income, demography, social capital and household composition. All these characteristics are predetermined and refer to 2011.

Our data allows us to test parallel trends in a very long pre-COVID-19 period, representing a major value-added compared to the literature. As the identifying condition of parallel trend holds, we can safely attribute the differential excess mortality we observe in 2020 to education and not to underlying diverging trends already existing pre-COVID-19 across municipalities.

We find that in Northern Italy, during the first wave, education played a significant protective role. The excess mortality rate among the over 60+ was much smaller among the more educated municipalities than among their less educated counterparts. Specifically, a 10 percentage points increase in the share of residents with at least secondary education was associated with a 0.7 deaths per 1000 inhabitants lower excess mortality, which correspond to about 39 percent of the average excess mortality registered in the North between March and May. During the second wave, which regarded the whole country, we do not find any significant differential effect related to education, neither in the North nor in the Centre-South.

We interpret these finding as supporting our hypothesis that education matters when information about the mechanics of COVID-19 transmission and the protective strategies is contradictory. We also point out that alternative candidate explanations of the role of education, based on the correlation between education and preference traits, such as risk aversion (Jung, 2015, Dohmen et al. 2010), loss aversion (Benjamin et al. 2013) or propensity to abide by regulations, would not explain why education was protective in the first but not the second wave.

The rest of the paper is organised as follows. Section 2 is devoted to the review of the relevant literature. Section 3 documents the phases of the pandemic in Italy and the evolution of the guidelines from March 2020 onwards. Section 4 describes our data while the empirical strategy is discussed in Section 5. Results are collected in Section 6 and Conclusions follow.

2. Relevant literature.

Our paper contributes to the literature that studies the local and individual correlates of the COVID-19 pandemic, and investigates if the pattern of the pandemic across different areas reflects an underlying heterogeneity of pre-determined local characteristics.

At the local level, a number of papers have investigated the mediating role of the presence of care homes, demographics, average income, poverty, income inequality and social capital, using data aggregated by municipality, county or zip code.

Alacevich et al. (2021) investigate the role of care homes in Lombard municipalities. In Lombardy, during the first wave, a disproportionate number of COVID-19 fatalities were registered among the guests of care homes. Alacevich et al. (2021) hypothesize that care homes could have been hotspots of the pandemic, which help to spread the virus in the nearby areas. They compute excess death for each day between January 1st and March 31st and each municipality and compare municipalities with and without care homes located in their territory, controlling for other municipality characteristics and province fixed effects. Results confirm that the presence of care homes is associated with 41 percent larger excess death rates in the first quarter of 2020. Brandily et al. (2020) study excess mortality across municipalities in France and focus on the role of poverty. They apply a triple difference strategy, which compares the excess death in poor and non-poor municipalities located in high and low intensity areas during the first wave of the epidemic. They conclude that excess mortality was twice as large in the poor (i.e. the bottom quartile of the municipal income distribution) than in the non-poor municipalities. Still for France, Ginsburg et al. (2021) suggest that departments with higher income inequality (measured by the Gini index) faced more COVID-19 deaths, more discharged patients, and a higher number of cases in the period between May 13th and September 3rd when France was experiencing the second and stronger epidemic wave. Their analysis is cross-sectional and controls for the age structure of the population, the supply of primary health care, the average household size and other local characteristics included the prevalence of COVID-19 tests. In neighbouring Belgium, Verwimp (2020) documents that COVID-19 spreads faster in municipalities that are larger, more densely populated, have higher income, more exposed to migration, business or leisure travelling, and have a larger share of elderly people and residents in care homes. However, later on, richer municipalities managed to contain the epidemic better than poorer municipalities. Turning to the US, Desmet and Wacziarg (2021) study the determinants of new infections and fatalities by county. They conclude that population density, presence of nursing home, lower income, higher poverty rates, and a greater presence of African Americans and Hispanics are positively correlated with the epidemic intensity and that their effects increased over time before plateauing or slightly declining.

Three important contributions study New York City at the level of zip code. Glaeser et al. (2020) show that mobility is a major determinant of COVID-19 spread and estimate that reducing mobility by 10 percent can reduce the number of cases by almost 30 percent. Almagro et al. (2020)

study the effect of the type of occupation on the cumulate number of COVID-19 cases, controlling for average income, racial and age composition. They find the strongest positive correlation on the share of positive tests with the share of workers in transportation, industrial, natural resources and construction, and non-essential – professional sector. Borjas (2020) warns however that the number of positive cases can be a misleading indicator of the pandemic spread, because it closely depends on the number of tests and, mainly, self-selection into testing. Indeed, Borjas (2020) finds that people residing in poor or immigrant neighbourhoods were less likely to be tested.

The level of compliance with mobility restrictions, social distancing, mask-wearing, and hygiene practices largely determines their effectiveness. Caselli et al. (2020) use Italian data on mobility by municipality and conclude that the average effect of the introduction and removal of mobility restrictions is associated with a variation in mobility of about 7 percent on average. Many researchers have studied the association between compliance and local and individual characteristics. Among these, Durante et al. (2021) study whether the fall in mobility following the mobility restrictions are related to the local level of civic capital in Italian provinces. They measure mobility by province by using mobile phone data and compare the mobility reductions between high and low civic capital provinces. They conclude that provinces richer of social capital, where people take more into account the social benefits, comply with mobility restrictions significantly more than provinces less endowed of civic capital. They control for province and time fixed effects and for the differential trends, which might be due to variables correlated with civic capital, including education. Similarly, Barrios et al. (2021) study the role of social capital in explaining voluntary social distancing at the county level in the US and confirm the result that social distancing was greater in areas with higher civic capital. After U.S. states began re-opening, high civic capital counties maintained a more sustained level of social distancing than low civic capital counties. Brodeur et al. (2020) perform a similar analysis focusing on the effect of trust and accounting for the differential trends, which depend on other county characteristics correlated with trust. The empirical strategies employed in Durante et al. (2021), Barrios et al. (2021) and Brodeur et al. (2020) are alike and close to the one we adopt in this paper.

Turning to the individual level, several studies investigate how compliance varies with beliefs and information, across genders, by level of income and occupation, among others.

Castriota et al. (2020) show that the demand for local and national news in Italy during the first pandemic wave (measured by TV viewership of the news in local and national canals) responded to national rather than the local pandemic situation. This implies that people consider epidemiological developments outside their own region as highly relevant and do not focus only on the information they can perceive by means of their own experience. Simonov et al. (2020) find that in the US viewership of the sceptical Fox news is associated with less compliance with mobility restrictions, pointing out the importance of the information that individuals absorb in shaping their beliefs and their behaviours.

Caselli et al. (2020) use phone data to track mobility in several European countries, aggregated by age groups and gender and conclude that females and young people have a stronger response to mobility restrictions. The finding that women tend to comply more is confirmed in several other papers, with different approaches and in different countries, such as Galasso et al. (2020), Papageorge et al. (2021), Raude (2020) and Uddin et al. (2021) among others. Furthermore, Galasso et al. (2020), exploiting a cross-country survey of OECD countries, find some evidence that the larger propensity to comply of females over their male counterparts is, if anything, reduced by education.

Papageorge et al. (2021) examine the correlates of compliance with protective measures and social distancing in the US and suggest that high-income individuals comply more. Importantly, the authors point out that people with lower income levels might have more difficulty in complying because they enjoy less flexible work arrangements and less comfortable housing. Differently, Nivette et al. (2021) who study a Swiss cohort of youths, find that at age 22, compliance with preventive measures and social distancing is negatively associated with education and SES.

Little attention has been devoted so far to the role of education. This is surprising as education shapes individual ability to elaborate information, to judge their credibility and to discriminate between contrasting indications. Education is an obvious determinant of income, type of occupation, social capital and beliefs. Several papers control for education, often without reporting its estimated effect. We have been able to find only one paper that studies the effect of education, and also in this case education is not the paper's main focus. Namely, Charoenwong et al. (2020) use data from Facebook in the US by county and estimate a DID model where they exploit the scattered introduction of mobility restrictions in the local areas at the beginning of the pandemic. They find that counties with a higher proportion of college graduates are more responsive and increase more their social distancing. They also find that having Facebook connections with less educated individuals decreases compliance. These findings contrast with those from the UCL's COVID-19 Social Study, a longitudinal study that follows a panel of about 50,000 Britons during the pandemic. These data constantly indicate that the more educated comply less than the lower educated, although they react more to the strengthening or the easing of the restrictions. At the time the first lockdown was enacted in the UK the level of compliance was rather uniformly high, independently of education. Next, the gap widened during the first ease of limitations and the more educated did never go back to their initial level of compliance (Fancourt et al. 2021).

Overall, the scant evidence about the effect of education is mixed. Some point to a protective role of education (Charoenwong et al. 2020) while others suggest the opposite (Fancourt et al. 2021, Ninette et al. 2021, Galasso et al. 2020). We suggest that, at least in part, these contrasting findings can be explained by taking into account the quality and the coherence of the available information at different phases of the pandemic.

3. Background: the epidemics in Italy

The first cases of COVID-19 detected in Italy date back to mid-January 2020 and regarded two Chinese immigrants returning to Italy. The first non-imported cases were reported in late February 2020 and the first fatality in February 21st in the small municipality of Vò Euganeo in the Veneto Region, which became famous for the first mass COVID-19 testing, which revealed that most COVID-19 cases were asymptomatic (Lavezzo et al. 2020). Lombardy and Veneto were the first two regions hit by the pandemic, but by early March all regions of Northern Italy registered COVID-19 cases. Since March 9th the whole country was locked down (following measures similar to those adopted in the areas of the first outbreaks on February 23rd). Lockdown was progressively eased since May 4th to be finally lifted on June 3rd. From that time on, travelling between regions was permitted again. During the period between June and September, mobility restrictions were dropped, economic activities re-opened and the obligation of wearing masks outdoors was removed.

From early October, with a significant delay with respect to Spain and France, the first European countries that started experiencing the second wave, the number of infections and deaths increased anew. Restrictive measures were re-established although at a lower level of intensity compared to those enacted between March and April. Primary schools remained open and so did secondary schools, albeit intermittently. Most firms continued to run, provided that they adopted adequate preventive measures. Heavy restrictions were instead imposed on hotel, bars and restaurants and personal services.

In Fig. 1 we report excess mortality rate among the population aged over 60, by month, comparing the level of mortality rate in 2020 with its average between 2011 and 2019.[1] We distinguish between Northern and Central-Southern Italy. It is apparent that excess mortality concentrates in two waves, between March and May in the North, and between October and December in the whole country. In the North, mortality rates were about 59 percent higher than usual during the first wave, and despite this experience, the North experienced the largest excess mortality even in the second wave (about 37 percent compared to less than 17 percent in the Centre and the South). More precisely, compared to a pre-covid monthly mortality rate of about 3.2 per 1000 inhabitants aged over 60, the excess mortality rate in the North was over 3 in March, just below 2 in April and again around 1.5 in November and December. In the Centre and South, excess mortality rates remained below 1 between November and December.

Excess mortality was concentrated in the age group 60+. We do not detect statistically significant variation at younger ages, although there certainly were a few cases of COVID-19 death also among those aged less than 60. In Figure 2 we report the average excess mortality rate in Italy by age group during the first and the second wave. Among the population aged over 60, excess mortality was 1 during the first wave and 0.88 during the second. Among younger groups excess mortality rates were very close to zero.

As in other countries (Zhang et al., 2021), during the first wave of the pandemic, there was quite some debate about the protective measures to be adopted. Early on, it was deemed unlikely that healthy people could spread the virus and hence testing was limited and restricted to subjects displaying symptoms. Thus, the large majority of the asymptomatic had little reason to take actions aimed to limit virus transmission.

Very telling of the confusion in public health messages was the communication about the use of face masks. WHO guidelines issued on January 29th maintained that masks should be used only by the healthcare personnel and not by the general public. This was also the official position of Italian authorities, despite many scientists supported opposite views and some regions started issuing contrasting messages. For instance, on the 3rd of April, the head of the Italian Civil Protection Agency, Angelo Borrelli, stated that he was not wearing masks, although he kept the social distancing of one meter. The same day, the Lombardy region issued a regulation that made the use of masks compulsory outdoors. On the day after, April 4th, the Chief Public Health

[1] By excess mortality rate we mean the absolute difference between the mortality rate among the over-60 recorded in 2020 and that recorded on average between 2011 and 2019. Mortality rates are computed as number of deaths in the age group 60+ per 1000 residents aged 60+, per month.

Officier, Franco Locatelli,[2] declared that there was no firm evidence of the effectiveness of masks, while Andrea Crisanti, the researcher who first proved the role of the asymptomatic in spreading the virus, simultaneously claimed that "masks are key: better use them also indoor".

Only in June (June 5th) the WHO updated its guidelines and stated "Many countries have recommended the use of fabric masks/face coverings for the general public. At the present time, the widespread use of masks by healthy people in the community setting is not yet supported by high quality or direct scientific evidence [...]. However, [...] WHO has updated its guidance to advise that to prevent COVID-19 transmission effectively in areas of community transmission, governments should encourage the general public to wear masks in specific situations and settings as part of a comprehensive approach to suppress SARS-CoV-2 transmission (WHO, 2020, p.6)".

Finally, on the 1st of December, WHO further updated its recommendations and stated "WHO advises that the general public should wear a non-medical mask in indoor (e.g. shops, shared workplaces, schools [...]) or outdoor settings where physical distancing of at least 1 metre cannot be maintained. If indoors, unless ventilation has been assessed to be adequate, WHO advises that the general public should wear a non-medical mask, regardless of whether physical distancing of at least 1 metre can be maintained (WHO 2020b, p.1)".

In Italy coherence between public health messaging was further complicated by the regional organization of healthcare. All Italian regions have important competencies regarding health and prevention, which should be coordinated with the central bodies at the ministry of public health. Especially during the first phases of the pandemic, however, coordination between central and regional bodies and among regions was limited. Regions took autonomous initiatives as regards the obligation of wearing masks outdoors, whether schools had to be closed, and the restrictions in public transports (Antonini et al. 2020; Berardi et al. 2020). Regional decisions were reported by the national media, reached the general public (Castriota et al. 2020) and increased confusion.

4. Data and Descriptive Statistics

We match age-specific mortality data, between 2012 and 2020, with socio-demographic indicators by municipality in 2011 and social capital indicators at the province level.

Mortality data are provided by the Italian National Statistical Institute (ISTAT) and consists of daily counts of deaths, by municipality, gender and age group, between January 2011 to December

[2] President, Consiglio Superiore della Sanità

2020, all causes of death combined. By using yearly data on population by municipality, age and gender, also provided by ISTAT, we compute age-specific mortality rates per 1000 inhabitants for each year, from 2012 to 2020, and each period January-February, March-May, June-September, October-December, a partition which closely follows the phases of the COVID-19 pandemic in 2020. By computing mortality rates, we neutralize the problem of accounting for municipality and population scale, which would instead emerge if we considered the absolute number of deaths (as other papers in the literature do). We focus on the population aged 60 or more,[3] since the data of the Italian health authority[4] shows that COVID-19 mortality is practically absent among people younger than 60. Our data confirm this fact as we do not practically detect any excess mortality in age groups younger than 60 (Figure 2).

Municipality socio-demographic indicators have been compiled by the Local Opportunities Lab,[5] a think tank, which matches and harmonizes data at the municipal level produced by ISTAT and other Italian government agencies. Particularly we select censual data for 2011, which include the share of individuals with at least upper secondary education, employment rate, the share of employment in manual occupations, an index of commuting, the share of families at risk of poverty, the share of migrant population, the incidence of house ownership, a housing price index, the number of hospital beds per inhabitant, the share of population living out of the main agglomeration of the municipality, average family size, the dependency ratio (i.e. the ratio of the population older than 65 to the population younger than 15), and the male to female ratio. Our analysis also includes three variables at the province level, which are commonly used in the economics and political science literature to measure the level of social capital for Italian provinces – the incident of blood donation, the turnout in the referendum on divorce in 1974 (Guiso, Sapienza, and Zingales, 2004) and the answer to 'trust' question in the World Value Survey (Tabellini, 2010). Table 1 provides summary statistics for all these variables.

We provide some graphical evidence on the relationship between education and mortality. Figure 3 shows the evolution of the monthly mortality rate among the population aged over 60 in the period 2019-2020 in Northern and Central-Southern municipalities, according to the proportion of residents with at least upper secondary education. Specifically, we identify groups of municipalities according to the quintile of the education distribution, from the lowest educated (Q1) to the highest educated (Q5). In Northern Italy (right panel), in 2019 and the first two months of 2020, mortality rates followed close trajectories in all five quintiles, the monthly mortality rate

[3] We define M_{its} = (deaths in period s of year t among the population aged 60+ in municipality i)/(population aged 60+ in year t in municipality i) x (1000/Ns), where Ns is the number of months in period s.

[4] Istituto Superiore di Sanità

[5] https://www.localopportunitieslab.it/

being slightly over 3 per 1000 inhabitants. Differently, between March and May, during the first wave of the pandemic, when mortality sharply increased, the municipalities in the lowest and the highest quintiles of the education distribution diverged. They almost reached 5 per 1000 inhabitants in the highest three quintiles and were close to 9 and 7 in the first and second quintile, respectively. As the first wave faded out, mortality rates dropped to pre-pandemic levels and remained stationary until September, when they increased again. During the second wave, differences by education level almost disappeared. In the municipalities with relatively high education (the the top three quintiles) mortality rates returned at the levels reached during the first wave. Instead, in the municipalities with lower education (the first two quintiles) mortality rates remained well below the peaks reached in the first wave, and actually aligned to the levels of the high education group. The municipalities in Central-Southern Italy (left panel) display no difference in the mortality trends during the entire period. The evidence of a parallel trend before the beginning of the pandemics supports the hypothesis that the evolution of mortality rates across the five groups of municipalities would have been the same absent the pandemics.

5. Empirical Analysis and Results

To disentangle the effect of education on excess mortality from that of other variables we exploit the battery of municipal variables listed in Section 4. To reduce dimensionality, we standardize all variables, run a principal component analysis and retain the (four) principal components (PC) with eigenvalues larger than one. These four components account for about two-thirds of the overall variation (64.2 percent). In Table 2 we report the factor loadings for each component. According to these loadings, we tentatively interpret component 1 as the endowment of social capital (the factor loadings corresponding to the indicators of social capital are the highest among all components) and component 2 as a degree of economic centrality and attractivity of the municipality, while component 3 indicates peripheral industrial areas mainly inhabited by natives,[6] and component 4 identifies peripheral areas with high immigration.

Next, we compare changes in mortality rates between municipalities with different levels of education, controlling for other municipality characteristics summarised by the four PCs.

We run separate analyses for Northern and Central-Southern Italy because the former experienced both waves of the pandemic, while the latter was de facto spared during the first wave. Moreover, we run the model separately for the periods January-February, March-May, June-September and

[6] The component is larger when house prices are low, the prevalence of manual occupations is high, population density is high, households are relatively young and large, and the immigrant share is low.

October-December in order to identify how the role of education changed across the four phases of the pandemic.

Hence for each period and area, we estimate continuous event study models specified as follows:

$$M_{it} = f_i + \sum_{\tau \neq 2019} \alpha_\tau D_\tau + \sum_{\tau \neq 2019} \beta_\tau Edu_i \times D_\tau + \sum_{\tau \neq 2019} \sum_{k=1}^{4} \delta_{k\tau} PC_{ik} \times D_\tau + \varepsilon_{it} \quad (1)$$

where M_{it} is the average monthly mortality rate in municipality i and year t for the age group 60+ (see footnote 2 for the precise definition), f_i are municipality fixed effects, D_τ are year dummies for each year between 2012 and 2020 with 2019 excluded, Edu_i is the share of residents with at least upper secondary education in 2011, PC_{ik}, $k=1,2,3,4$ are the four principal components defined in the previous section. The year-specific effects $\beta_\tau Edu_i$ and $\delta_{k\tau} PC_{ik}$ capture the differential time effects for each year due to municipal education and other characteristics with respect to common trend α_τ. This model allows us to disentangle the effect of education from that of other confounding factors, testing for a parallel trend in the pre-pandemic period.

Standard errors are clustered at the local labour market level, a concept equivalent to that of commuting areas.

6. Results

Estimates for Northern Italy, by period, are reported in Table 5. Columns 1-4 correspond to a more parsimonious specifications of model (1), where the principal components PCs are excluded, while columns 5-8 correspond to the full specification. The coefficients of the interactions between Edu_i and the year dummies for the years between 2012 and 2018 are not statistically significant in all columns, but for 2013 in column 6. Overall, this finding suggests that there are no significant differences in mortality rates across municipalities before the beginning of the pandemic depending on municipality education. Unsurprisingly, there are no differential effects among municipalities also in the period January-February 2020, before the arrival of the virus, and in the summer period between June and September 2020 where the virus circulation was largely reduced (the corresponding interactions are very small and not statistically significant).

Instead, we detect differences across more and less educated municipalities in the period between March and May, which corresponds to the first wave of the pandemic. The interaction between Edu_i and the 2020 dummy is negative and statistically significant in column 2 and 6. Actually, the inclusion of controls reinforces the finding. The size of the effect is large: an increase of 10 percentage points in the share of residents with at least upper secondary education, slightly more than one standard deviation, would correspond to smaller excess mortality of about 0.7 deaths per 1000 inhabitants aged 60+, per month, between March and May, which corresponds to 23 percent of the pre-COVID-19 average monthly mortality rate (0.7/3) and compares with the 39 percent increase of mortality rates documented in Figure 1.

This pattern is not replicated between October and December 2020, during the second wave of the epidemic (columns 4 and 8). In this case, excess mortality is not correlated with education, the point estimate of the interaction between Edu_i and the 2020 dummy being very small and even positive. This is not specific to the North, but extends also to Central-Southern Italy, despite the latter experienced the epidemic only during the second wave.

7. Conclusions

We have analysed the effect of education on excess mortality during the first year of the COVID-19 epidemic in Italy, exploiting detailed mortality data by municipality. Our results indicate that education played a protective role during the first wave of the pandemic (between March to May 2020), when municipalities with a better educated population experienced an increase in mortality significantly smaller compared to municipalities similar in many regards, but for a lower level of education. Differently and surprisingly at first sight, during the second wave education was not associated with any differential excess mortality across Italian municipalities.

We argue that these results are driven by the interplay between education and information. During the first wave, information about preventive and protective measures against COVID-19 was confusing and contradictory. Health institutions and experts gave indications quite far apart, for instance as regards the use of face masks. Instead, during the second wave, information was more coherent and univocal. Education is likely to play a role when information is incomplete and confusing, because the better educated are more able to discriminate between alternative sources, access more and better information, understand the mechanics of virus transmission and hence are more likely to adopt the strategies that will turn to be the correct ones ex-post. When information is clear and univocal, there is only one generally supported strategy and education does not have a role in the choice.

Our dataset covers a long time span from 2012 to 2020. Its length is one of the major points of interest of the paper compared to the literature because we can check that the differences in excess mortality observed during the pandemic are not due to divergent mortality paths pre-dating the pandemic. This is not an obvious result, because, a priori, the well known socio-economic gradient of health, whereby individual socio-economic status (and education) is associated with better health and longer life expectancy (Marmot, 2010), might have been responsible for divergent mortality trends.

Our findings add to the established evidence of the socio-economic gradient of health, suggesting that better educated people, in the midst of an unexpected crisis, are better able to cope than the less educated. Our findings also suggest that future mortality patterns could diverge among municipalities with different endowments of education until the effect of the pandemic is not reabsorbed.

We draw a double policy implication: on the one hand, supporting education, including adult education, might have important returns in the health domain and could help shelter people against possible new pandemics. On the other hand, avoiding contradictory information should be a primary concern of the public health agencies in order to reduce inequalities associated with differential levels of education.

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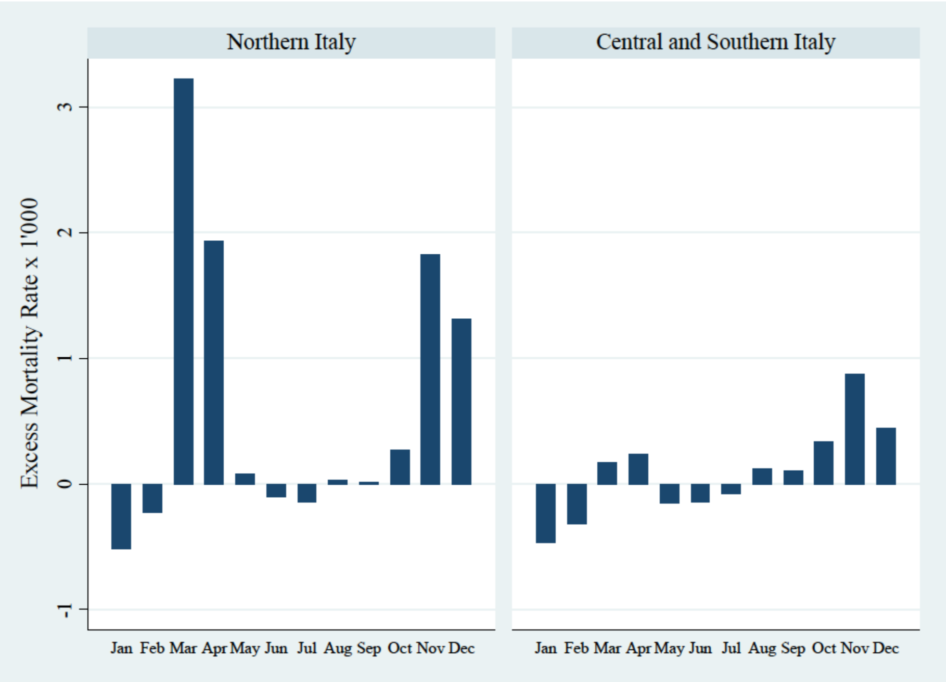
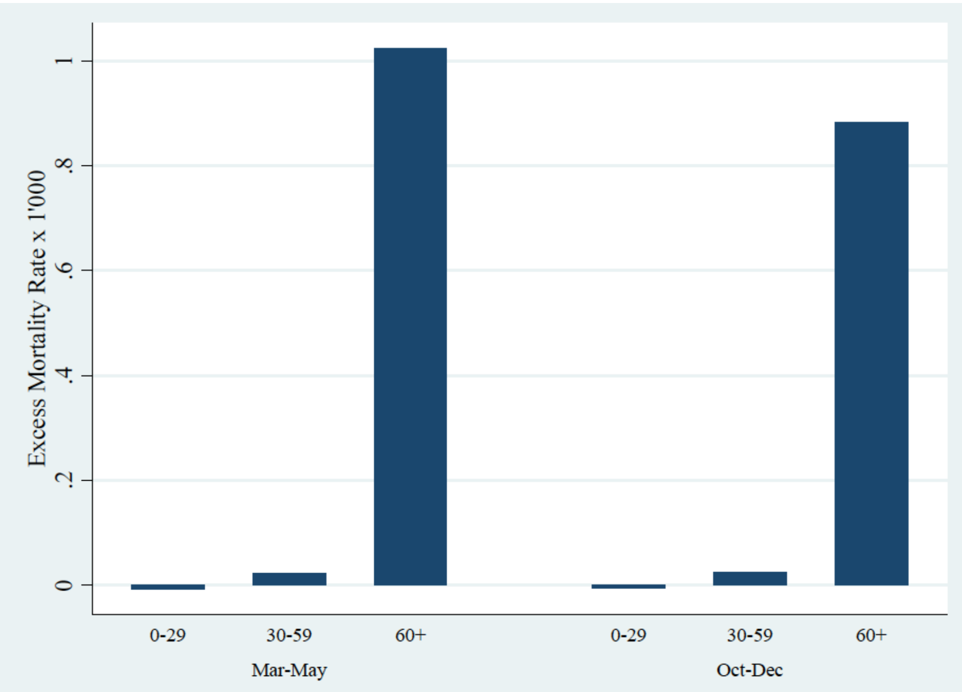
Figures and Tables

Figure 1: Average excess mortality in 2020 compared to the average 2012-2019, by month



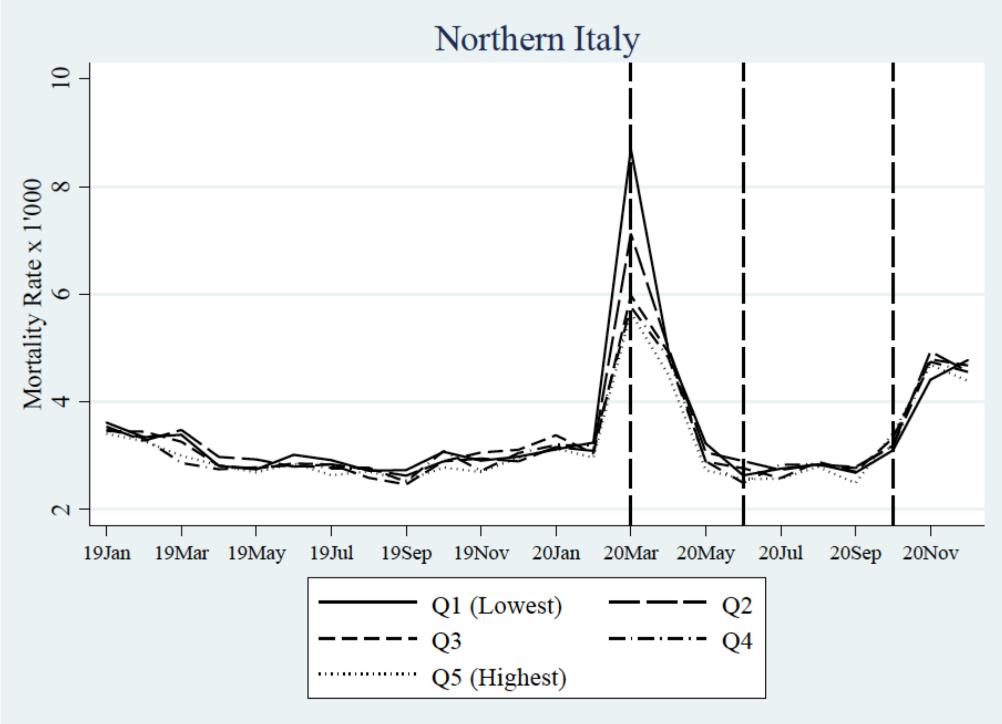
Note: The figure shows the average excess mortality in Northern and in Central-Southern Italian municipalities for each month of 2020. Excess mortality is the difference between the average mortality rate in 2020 for the age group 60+ and its 2012-2019 average. Source: ISTAT

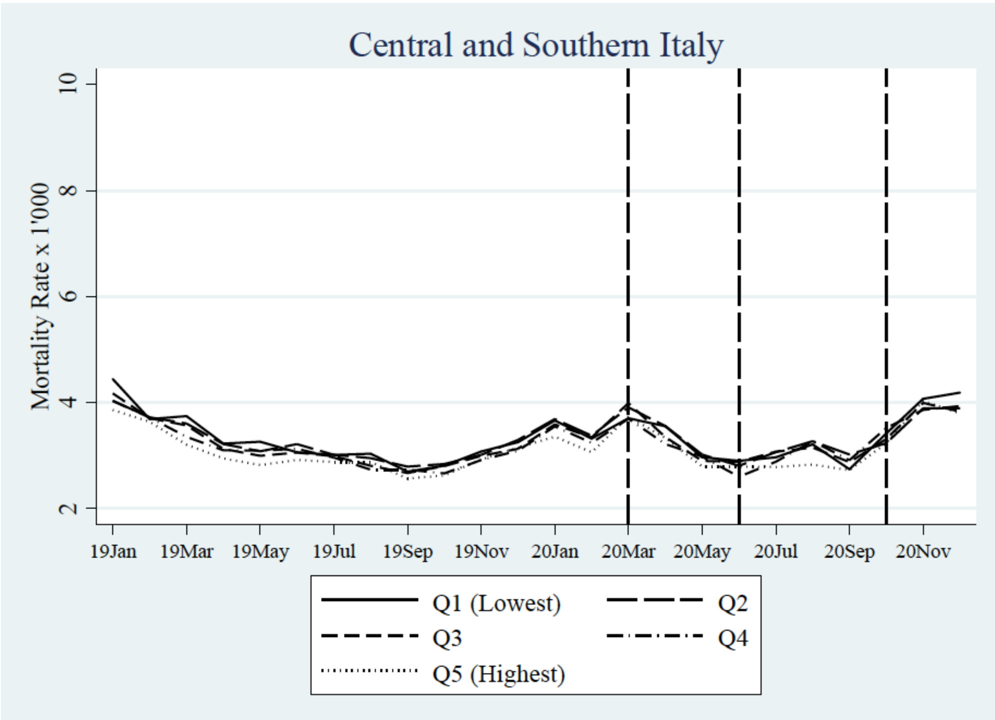
Figure 2 – Average excess mortality in 2020 compared to the average 2012-2019, by age group



Note: The figure shows the average excess mortality for the first (Mar-May) and second wave (Oct-Dec) of the pandemic by age group (Northern and Central-Southern Italy combined). Excess mortality is equal to the difference between the average mortality rate in 2020 and its 2012-2019 average. Source: ISTAT

Figure 2: Average Mortality Rate, by education (2019-2020)





Note: The figure shows the evolution of municipalities' average mortality rate between January 2019 and December 2020, separately for Northern and Central-Southern Italy. The figure also distinguishes five groups of municipalities according to their level of education. The three vertical bars identify the phases of the pandemics: January-February 2020, March-May 2020, June-September 2020, and October-December 2020.

Table 1: Summary Statistics

	Mean	Sd	Min	Max
Monthly Mortality rate (2020) x 1000 inhabitants	3.562	2301	0.000	38.363
Monthly Mortality Rate (2012-19) x 1000 inhabitants	3.188	0.671	1.433	9.040
At least upper secondary education	49.640	8.874	16.500	83.500
Employment rate	45.148	7.885	18.000	74.000
Incidence of employment in manual occupations	26.852	7.836	4.600	71.700
Index of commuting	80.194	7.065	22.000	96.000
Number of hospital beds	1.098	10.352	0.000	684.100
Incidence of house ownership	76.703	6.624	17.600	100.000
Housing price index	78.442	43.952	17.218	750.870
Share of population out of the main center	17.798	18.192	0.000	97.400
Share of families at risk of poverty	2.028	1.881	0.000	17.900
Share of migrant population	5.884	4.191	0.000	36.700
Population density	283.674	611.398	1.400	11346.300
Average family size	2.358	0.265	1.200	3.400
Ratio of population older than 64 to population younger than 15	194.617	138.108	25.400	2850
Male/female ratio	97.061	6.206	67.800	182.800
Votes on Divorce	87.559	7.373	68.000	97.000
Donation	2.933	2.156	0.000	10.521
Trust	80.245	8.078	62.000	92.000
Observations:		280516		

Note: The table shows summary statistics for our dependent and control variables for the 2012-2020 period. All variables are at the municipal level, except for the last three variables (Votes on Divorce, Blood donation and Trust), which are only available at the province level. An observation is a municipality-period-year. Source: ISTAT.

Table 2: Factor loadings.

Variable	Comp1	Comp2	Comp3	Comp4	Unexplained
Employment rate	0.394	0.149	0.081	0.028	0.178
Incidence of employment in manual occupation	0.249	-0.244	0.330	0.130	0.349
Index of commuting	0.196	0.372	0.179	-0.244	0.309
Number of hospital beds	0.005	0.051	-0.141	-0.000	0.963
Incidence of house ownership	0.144	-0.252	0.240	-0.550	0.293
Housing price index	0.137	0.263	-0.446	0.144	0.393
Share of population out of the main center	0.044	-0.299	0.156	0.430	0.495
Share of families at risk of poverty	-0.351	0.199	0.097	0.222	0.223
Share of migrants	0.290	0.123	-0.089	0.337	0.411
Population density	-0.025	0.357	-0.231	0.112	0.544
Average family size	-0.059	0.389	0.486	0.035	0.203
Ratio of population older than 64 to population younger than 15	-0.033	-0.430	-0.394	-0.056	0.238
Male and female ratio	0.099	-0.191	0.253	0.483	0.489
Votes on Divorce	0.420	0.023	-0.125	-0.002	0.122
Donation	0.346	0.013	0.028	-0.029	0.420
Trust	0.429	-0.002	-0.097	-0.018	0.097

Note: The table shows the correlation coefficients between the observed variables and the four principal components with eigenvalues larger than one.

Table 3: OLS regressions for Mortality Rates. Northern Italy

VARIABLES	(1) Jan-Feb	(2) Mar-May	(3) Jun-Sep	(4) Oct-Dec	(5) Jan-Feb	(6) Mar-May	(7) Jun-Sep	(8) Oct-Dec
Edu x D2012	-0.0125	0.00570	-0.00424	-0.00319	-0.00553	0.0120	-0.00588	-0.00510
	(0.00929)	(0.00593)	(0.00526)	(0.00523)	(0.0112)	(0.00830)	(0.00812)	(0.00750)
Edu x D2013	-0.00616	0.00711	-0.000216	0.00241	-0.00126	0.0204**	-0.000389	0.000373
	(0.00757)	(0.00701)	(0.00576)	(0.00580)	(0.0113)	(0.00980)	(0.00903)	(0.00754)
Edu x D2014	-0.00870	5.12e-05	-0.00281	0.00123	-0.00244	0.00711	0.000241	0.00157
	(0.00847)	(0.00602)	(0.00505)	(0.00630)	(0.0107)	(0.00826)	(0.00754)	(0.00876)
Edu x D2015	-0.0118	0.000839	-0.00867	0.00527	-0.00780	0.00329	-0.0122	0.00914
	(0.00870)	(0.00649)	(0.00574)	(0.00581)	(0.0119)	(0.00892)	(0.00837)	(0.00778)
Edu x D2016	0.00169	0.000563	-0.00383	-0.00315	0.00583	0.00788	-0.00584	-6.87e-05
	(0.00846)	(0.00536)	(0.00479)	(0.00669)	(0.0124)	(0.00755)	(0.00645)	(0.00857)
Edu x D2017	0.00153	0.00497	-0.00537	-0.00192	0.0110	0.00804	-0.00542	0.00310
	(0.00714)	(0.00526)	(0.00547)	(0.00626)	(0.00990)	(0.00678)	(0.00716)	(0.00832)
Edu x D2018	-0.00636	0.00342	-0.00628	-0.000555	-0.00673	0.00239	-0.00769	-0.00173
	(0.00836)	(0.00579)	(0.00499)	(0.00518)	(0.0132)	(0.00873)	(0.00689)	(0.00654)
Edu x D2020	-0.00472	-0.0432***	-0.00235	0.00960	-0.00334	-0.0672***	-0.00310	0.00952
	(0.00919)	(0.0162)	(0.00526)	(0.00718)	(0.0141)	(0.0198)	(0.00839)	(0.00901)
Observations	39,287	39,329	39,312	39,328	35,337	35,378	35,370	35,386
R-2	0.187	0.248	0.214	0.214	0.193	0.267	0.220	0.221
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Municipality FE	YES	YES	YES	YES	YES	YES	YES	YES
PCs included	NO	NO	NO	NO	YES	YES	YES	YES
Average Mortality Rate (12-19)	3.533	3.009	2.760	3.049	3.533	3.009	2.760	3.049
Excess Mortality Rate	-0.381	1.778	-0.0403	1.146	-0.381	1.778	-0.0403	1.146

*Note: Years: 2012-2020. Robust standard errors clustered at the local labour market level in parentheses. The dependent variable is the monthly mortality rate for the age group aged 60+ in the given period. Edu measures the share of individuals with at least upper secondary education. All regressions are conducted at the municipal level and include year dummies and municipalities fixed effects. Regressions in columns 5-8 also include the PCs and their interactions with year dummies. *** p<0.01, ** p<0.05, * p<0.1.*

Table 4: OLS regressions for Mortality Rates. Central and Southern Italy

VARIABLES	(1) Oct-Dec	(2) Oct-Dec
Edu x D2012	0.00583	0.00488
	(0.00425)	(0.00492)
Edu x D2013	0.0102*	0.0130**
	(0.00572)	(0.00605)
Edu x D2014	0.00420	0.00257
	(0.00435)	(0.00537)
Edu x D2015	0.00280	0.00407
	(0.00398)	(0.00483)
Edu x D2016	0.00173	0.000159
	(0.00443)	(0.00506)
Edu x D2017	0.00398	0.00404
	(0.00433)	(0.00518)
Edu x D2018	0.00126	0.00299
	(0.00432)	(0.00518)
Edu x D2020	-0.00300	-0.00481
	(0.00495)	(0.00529)
Observations	30,815	29,853
R-2	0.195	0.195
Year FE	YES	YES
Municipality FE	YES	YES
PCs included	NO	YES
Average Mortality Rate (12-19)	3.207	3.207
Excess Mortality Rate	0.551	0.551

Note: Years: 2012-2020. Robust standard errors clustered at the local labour market level in parentheses. The dependent variable is the monthly mortality rate for the age group aged 60+. Edu measures the share of individuals with at least upper secondary education. All regressions are conducted at the municipal level and include year dummies and municipalities fixed effects. The regression in column 2 also includes the PCs and their interactions with year dummies.
**** p<0.01, ** p<0.05, * p<0.1.*