Inequality, poverty, deprivation and the uneven spread of COVID-19 in Europe

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by

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Abstract: COVID-19 is mostly considered to have ravaged places with high levels of inequality and poverty. Yet, in the case of Europe, the evidence for this is limited. In this paper we address this gap in our knowledge by exploring how regional variations in poverty, wealth, and inter-personal inequality have shaped COVID-19-related excess mortality. The results show that during the first 18 months of the pandemic there is no link between inequality and poverty, on the one hand, and the lethality of the disease, on the other. The geographical concentration of wealthy people is related to more, not less, excess mortality.

Keywords: COVID-19, pandemic, inequality, poverty, institutions, regions, Europe

JEL codes: D31; O43; R58

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1. Introduction

Since the outbreak of COVID-19 there has been no shortage of research, from different disciplinary perspectives, examining the factors behind the unequal diffusion of the pandemic across countries and regions. The factors attracting the greatest degree of scrutiny include: agglomeration and density (Bailey et al, 2020); variations in the preparation and readiness of health systems to cope with the pandemic (Waitzberg et al, 2021); differences in accessibility (Cartenì et al., 2021); environmental conditions and pollution (Nižetić, 2020; Travaglio et al., 2021); the structure of local economies (Ascani et al., 2021); or the quality of national and local institutions (McCann et al., 2021; Rodríguez-Pose and Burlina, 2021). Inequality and poverty have also been identified as key drivers of the uneven geography of COVID-19 (e.g., Blundell et al, 2020; Florida et al., 2021).

Wealthier citizens have been often considered to be more shielded from the incidence of the pandemic. They have a greater capacity to work remotely and thus avoid long public transport commutes. They also generally have more space at home, can isolate easier from other members of their household, if hit by the virus, and, during the heights of lockdowns, could escape to their secondary residences in the countryside, mountains, or on the coast. Most less well-off citizens could not afford such luxuries. They often have essential jobs that require face-to-face interaction and cannot be performed remotely. They rely on public transport commutes to reach the office and are often crammed into small apartments in cities. This means that they have been far more exposed to contagion than their wealthier peers. Particularly in cities, at the height of lockdowns there was a return to situations we thought were confined to medieval and early modern history books: the rich, as medieval kings and princes, abandoned the city, while the poor remained stuck to brave the pandemic. Hence, as the risk of contagion for those at the bottom of the pyramid is far greater, higher levels of poverty, more deprivation, and greater inequality have been regarded as facilitators of the spread and incidence of COVID-19 (Patel et al., 2020; Rose et al., 2020).

There is no shortage of evidence that this might be the case. Copious research has established a link between poverty and inequality and the impact of the pandemic (Palomino et al., 2020; Tavares and Betti, 2021). However, the majority of the research reaching these conclusions has centred around individual cities or countries (e.g., Wildman, 2021). Subnational comparative analysis involving a large number of territorial units is scarce. At the time of writing, it mostly remains limited to the US. Tan et al. (2020), for example, have reported that the degree of income inequalities within US counties determined territorial differences in the incidence of COVID-19. In the case of Europe, there is, to date, no similar comparative analysis covering most regions.

However, not all evidence supports the idea that the poor have suffered more from the pandemic. Country-level research has brought to light that many developed countries have been hard hit by the pandemic. The evidence from less developed is far more mixed. Some have suffered greatly from successive waves of COVID-19, but others, especially in Africa and Asia, have weathered the storm relatively unscathed, notwithstanding their weaker health systems and institutions (Adams-Prassi et al., 2020; Ali et al., 2020; Deaton, 2021;).

In this paper we assess the extent to which poverty, material deprivation, wealth, and interpersonal inequality at a regional level in Europe are related to geographical variations in the impact of COVID-19, proxied by excess mortality, during the first three waves of the pandemic (January 2020-end of June 2021). The analysis is conducted for a total of 228 regions, building an original database using different data sources: Eurostat, EU-SILC, the Luxembourg Income Study (LIS), and the Quality of Government Index. We use different indices to reflect the broad field of interpersonal inequality: the Gini coefficient at the local level, as well as poverty and material deprivation levels and shares of the population in different income groups. We compute the excess death rates relative to the previous five years on a weekly basis from January 2020 until June 2021, as a percentage change. We also control for other possible factors identified by the scholarly literature that may influence the impact of COVID-19.

Our results highlight that, in the case of Europe, in regions with a greater share of poor people or higher levels of material deprivation, the connection between poverty and excess mortality is, in contrast with expectations, mostly negative. There is thus no evidence, across the whole of Europe, that poverty and deprivation at the regional level has influenced geographical differences in the impact of the pandemic. When we consider the share of the regional population in the top quintile or the top 5% of the European income distribution, we find that places with a higher share of wealthy people have had a 'bad' pandemic. We also find no link between variations in the levels of regional interpersonal inequality and excess mortality.

This paper is structured as follows. Section two delves into research connecting inter-personal inequalities and the spread of the pandemic. Section 3 describes the main data and methodology, followed by a section presenting the main results. Finally, section 5 concludes and dwells on some potential policy implications and the lessons learned for future crises.

2. Inequalities and the pandemic

The geographical spread of COVID-19 is considered to be the consequence of a variety of different factors. These factors range for the purely economic, to social, political, and environmental (McKibben, and Fernando, 2020; Zambrano-Monserrate et al., 2020; Bailey et al., 2021; McCann et al., 2021). Among these, substantial attention has been paid to the extent to which income inequalities have affected COVID-19-related differences in mortality (Brodeur et al., 2021). The focus on the link between inequality and the incidence of pandemics is not new. Research analysing previous pandemics has also put the limelight on inequality. The results from this type of research mostly point in the direction that inequalities shape geographical variations in the intensity of COVID-19 and that individuals at the bottom of the income pyramid have been more exposed to contagion throughout the pandemic (Glover et al., 2020; O'Donoghue et al., 2020; Costa Dias et al., 2021; Deaton, 2021; Paul et al, 2021; Wildman, 2021). Oronce et al. (2021) connect interpersonal inequalities —proxied by the Gini index— with COVID-19 cases and deaths during the first four months of the pandemic in the US. They find that states with a higher Gini index were precisely those with a higher number of COVID-19-related deaths. The presence of disadvantaged population groups has also been associated with a higher incidence of disease. Areas of the US with an ageing population, large, disadvantaged minorities (mainly African American and/or Hispanic), or a higher share of people below the poverty line have been more affected by the virus (Oronce et al., 2021: 2791).

The reasons for this connection are multiple. Individuals at or below the poverty line or suffering material deprivation usually face worse conditions in their daily lives. First, they are more likely to live in small and overcrowded flats, situated in high-density areas (Wheeler and La Jeunesse, 2008; Aldridge et al, 2021; Clair, 2021; Kemis et al. 2021). They also have less information (or less access to information) about the illness and its consequences and, on average, tend to perform low-skilled jobs which require, in most of the cases, face-to-face interactions (Avdiu and Nayyar, 2020; Montenovo et al., 2020; Alam and Parvin, 2021; Goldman et al., 2021). Finally, due to their precarious economic conditions, they had limited opportunities to flee the big cities when the pandemic first struck (Davydiuk and Gupta, 2020; Fraiberger et al., 2020). Hence, many individuals at or below the poverty line have been stuck in densely populated cities —which were the initial foci of COVID-19— throughout the pandemic. They have weathered lockdowns and confinements mostly in crammed accommodation, while, in many cases, continuing to perform their essential duties face-to-face. Especially in the US, many people have also had more limited access to healthcare.

By contrast, the better-off have been more sheltered from the virus (Schellekens and Sourrouille, 2020; Sibley et al., 2020; Esposito et al. 2021). Wealthier citizens have bigger houses and live in less crammed conditions and with far greater access to gardens and outdoor open space. They make the bulk of the ranks of white-collar jobs that have been far more easily conducted remotely than blue-collar and low-skilled service jobs (Belzunegui-Eraso and Erro-Garcés, 2020; Lambert et al., 2020). They are also less likely to use public transport and rely to a greater extent on the car. And, at the outbreak of the pandemic, many of them were capable of leaving the cities for their secondary residences in the countryside, mountains, or by the sea. Fleeing the city provided them with greater shelter from contagion (Coven and Gupta, 2020).

Overall, this evidence has been translated into a widespread perception that, in places with a higher concentration of poor and materially-deprived people, the impact of the pandemic would have been greater; that the poor have had a worse pandemic (Palomino et al., 2022). By contrast, areas with a high share of people in the top income ranks would have had —everything else being equal— an easier ride. Therefore, inequality should be an important driver for the diffusion of, and for variations in, the incidence of COVID-19.

However, despite the abundance of scientific research focusing on inequality, wealth, poverty, and material deprivation and how these factors may have affected the diffusion and incidence of the pandemic, considerable gaps remain in our knowledge. Many of the studies focusing on poverty and inequality are centred around specific cases —often at the local or city level— or, by contrast, are conducted at national level (Elgar et al., 2020; Deaton, 2021; Hacıoğlu-Hoke et al., 2021; Holst et al, 2021; Darvas, 2021). But there remains a dearth of research centred on how inequality, poverty, material deprivation, and wealth affect the diffusion of the pandemic at a wider regional level. Comparative and multiscale cross-regional analysis remain limited. And there is considerable scope for improvement when comparing how inequalities and poverty have shaped geographical variations in the pandemic with the potential sway of other factors, such as density, accessibility, regional wealth, government efficiency, pollution, or the readiness of health systems to cope with such an emergency (Rodríguez-Pose and Burlina, 2021).

The reason behind the lack of in-depth, comparative cross-regional analyses is often related to the absence of data on interpersonal inequality. This is particularly a problem at the European level. Until now, in Europe variations in interpersonal inequality across regions have not been adequately mapped. We fill this gap in existing knowledge by establishing a link between different measures of poverty and wealth and income inequalities, on the one hand, and the geographical variation in the incidence of COVID-19, on the other, across as many regions of Europe as the data allow. This implies answering two different research questions. First, *what is the role of poverty, material deprivation, wealth, and inequality within regions of Europe in the incidence of the COVID-19 pandemic*? Second, *how do poverty, material deprivation, wealth, and inequality compare with other factors that have been highlighted by past research as drivers of variations in the incidence of COVID-19*?

Based on the existing scholarly literature on inequalities and the spread of the pandemic, from each research question we derive hypotheses to be tested in the empirical analysis. The first hypothesis is directly related to the first research question and can be divided into three sub-hypotheses, considering poverty, material deprivation, wealth, and overall inequality levels across European regions. This hypothesis is formulated as follows:

H_{1a}: *A greater share of people at or below the poverty line or suffering from material deprivation in a region will lead to increases in the incidence of COVID-19*;

H_{1b}: *A greater share of wealthy individuals in a region will lower the incidence of COVID-19*;

H_{1c}: *Interpersonal inequality will thus be a driver of variations in the incidence of COVID-19 across regions of Europe*;

In response to the second research question, we can formulate the following hypothesis:

H_2: *Interpersonal inequality is, at least, as important a factor explaining variations in the incidence of COVID-19 as other factors that have been previously highlighted by the literature, such as regional wealth, government efficiency, pollution, levels of education, age of the population, or the readiness of health systems.*

3. Data description and Methodology

In order to address the questions driving this research and to assess the link between the different measures related to income inequalities and variations in the impact of the COVID-19 pandemic, we put together a unique dataset covering both the incidence of the pandemic —proxied by excess mortality relative to the previous five years— alongside different measures of poverty, wealth, and interpersonal inequality. The dataset is complemented by a number of controls for European regions.

3.1 The dependent variable

Our dependent variable is the incidence of the pandemic. Following a rising number of studies (e.g., Beaney et al., 2020; Davies et al., 2021; Rodríguez-Pose and Burlina, 2021), we use all-purpose excess mortality rates in the previous five years prior to the outbreak of the pandemic. This variable is preferred to alternatives, such as the number of cases or the number of cases treated in hospital, because it has been measured in a far more consistent and accurate way — the number of COVID-19 cases, for example, has been greatly affected by factors such as the capacity to measure at different times of the pandemic and is prone to political manipulation (Rodríguez-Pose and Burlina, 2021). We cover four periods of the spread of COVID-19: (i) the period between January 2020 and the end of June 2021; (ii) the first six months of 2020; (iii) the second six months of 2020; and finally, (iv) the first six months of the year 2021.

The dependent variable —displayed here for the year 2020, as an example— is computed according to the following formula:

$$Exc\_deaths_{2020} = \frac{deaths_{2020} - deaths_{2019-2015}}{deaths_{2019-2015}} * 100 \qquad [1]$$

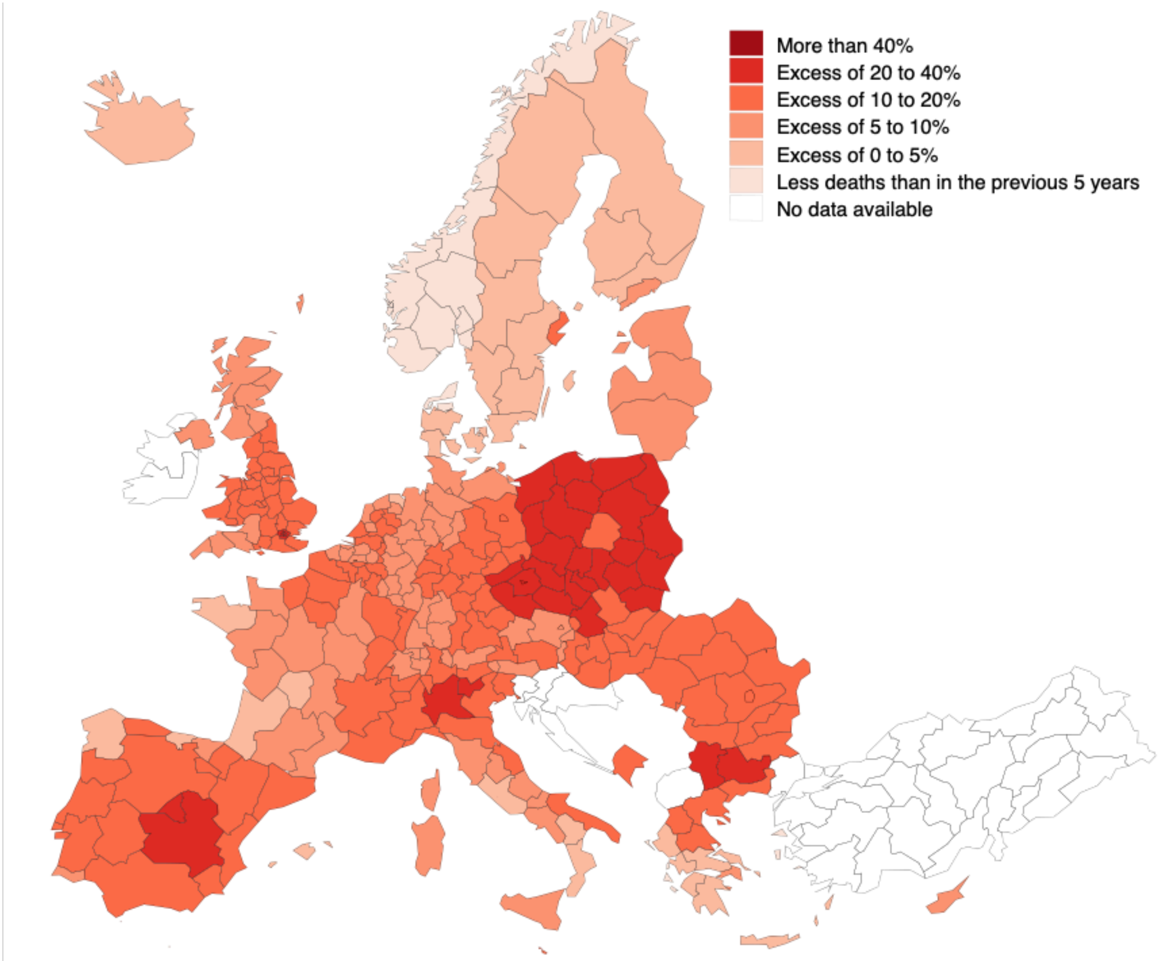
Excess mortality is calculated as the percentage difference between the number of deaths per week in a given period and the average deaths in the same period during the years 2015-2019, divided by the average number of deaths between 2015 and 2019. Table 1 reports the four different periods considered in the analysis, highlighting both the starting and ending week.

Table 1. Excess deaths periods.

Period	Start Week	End Week
Year 2020-2021	Week 1, 2020	Week 27, 2021
I semester 2020	Week 1, 2020	Week 27, 2020
II semester 2020	Week 28, 2020	Week 54, 2020
I semester 2021	Week 1, 2021	Week 27, 2021

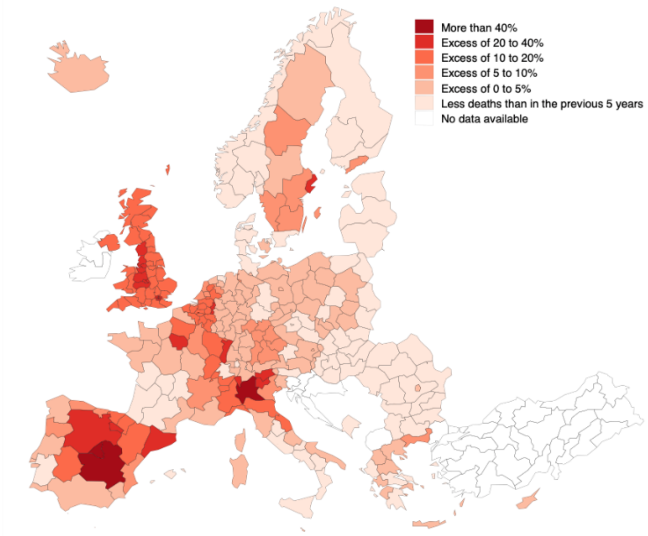
The geographical incidence of the pandemic has varied significantly both across time and space (Figure 1). Overall, during the first 18 months of the pandemic there were areas of Europe which had a 'good' pandemic. In Norway, for example, mortality between January 2020 and the end of June 2021 was lower than the average of the previous five years. Some other European regions in southern and western Greece, southern Italy (Basilicata and Calabria), Lazio, Aquitaine, Brittany, and Limousin in France, or Galicia and Cantabria in Spain, witnessed only marginal increases in mortality. By contrast, COVID-19 ravaged through most of Poland, the Czech Republic, parts of Slovakia, and Bulgaria. Some western European regions, including some of the continent's wealthiest, such as Lombardy and Trentino in Italy, Madrid and Castile-La Mancha in Spain, or London in the UK, were also prominent foci of the pandemic.

Figure 1. Excess death rates (as a percentage deviation from expected deaths, based on the previous 5 years) by region for the period January 2020 – June 2021. Source: Own elaboration

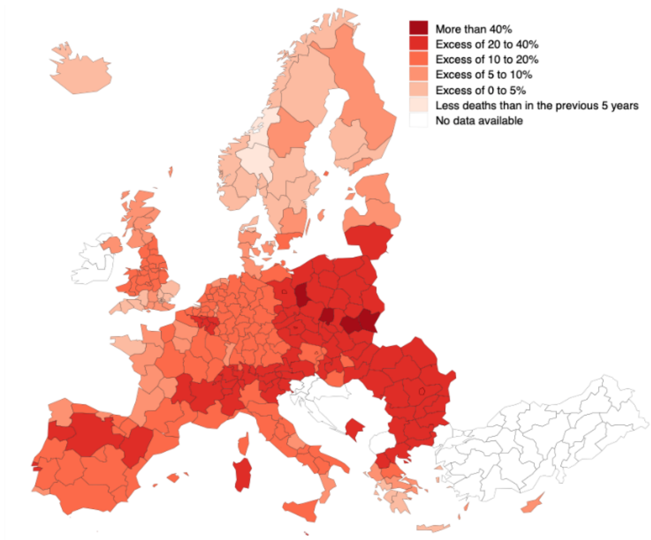


However, the picture of the first 18 months of COVID-19 in Europe hides considerable time variations. Different waves and variants of the virus have affected regions of Europe differently. These differences are represented in Figures 2a, 2b, and 2c. The first wave —covering the first six months of 2020, but really hitting Europe between late February and May 2020 (Figure 2a)— caught most of Europe by surprise (Ahmed et al., 2020; Liang et al., 2020; Kandel et al., 2020). The highest incidence took place in Western Europe and, very often, in highly connected and large cities, which acted as the entry points of COVID-19. Some of the largest European agglomerations —Madrid, Milan, London, Paris, Brussels, or Stockholm— suffered massively during the first wave. In contrast, the incidence was limited in many rural areas and across most of Central and Eastern Europe, with the exception of parts western of Poland and western Czechia.

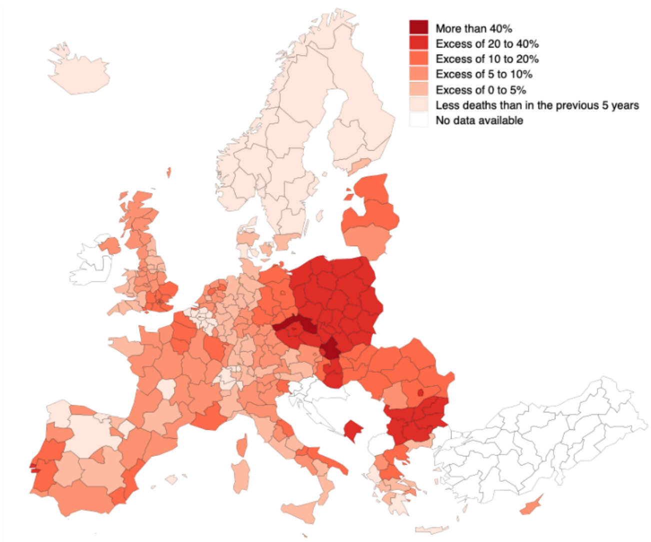
Figure 2. Excess death rates (as a percentage deviation from expected deaths, based on the previous 5 years) by region for the first six months of 2020 (a), the second six months of 2020 (b), and the first six months of 2021 (c). Source: Own elaboration



(a)



(b)



(c)

The second wave, reported in figure 2b, took place during the autumn of 2020. It hit Central and Eastern Europe hardest, while the Nordic countries, western France, southern Greece, and parts of the UK were relatively spared. All the way from Bulgaria to Lithuania excess mortality surpassed 20% with respect to the same period in the previous five years. Regions along the Alpine Arc from Slovenia to central France and across Austria, Switzerland, and northern Italy, also saw the incidence of the pandemic soar, as was the case of Wallonia in Belgium, Sardinia in Italy, and regions in northern Spain and northern Portugal.

The final wave covered in the analysis is concerned with the first six months of 2021 and coincided with the launch of mass vaccination across the continent. This third wave fundamentally affected Central and Eastern European countries. Czechia, Slovakia, Bulgaria, and Poland were hit by the spread of COVID-19 with full force. Many regions in France, the Netherlands, Portugal, and the UK also had a 'bad' third wave. But, in general, the incidence of the pandemic was far lower across Western Europe and, in particular, in the Nordic countries, Belgium, western Switzerland, and parts of north-western Spain. In most of these places there was no excess mortality in the first half of 2021.

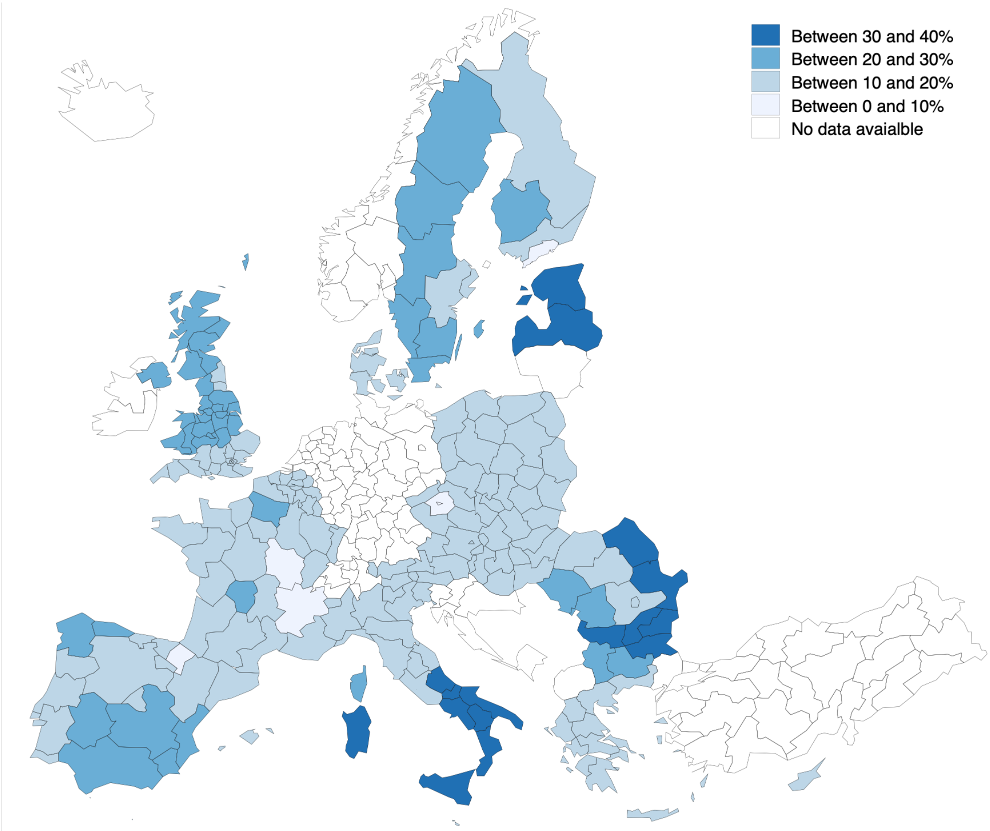
3.2 The inequality variables

Our main variables of interest relate to different measures of poverty and inequality. We test the connection between poverty, wealth, and income inequalities and geographical variations in the impact of the pandemic using several variables: the overall share of relative poverty and the percentage of people at severe risk of material deprivation in a region; the share of people in the top 20% of the income distribution; the share in the top 5%; and the Gini index, as our proxy for interpersonal inequality within regions.

The relative poverty measure stems from Eurostat's Statistic on Income and Living Conditions (SILC) survey. This survey collects information on age, year of birth, country of birth, living conditions, and poverty for European citizens at the NUTS2 regional level. The relative poverty index is selected for the year 2018, except for the UK where, for lack of data, the reference year is 2017.[1]

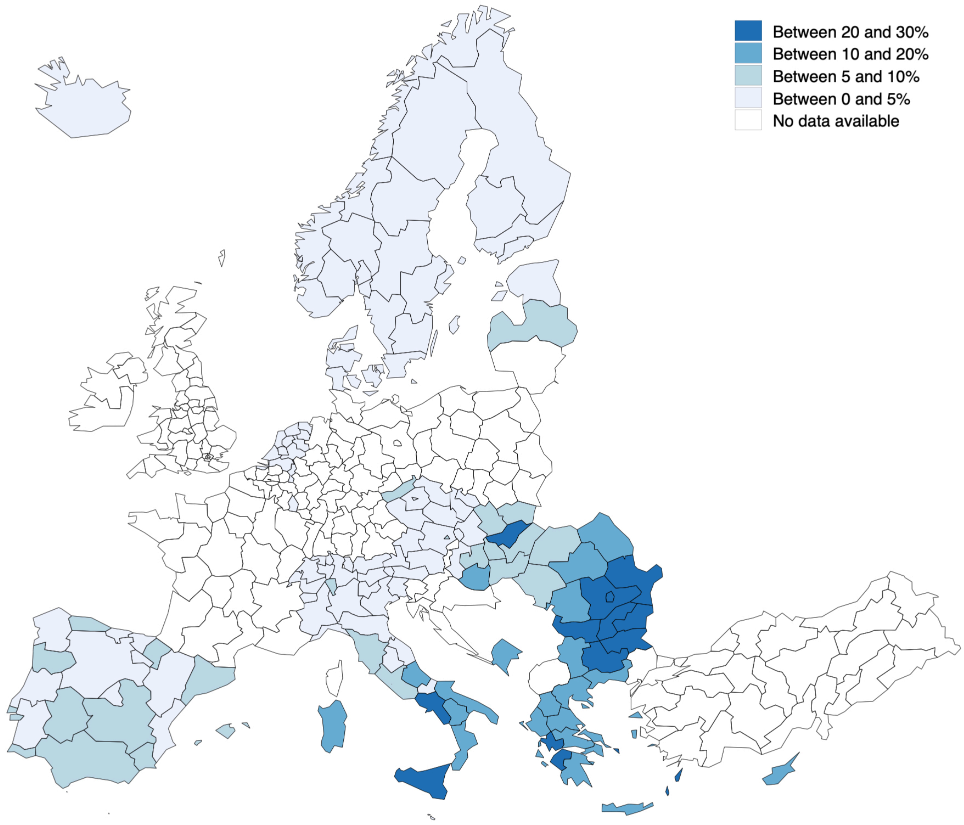
As shown in Figure 3, poverty is highly concentrated in certain regions of Europe. Levels of poverty in the Italian Mezzogiorno, northern and eastern Bulgaria, north-eastern and eastern Romania, and Estonia and Latvia exceeded 30% of the population in 2018. By contrast, in specific regions like Helsinki in Finland, Central Bohemia in Czechia, Navarra in Spain, or Burgundy and Rhône-Alps in France, less than 10% of the population were below the poverty line.

Figure 3. Relative poverty index by region. Source: Own elaboration



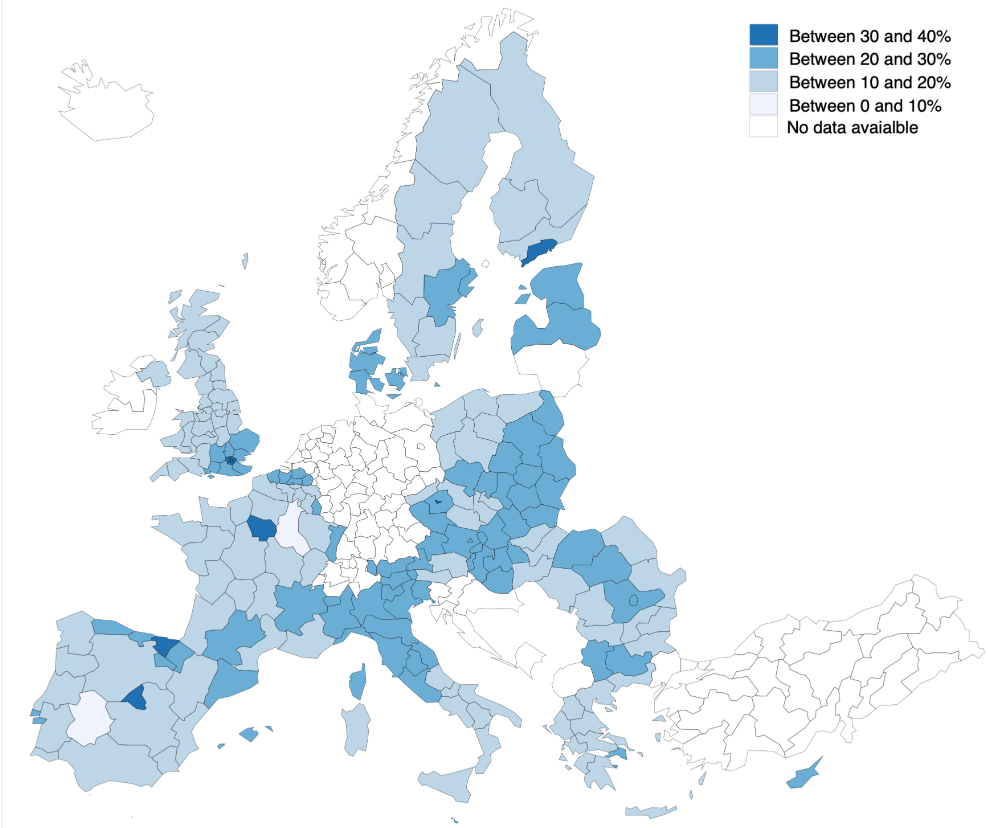
The index for material deprivation uses EUROSTAT data (Figure 4). It compiles indicators measuring economic strain, durables, housing deprivation, and dwelling conditions. The index is frequently used as another proxy for the level of absolute poverty, and takes into account incomes in kind, free or subsidised goods, and self-supply (Łuczak and Kalinowski, 2020; Serafino and Tonking, 2017).[2] Material deprivation is higher in the southern and southeastern fringes of Europe and, fundamentally, in eastern Bulgaria and Romania, Campania and Sicily in Italy, and Western Greece. Material deprivation is far lower in the Nordics or the Netherlands.

Figure 4. Severe material deprivation index by region. Source: Own elaboration



On the other side of the coin, wealth is equally geographical concentrated.[3] But rather than in lagging-behind regions, mostly in large cities. In London, Paris, Madrid, Prague, or Helsinki more than 30% of the regional population was in the top quintile in terms of income (Figure 5). The Basque Country belongs in this group as well. More than 20% of the population is in the top quintile of income in Denmark, the North of Italy, the Southeast of England and East Anglia, some northern Spanish regions, Lisbon, and certain regions in France. But a non-negligible number of regions in Central and Eastern Europe, from the Baltics to Bulgaria, also belong in this category. By contrast, in Extremadura in Spain and Champagne-Ardenne in France, less than 10% of the population had incomes in the top quintile (Figure 5).

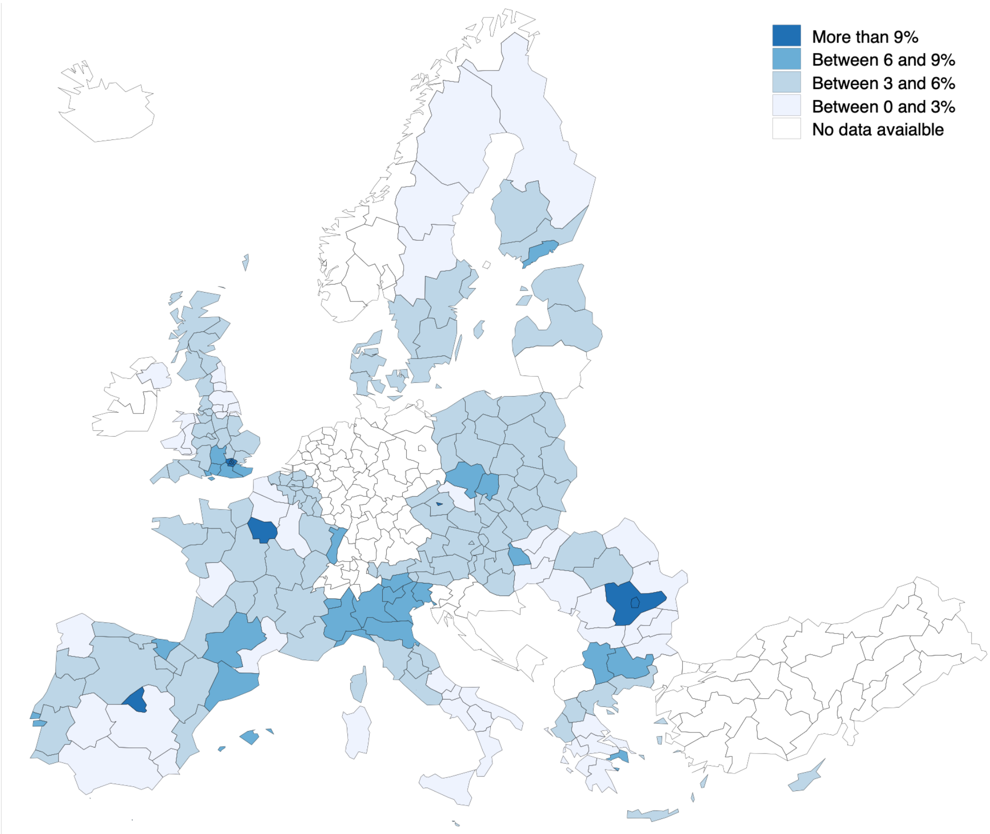
Figure 5. Share of population in the top 20% of the income distribution by region. Source: Own elaboration



Mapping the population in the top 5% of the income band reveals a pattern that is not that dissimilar from that of the population in the top income quintile (Figure 6). The richest individuals concentrate in the three largest agglomerations (by population) covered in the analysis: London, Paris, and Madrid, precisely cities strongly affected by the outbreak of the pandemic. Concentrations of population in the top 5% of income band can also be found in some rich regions, such as parts of the Southeast of England, the North of Italy, Helsinki, the Balearic Islands, the Basque Country and Catalonia in Spain, Alsace and Midi-Pyrénées in France, and in capital cities, such as Athens, Budapest, Helsinki, Lisbon, Prague, or Sofia. There is an even higher percentage of population in the top income band in Bucharest and the surrounding region (Figure 6).

By contrast, the North of Finland and Sweden, the north-east of England and Yorkshire, the South of Italy, southern Spain and southern Greece, as well as Eastern Hungary, and most of Bulgaria and Romania had the lowest shares of people at the top of the income pyramid (Figure 6).

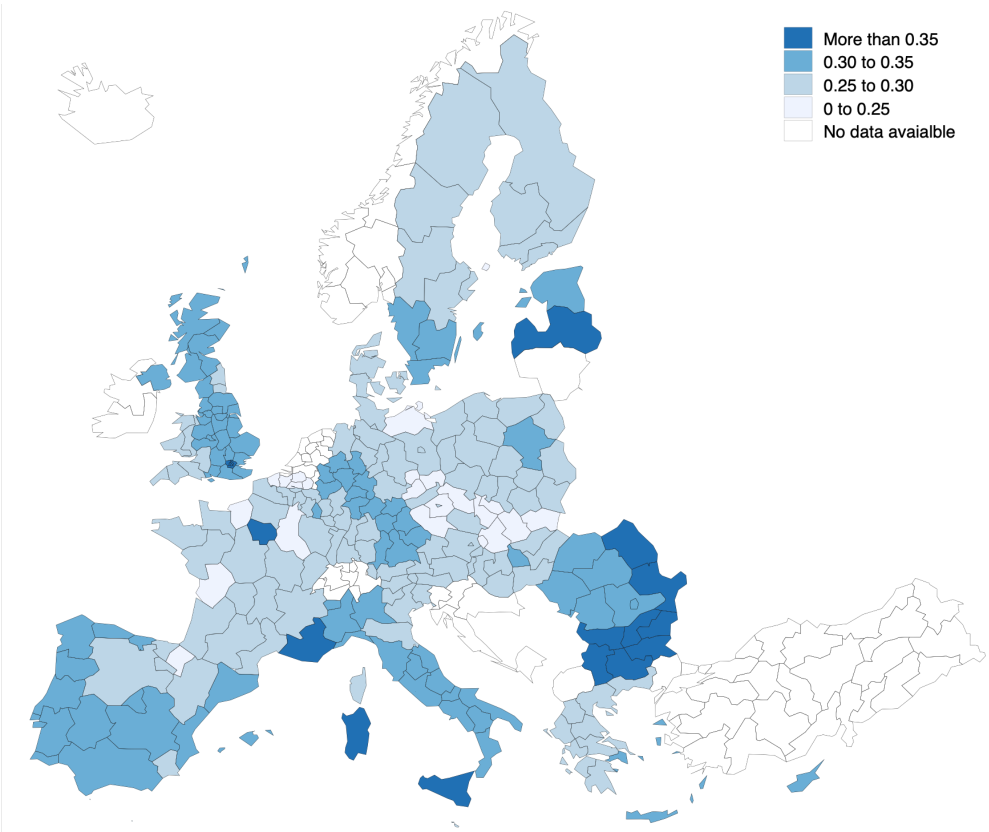
Figure 6. Share of population in the top 5% of the income distribution by region. Source: Own elaboration



The last inequality variable is represented by the Gini of disposable income. For this index we rely on two data sources. The first is the SILC survey, which measures this index as the extent to which the distribution of equivalised disposable income after social transfers deviates from a perfectly equal distribution. The second source is the Luxembourg Income Study (LIS) (Ravallion, 2015), used for German regions in 2016 (the last available year for this country). In both cases, the Gini index is a summary measure of the cumulative share of equivalised income accounted for by the cumulative percentages of the number of individuals. Its value ranges from 0 (complete equality) to 1 (complete inequality). The geographical representation of this variable is reported in Figure 7.

Interpersonal inequalities in Europe are highest in some of the poorest regions of Eastern Europe, including all of Bulgaria, the North East of Romania, and Latvia. Some poorer regions in western Europe —such as Sardinia or Sicily, and, to a lesser extent, most of the South of Italy, the majority of the North and East of the UK, most parts of Spain, and the whole of Portugal— also had high internal levels of income polarisation. However, interpersonal inequality was also high in the biggest and most dynamic cities, such as London and Paris and, to a lesser degree, Madrid, Budapest, Warsaw, and the relatively prosperous German regions of Bavaria and Hesse (Figure 7). The lowest levels of income inequality were confined to Slovakia, most of the Czechia, Saxony in Germany, and regions like Navarre in Spain, Champagne-Ardenne, Lower Normandy and Poitou-Charentes in France.

Figure 7. Gini disposable income by region. Source: Own elaboration



3.3 Control variables

Other factors, such as regional wealth, pollution, or accessibility also influence —according to previous scholarly literature— the geographical variations in the incidence of COVID-19. We use different indicators to control for these factors. First, we resort to GDP per capita in 2018 as our proxy for regional wealth. Density is measured by the population per square kilometre in 2018. The role of institutions is proxied by the national government effectiveness in 2018, which captures the quality of public and civil services and the degree of its independence from political pressure (Kaufmann & Kraay, 2020). Our proxy for environmental conditions is exposure to air pollution by particulate matter (PM 2.5) at regional level in 2019. The readiness of different health systems to fight the pandemic are measured by the number of per capita hospital beds in the same year. We also control for the education of the population and its median age. Finally, we introduce connectivity, a factor deemed to have severely affected the spread of the pandemic (Bourdin et al., 2021; Rodríguez-Pose and Burlina, 2021). We measure connectivity both by air and road, using the number of air passengers arriving in a region in 2018, for the former, and the inverse time-distance weighted population for 2014, for the latter.

The description, source, and summary statistics of the different variables included in the analysis are reported in Table A1 in the Appendix.

3.4 Methodology

The empirical analysis is based on a set of OLS regressions covering the period under observation. The general model adopts the following form:

$$Y_i = \beta_0 + \beta_1 Income\ Inequalities_i + \beta_2 X_i + \varepsilon_i \qquad [2]$$

where Y_i represents the excess of mortality rates computed in the four periods presented in Table 1. $Income\ Inequalities_i$ stands for the relative poverty index, the 20% and 5% shares of people in the regional income distribution, and the Gini coefficient. Each of these variables are included in the model successively. Finally, the vector X_i contains the other control variables —GDP per capita, change in national government effectiveness, population density, accessibility (both by air and road), and hospital beds per capita. ε_i is the error term. To correct for error correlation within regions, we cluster the standard errors at the regional level.

4. Results

Table 2 introduces the results when relative poverty is considered as the main variable for income inequalities. Each column reports the four different periods under scrutiny, first introducing relative poverty and GDP per capita, second adding to these two variables the other factors that reportedly affect the spread of the pandemic.

According to H_1, a concentration of people below the poverty line should have resulted in a greater incidence of COVID 19-related excess mortality. However, there is no evidence in our results of this being the case (Table 2). European regions with a greater share of people at the bottom of the income pyramid have, as a general rule, less —and not more, as expected— excess mortality during the first 18 months of the pandemic and especially in the second and third waves. The coefficient for relative poverty in a region is negative and significant in Regressions 1, 5, and 7 of Table 2, when controlling for regional wealth. Once other factors that may have affected variations in the incidence of COVID-19 are inserted in the analysis, the coefficient for relative poverty remains negative, but becomes insignificant (Table 2, Regressions 2, 4, 6, and 8). Hence, there is no evidence across European regions that poverty has been a driver of the pandemic. Other factors such as regional wealth, pollution, or accessibility by road show a significant and stronger connection with excess mortality (Rodríguez-Pose and Burlina, 2021).

Table 2. Excess mortality and relative poverty

Dependent variable:	(1) Excess mortality 2020-2021	(2) Excess mortality 2020-2021	(3) Excess mortality first six months 2020	(4) Excess mortality first six months 2020	(5) Excess mortality second six months 2020	(6) Excess mortality second six months 2020	(7) Excess mortality first six months 2021	(8) Excess mortality first six months 2021
Relative poverty 2018	-31.530***	-15.828**	-6.028	-25.670**	-42.340***	-3.286	-51.774***	-18.100
	(7.179)	(7.051)	(9.964)	(11.256)	(9.705)	(10.854)	(11.474)	(12.701)
GDP per capita 2018 (ln)	-5.464***	-2.406	7.938***	5.048	-12.185***	-3.365	-12.389***	-7.945***
	(0.858)	(1.634)	(1.179)	(3.352)	(1.298)	(2.328)	(1.243)	(2.136)
National government effectiveness 2018		-1.727*		-3.170**		-2.846		0.652
		(1.021)		(1.426)		(1.754)		(1.635)
Change in national government effectiveness 1998–2018		3.251**		-2.480		2.525		10.321***
		(1.419)		(2.602)		(2.195)		(2.269)
Air pollution 2019 (ln)		6.058***		-1.128		11.164***		8.905***
		(2.166)		(4.729)		(2.707)		(2.379)
Population density 2018 (ln)		-0.668		-0.866		-1.635*		0.518
		(0.624)		(1.247)		(0.874)		(0.784)
Accessibility by road 2014 (ln)		3.238***		3.820***		3.017**		2.704***
		(0.772)		(1.350)		(1.183)		(0.934)
Air passengers 2018 (ln)		-0.206*		-0.002		-0.320*		-0.315*
		(0.120)		(0.219)		(0.168)		(0.184)
Hospital beds per capita 2019 (ln)		-0.323		2.204		-3.017*		-0.351
		(0.966)		(1.581)		(1.577)		(1.547)
Education – ISCED 3-8 2018		-0.081*		-0.245***		-0.010		0.052
		(0.044)		(0.090)		(0.061)		(0.057)
Median Age 2018 (Ln)		-31.669***		-35.467***		-30.936***		-27.579**
		(6.758)		(12.616)		(11.407)		(10.963)
Observations	181	166	181	166	181	166	181	166
R-squared	0.206	0.582	0.190	0.366	0.367	0.620	0.345	0.694
Adjusted R-squared	0.197	0.552	0.181	0.320	0.359	0.593	0.338	0.672
F test	21.93	24.65	23.21	5.855	44.06	37.31	49.66	33.74

Note: Robust standard errors at regional level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

On the whole, poorer, more polluted, more accessible regions, and those with a weaker health system have suffered more from the impact of COVID-19 (Table 2). By contrast, regions with a more educated population and with a higher average age, once other factors are controlled for, experienced lower excess mortality. The main exception is the first wave of the pandemic in the first half of 2020, which caught everyone by surprise and trying to understand what befell upon us (Bourdin et al, 2021). During this wave, wealthier regions with a better health system —often also the entry ports of the pandemic in Europe— experienced higher excess mortality. But, as the pandemic increasingly became endemic, excess mortality receded in regions with stronger health systems and surged elsewhere.

The results hold also when we look at the percentage of people experiencing severe material deprivation in Table 3. The coefficients point to a negative link between the prevalence of material deprivation at a regional level and the incidence of COVID-19-related mortality. The coefficient for material deprivation becomes stronger when the other control variables are included in the model, supporting the results of Table 2.

When rather than focusing on those at the bottom of the pyramid, we put the spotlight on those at the top, the results go in the same direction. Having a greater share of individuals in the top income quintile has been connected to higher, not lower excess mortality. This applies for the first 18 months of the process, as well as for every subperiod considered (Table 4). At a regional level in Europe, we find no evidence that the presence of wealthy individuals in a place reduces the incidence of the pandemic (Deaton, 2021; Han et al, 2020; Islam et al., 2021).

Most other control factors have similar coefficients to those reported in Table 2. More polluted and more accessible places (by road) have been more vulnerable to the pandemic, as have been poorer regions, with the exception of the first wave (Table 4, Regression 4) (Valero and Valero-

Gil, 2021). These results are confirmed when we consider the share of individuals in the top 5% of the income distribution in Table 5.

To test hypothesis H_{1c} we introduce in Table 6 the overall measure for income inequalities, proxied by the regional Gini index. The results suggest that interpersonal inequality at a regional level is incapable of explaining geographical variations in the incidence of COVID-19 across Europe. Only in the first wave of the pandemic, there seems to be a positive connection between regional inequality and excess mortality (Table 6, Regression 3), but this association disappears completely when the controls are introduced in the regression (Regression 4). On the whole, the connection between interpersonal inequality and excess mortality is insignificant.

The results for Europe thus go against most expectations in the scholarly literature on COVID-19. We find no evidence whatsoever to support H_1, as regional excess mortality during the first 18 months of the pandemic in Europe is not connected with poverty or inequality levels and, if anything, is linked to the presence of wealthy individuals in a region. Hence, interpersonal inequality in European regions seems to have played a far less important role in variations of the impact of the pandemic than studies conducted at country level have portrayed (e.g.: Wildman, 2021).

Table 3. Excess mortality and material deprivation

Dependent variable:	(1) Excess mortality 2020-2021	(2) Excess mortality 2020-2021	(3) Excess mortality first six months 2020	(4) Excess mortality first six months 2020	(5) Excess mortality second six months 2020	(6) Excess mortality second six months 2020	(7) Excess mortality first six months 2021	(8) Excess mortality first six months 2021
Material deprivation 2018	-0.532***	-0.482***	-0.030	-0.210	-0.703***	-0.622***	-0.882***	-0.596***
	(0.089)	(0.068)	(0.075)	(0.128)	(0.143)	(0.114)	(0.149)	(0.121)
GDP per capita 2018 (ln)	-7.125***	-3.691**	6.595***	4.883	-13.090***	-4.972**	-14.873***	-9.908***
	(1.040)	(1.543)	(1.190)	(3.385)	(1.603)	(2.177)	(1.666)	(2.066)
National government effectiveness 2018		-1.726		-4.059**		-1.892		0.491
		(1.167)		(1.676)		(1.779)		(1.945)
Change in national government effectiveness 1998–2018		3.583**		-4.059		4.424**		10.930***
		(1.408)		(2.600)		(2.176)		(2.058)
Air pollution 2019 (ln)		5.834***		-1.420		11.309***		8.280***
		(2.151)		(5.150)		(2.463)		(2.384)
Population density 2018 (ln)		-0.396		-0.547		-1.328*		0.733
		(0.584)		(1.294)		(0.767)		(0.753)
Accessibility by road 2014 (ln)		3.024***		3.346**		2.415*		3.071***
		(0.799)		(1.608)		(1.403)		(0.943)
Air passengers 2018 (ln)		-0.219*		-0.069		-0.318*		-0.309
		(0.123)		(0.249)		(0.172)		(0.188)
Hospital beds per capita 2019 (ln)		-2.162**		1.970		-5.984***		-2.527*
		(0.916)		(1.636)		(1.800)		(1.494)
Education – ISCED 3-8 2018		-0.123**		-0.179*		-0.128**		-0.012
		(0.049)		(0.100)		(0.062)		(0.060)
Median Age 2018 (Ln)		-26.787***		-26.767*		-25.645**		-26.598**
		(6.753)		(13.711)		(10.754)		(11.949)
Observations	164	144	164	144	164	144	164	144
R-squared	0.251	0.686	0.178	0.349	0.355	0.717	0.368	0.767
Adjusted R-squared	0.241	0.660	0.168	0.295	0.347	0.693	0.360	0.748
F test	26.69	38.70	22.07	5.499	33.34	37.47	39.97	43.85

Note: Robust standard errors at regional level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4. Excess mortality and share of people in the top 20% of the income distribution

Dependent variable:	(1) Excess mortality 2020-2021	(2) Excess mortality 2020-2021	(3) Excess mortality first six months 2020	(4) Excess mortality first six months 2020	(5) Excess mortality second six months 2020	(6) Excess mortality second six months 2020	(7) Excess mortality first six months 2021	(8) Excess mortality first six months 2021
Population in the top 20% of the income bracket	53.525***	44.544***	34.496*	68.600***	62.162***	40.148***	68.427***	23.615*
	(9.260)	(9.583)	(18.809)	(18.769)	(11.398)	(12.597)	(13.094)	(14.058)
GDP per capita 2018 (ln)	-5.607***	-3.679**	7.370***	3.110	-12.160***	-4.712**	-12.190***	-8.444***
	(0.712)	(1.639)	(1.031)	(3.548)	(1.176)	(2.276)	(1.138)	(2.307)
National government effectiveness 2018		-0.954		-1.978		-2.163		1.074
		(0.857)		(1.386)		(1.554)		(1.734)
Change in national government effectiveness 1998–2018		1.778		-4.824*		1.829		8.981***
		(1.429)		(2.563)		(2.157)		(2.166)
Air pollution 2019 (ln)		5.473***		-2.032		10.661***		8.573***
		(1.994)		(4.573)		(2.600)		(2.305)
Population density 2018 (ln)		-1.748***		-2.534**		-2.571***		-0.089
		(0.525)		(1.037)		(0.841)		(0.840)
Accessibility by road 2014 (ln)		4.029***		5.063***		3.510***		3.316***
		(0.667)		(1.350)		(1.132)		(0.853)
Air passengers 2018 (ln)		-0.194*		0.017		-0.311*		-0.306*
		(0.103)		(0.207)		(0.158)		(0.183)
Hospital beds per capita 2019 (ln)		-0.948		1.221		-3.421**		-0.823
		(0.906)		(1.476)		(1.610)		(1.479)
Education – ISCED 3-8 2018		-0.099**		-0.270***		-0.052		0.065
		(0.040)		(0.078)		(0.058)		(0.057)
Median Age 2018 (Ln)		-34.856***		-40.324***		-34.236***		-28.890***
		(6.375)		(12.213)		(11.227)		(10.942)
Observations	181	166	181	166	181	166	181	166
R-squared	0.282	0.634	0.216	0.424	0.394	0.642	0.361	0.695
Adjusted R-squared	0.274	0.608	0.207	0.383	0.388	0.617	0.354	0.673
F test	42.57	28.71	26.24	6.698	60.87	39.15	62.85	33.15

Note: Robust standard errors at regional level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5. Excess mortality and share of people in the top 5% of the income distribution

Dependent variable:	(1) Excess mortality 2020-2021	(2) Excess mortality 2020-2021	(3) Excess mortality first six months 2020	(4) Excess mortality first six months 2020	(5) Excess mortality second six months 2020	(6) Excess mortality second six months 2020	(7) Excess mortality first six months 2021	(8) Excess mortality first six months 2021
Population in the top 5% of the income bracket	125.218***	92.698***	87.266*	175.889***	136.377***	71.680*	160.103***	22.139
	(24.374)	(31.749)	(52.502)	(64.746)	(27.165)	(39.246)	(38.613)	(37.535)
GDP per capita 2018 (ln)	-5.649***	-3.433*	7.279***	3.020	-12.119***	-4.322*	-12.243***	-7.931***
	(0.749)	(1.812)	(1.014)	(3.763)	(1.217)	(2.357)	(1.219)	(2.357)
National government effectiveness 2018		-1.131		-2.047		-2.397		0.812
		(0.972)		(1.503)		(1.663)		(1.760)
Change in national government effectiveness 1998–2018		1.645		-5.277*		1.798		9.112***
		(1.527)		(2.768)		(2.201)		(2.193)
Air pollution 2019 (ln)		5.706***		-1.786		10.912***		8.789***
		(2.096)		(4.674)		(2.566)		(2.388)
Population density 2018 (ln)		-1.699***		-2.808***		-2.402***		0.222
		(0.590)		(1.032)		(0.890)		(0.922)
Accessibility by road 2014 (ln)		3.947***		5.077***		3.386***		3.158***
		(0.723)		(1.454)		(1.089)		(0.901)
Air passengers 2018 (ln)		-0.179		0.049		-0.301*		-0.305
		(0.117)		(0.216)		(0.163)		(0.194)
Hospital beds per capita 2019 (ln)		-0.958		1.061		-3.378**		-0.711
		(0.942)		(1.491)		(1.613)		(1.537)
Education – ISCED 3-8 2018		-0.076*		-0.245***		-0.027		0.087
		(0.040)		(0.080)		(0.057)		(0.056)
Median Age 2018 (Ln)		-32.394***		-37.013***		-31.846***		-27.194**
		(6.592)		(12.017)		(11.333)		(11.417)
Observations	181	166	181	166	181	166	181	166
R-squared	0.251	0.604	0.214	0.410	0.369	0.628	0.343	0.689
Adjusted R-squared	0.243	0.576	0.205	0.368	0.362	0.602	0.335	0.667
F test	34.26	25.78	27.19	6.215	53.50	38.05	50.75	33.19

Note: Robust standard errors at regional level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6. Excess mortality and Gini disposable income

Dependent variable:	(1) Excess mortality 2020-2021	(2) Excess mortality 2020-2021	(3) Excess mortality first six months 2020	(4) Excess mortality first six months 2020	(5) Excess mortality second six months 2020	(6) Excess mortality second six months 2020	(7) Excess mortality first six months 2021	(8) Excess mortality first six months 2021
Gini coefficient 2018	-1.001	-5.540	40.187**	9.333	-16.532	8.460	-33.943	-37.124**
	(12.352)	(10.427)	(16.581)	(17.533)	(15.558)	(15.774)	(22.640)	(17.635)
GDP per capita 2018 (ln)	-4.592***	-2.098	7.612***	5.631*	-10.548***	-3.082	-10.987***	-7.586***
	(0.827)	(1.560)	(1.141)	(3.073)	(1.166)	(2.304)	(1.273)	(1.927)
National government effectiveness 2018		-1.571		-3.070**		-2.420		0.192
		(1.040)		(1.442)		(1.676)		(1.599)
Change in national government effectiveness 1998–2018		2.312		-4.489		1.806		10.663***
		(1.634)		(2.852)		(2.330)		(2.366)
Air pollution 2019 (ln)		6.431***		-0.904		11.160***		9.900***
		(2.181)		(4.673)		(2.564)		(2.354)
Population density 2018 (ln)		-0.790		-1.268		-1.643**		0.470
		(0.537)		(0.942)		(0.820)		(0.738)
Accessibility by road 2014 (ln)		3.189***		4.180***		2.446*		2.678***
		(0.743)		(1.305)		(1.254)		(0.810)
Air passengers 2018 (ln)		-0.190		-0.030		-0.316*		-0.248
		(0.116)		(0.188)		(0.167)		(0.174)
Hospital beds per capita 2019 (ln)		-0.463		1.878		-2.970**		-0.273
		(0.901)		(1.535)		(1.419)		(1.505)
Education – ISCED 3-8 2018		-0.037		-0.169*		0.033		0.055
		(0.045)		(0.090)		(0.058)		(0.053)
Median Age 2018 (Ln)		-27.540***		-33.819***		-27.309***		-23.327**
		(6.222)		(10.558)		(10.429)		(9.700)
Observations	198	183	198	183	198	183	198	183
R-squared	0.145	0.554	0.178	0.347	0.305	0.584	0.291	0.693
Adjusted R-squared	0.136	0.525	0.170	0.305	0.298	0.557	0.284	0.673
F test	19.88	24.79	23.48	7.514	41.89	27.76	41.96	39.57

Note: Robust standard errors at regional level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

The results also lead us to reject H_2. Excess mortality across regions of Europe during the first 18 months of COVID-19 are far more related to issues of accessibility, pollution, the overall wealth of the region and the education of the population and, in the later waves of the pandemic, the preparedness of the health system than to poverty and inequality.

Another aspect to be considered is the importance of the timing of factors behind the variation of incidence. Our analysis reveals that variations in the incidence of each four waves of the pandemic are related to different factors. The first wave of the pandemic, from January to June 2020, caught Europe unaware and unprepared. During this period excess mortality was fundamentally concentrated in more accessible entry points by road and in places with a lower overall government efficiency. It also affected richer European regions to a far greater extent than poorer ones. However, because of this element of surprise, the preparedness of the health system did not represent an asset. Places with more hospital beds suffered more. In the successive two waves many of the factors potentially driving the incidence of the pandemic changed. Road accessibility remained a key driver of contagion and air pollution began to play a far more prominent role (Conticini et al., 2020). After the first wave, which, in certain ways, was more 'democratic' in its incidence, the pandemic has feasted more on poorer, rather than on richer regions, as well as on those with weaker and less prepared health systems. Population density, a factor that was considered in the early stages of the pandemic as essential for explaining variations in its incidence (Mogi and Spijker, 2021), may have played a very small role (if at all) for the diffusion of the pandemic across regions of Europe.

As the spread of COVID-19 followed geographical patterns, we also test for the presence of possible spatial correlation among our inequality variables, to be sure that the level of inequalities in a region does not influence the excess mortality rates of the neighbouring regions. For this reason, we implement several spatial autoregressive models for the five inequalities indicators and the level of regional wealth proxied by the GDP per capita. The results are reported in Tables A2 to A6 in the Appendix. Looking at the bottom part of each table, where the coefficients are linked to the contiguity matrix *W*, we detect in some specifications the presence of spatial correlation, particularly affecting the regional growth variable. We then compute the direct, indirect, and total effects to better understand which are the direct (internal) and indirect (external) spatial spillovers emerging among the inequality variables and excess mortality. The results are reported in the bottom part of each table. The coefficients for the direct (internal) effects are greater than those for the external ones, meaning that the spillover effects on the dependent variable are weak, apart some exceptions like the top 20% and 5% of the income distribution (Tables A4 and A5, respectively). Overall, the results point in the direction that inequalities in a region have had a limited effect on the impact of COVID-19 in neighbouring regions.

5. Conclusions

Poverty and inequality have traditionally been considered drivers of pandemics. They are generally viewed as two factors that facilitate the spread of all types of illnesses. Research on the incidence of the COVID-19 pandemic has, so far, supported this perception (e.g., Blundell et al, 2020; Patel et al., 2020; Rose et al., 2020; Palomino et al., 2020; Tavares and Betti, 2021; Wildman, 2021): poverty and inequality matter for the impact of COVID-19 and they matter as much, if not more, than other factors behind the spread of the disease. Yet, the evidence that poverty and inequality are at the root of the highly uneven geography of COVID-19 in Europe is so far limited. The limited availability of data on interpersonal inequalities, among other factors, has stymied this type of analysis, leading to a situation whereby the supposed influence of poverty and inequality on the spread of the pandemic has been mostly assumed rather than demonstrated.

In this paper we have sought to fill this gap in our knowledge by assessing the extent to which regional excess mortality rates during the first 18 months of the COVID-19 pandemic in Europe are related to regional poverty, material deprivation, wealth, and inequality.

The analysis shows that, in contrast with the dominant assumption and with research conducted for the US (Tan et al., 2020), poverty, material deprivation, wealth, and inequality seem to have a limited capacity to explain the uneven European geography of COVID-19. There is no connection whatsoever between differences in inequality and the incidence of the pandemic. Poverty levels and material deprivation are not related to higher excess mortality, while the presence of pockets of wealthy individuals is connected with more, not less, excess mortality. It seems that, at least in the case of Europe, variations in the lethality of the incidence of COVID-19 are much more related to other factors —regional wealth, accessibility, pollution, education, and the readiness of the health system— than to the presence of poor people or high interpersonal inequality.

These results may be simply due to the fact that the regional scale is not the best to assess how inequality shapes the diffusion of the disease. Inequality may strike harder at the local, often urban, scale rather than at the regional one. Poverty may have a greater influence on COVID-19-related excess mortality within our neighbourhoods or our cities than at the regional level.

But, on the whole, the results provide significant food for thought and a stimulus to further delve into what is clearly a complex link between wealth polarisation and inequality and the uneven prevalence of COVID-19. There is a need to know much more about the exact mechanisms through which poverty and inequality may increase or decrease the risk of contagion and, after contagion, why in some places COVID-19 has had a far more devastating effect on human lives than in others. It might be the case that in Europe —in contrast, for example, to North America— the provision of universal (or nearly universal) health systems has meant that the results of contagion amongst Europe's poor have not been as tragic as on the other side of the Atlantic (Oronce et al., 2021). Lack of health insurance and/or the fear of having to pay high health bills may have discouraged those at the bottom of the income scale in the US from going to hospital until it was too late, or at all. Widespread and free healthcare across most of Europe will have driven poor individuals with initial COVID-19 symptoms more into hospitals than their often uninsured peers in the US. Lower levels of inequality and spatial segregation than in the US may have also contributed to moderate the incidence of the pandemic amongst Europe's poor. And, finally, a more developed welfare system may have shielded greater shares of the European population from exposure to the virus, through generous furlough or similar mechanisms. Universal or equivalent healthcare systems and a more widespread welfare state are likely to have functioned as shields to the most pernicious effects of the pandemic. Hence, protecting and expanding these systems —what is normally known as the European social welfare system— has been not only a significant protection against COVID-19 for the most vulnerable in Europe, but also represents a potential safeguard against future pandemics.

Having said that, there is still considerable need to analyse what determines why some places are —and may continue to be— far more vulnerable to COVID-19 or, for that sake, to any other pandemic, than others. Understanding the drivers of the uneven geography of COVID-19 is fundamental to build the foundations to make sure that our societies are far better prepared for future health and natural challenges and that the most vulnerable are not at greater risk of suffering the consequences of future plagues than the rest of society.

Endnotes

1. The share of relative poverty and the other inequality indices are missing for Germany and the Netherlands. Belgium and the UK only have data available at NUTS1 level, while for all other countries information is provided at NUTS2 level.

2. Unfortunately, this indicator is not available for regions in Belgium, France, Germany, if you any, and the UK.

3. The SILC survey is also the source of the data for the share of people in the top 20% and top 5% of the income distribution. This index is built as the total equivalised disposable income received by the 20% of the regional population with the highest equivalised disposable income (top quintile) to that received by the 20% of the regional population with the lowest equivalised disposable income (lowest quintile). The same logic is used when considering the share of the population in the top 5% of the income distribution (EUROSTAT, 2020).

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APPENDIX

Table A1. Variable description and summary statistics.

VARIABLES	Year	Source	Description	N	mean	sd	min	max
Excess mortality first six months 2020	2020	EUROSTAT	Excess deaths, first semester 2020	236	4.576	10.23	-7.992	68.17
Excess mortality second six months 2020	2020	EUROSTAT	Excess deaths, second semester 2020	236	17.47	10.83	-6.368	47.49
Excess mortality first six months 2021	2021	EUROSTAT	Excess deaths, first semester 2021	236	9.763	12.08	-12.59	67.24
Excess mortality 2020-2021	2020-2021	EUROSTAT	Excess deaths, years 2020 and 2021	236	11.27	7.310	-5.733	43.62
Gini coefficient 2018	2017-2018	EU-SILC and LIS	Gini index	198	0.302	0.0409	0.230	0.452
Relative poverty 2018	2017-2018	EU	Relative poverty	181	0.187	0.0646	0.0638	0.366
Population in the top 5% of the income bracket	2017-2018	EU-SILC	Share of the population in the top 5% of the income distribution	181	0.0458	0.0204	0.0110	0.142
Population in the top 20% of the income bracket	2017-2018	EU-SILC	Share of the population in the top 20% of the income distribution	181	0.191	0.0530	0.0809	0.367
Material deprivation 2018	2018	EUROSTAT	Percentage of people facing severe material deprivation	159	7.438	6.726	0.3	28

Hospital beds per capita	2019	EUROSTAT	Number of hospital beds over population	207	247.8	143.9	78.24	1,205
GDP per capita	2018	EUROSTAT	GDP per capita	220	26,975	14,594	4,000	98,600
Population density	2018	EUROSTAT	Population per km2	233	370.7	933.3	3.400	7,472
Accessibility by air	2018	EUROSTAT	Number of passengers transiting through airports	232	7,794	15,227	0	105,311
Accessibility by road	2014	European Commission	Potential road accessibility per NUTS-2 region for the period 1995-2014	225	2.499e+06	1.859e+06	101,478	8.662e+06
National government effectiveness	2018	Kaufmann and Kraay (2020) and World Bank	Worldwide Governance Indicators	236	1.100	0.612	-0.253	2.040
Air pollution	2019	OECD	Exposure to air pollution by particulate matter (PM 2.5)	236	12.66	5.079	4.230	30.92
Education 2018	2018	EUROSTAT	Percentage of people with secondary and/or tertiary education	234	77.75	12.804	34.3	97.3
Median Age 2018	2018	EUROSTAT	Median age	236	43.019	3.649	17.7	50.7

Table A2. Excess mortality and relative poverty.

Dependent variable:	(1) Excess mortality 2020-2021	(2) Excess mortality first six months 2020	(3) Excess mortality second six months 2020	(4) Excess mortality first six months 2021
Relative poverty 2018	-18.329**	-0.016	-21.879*	-37.287***
	(9.319)	(14.582)	(13.094)	(14.386)
lnGDPpc2018	-5.096***	8.834***	-11.913***	-12.566***
	(0.928)	(1.451)	(1.303)	(1.432)
Spatial effects				
W*Poverty_1718	-13.892	11.882	-29.004	-29.766
	(17.562)	(27.480)	(24.675)	(27.111)
W*lnGDPpc2018	0.643**	0.204	1.032**	0.776
	(0.326)	(0.511)	(0.459)	(0.504)
Direct Effect				
Poverty_1718	-18.329*		-21.879*	
	(9.319)		(13.094)	
lnGDPpc2018	-5.096***		-11.913***	
	(0.927)		(1.303)	
Indirect Effect				
Poverty_1718	-9.363		-19.548	
	(11.836)		(16.630)	
lnGDPpc2018	0.433**		0.695**	
	(0.219)		(0.309)	
Total				
Poverty_1718	-27.692**		-41.428**	
	(10.52)		(14.793)	
lnGDPpc2018	-4.663***		-11.217***	
	(0.894)		(1.257)	
Observations	181	181	181	181
Wald test	10.36	4.168	10.05	2.997
Prob > chi2	0.005	0.124	0.006	0.223

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A3. Excess mortality and material deprivation.

Dependent variable:	(1) Excess mortality 2020-2021	(2) Excess mortality first six months 2020	(3) Excess mortality second six months 2020	(4) Excess mortality first six months 2021
Material deprivation 2018	-0.193	0.289	-0.298	-0.566**
	(0.139)	(0.216)	(0.193)	(0.222)
lnGDPpc2018	-4.306***	6.603***	-7.351***	-11.346***
	(1.444)	(2.240)	(2.001)	(2.305)
Spatial effects				
W*deprivation_2018	-0.126	-0.494*	0.200	-0.006
	(0.180)	(0.279)	(0.249)	(0.287)
W*lnGDPpc2018	0.486**	0.895***	0.321	0.211
	(0.190)	(0.295)	(0.264)	(0.304)
Direct Effect				
deprivation_2018	-0.193	0.289		
	(0.139)	(0.216)		
lnGDPpc2018	-4.306***	6.603***		
	(1.444)	(2.240)		
Indirect Effect				
deprivation_2018	-0.081	-0.316*		
	(0.115)	(0.179)		
lnGDPpc2018	0.311**	7.176***		
	(0.122)	(2.224)		
Total				
deprivation_2018	-0.273**	-0.270		
	(0.134)	(0.208)		
lnGDPpc2018	-3.994**	7.176***		
	(1.449)	(2.248)		
Observations	144	144	144	144
Wald test	8.342	9.305	6.211	0.844
Prob > chi2	0.0154	0.009	0.0448	0.656

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A4. Excess mortality and share of people in the top 20% of the income distribution.

Dependent variable:	(1) Excess mortality 2020-2021	(2) Excess mortality first six months 2020	(3) Excess mortality second six months 2020	(4) Excess mortality first six months 2021
Population in the top 20% of the income bracket 2018	49.401***	41.252***	46.729***	62.629***
	(8.914)	(14.960)	(12.766)	(14.581)
lnGDPpc2018	-4.866***	7.258***	-10.517***	-11.330***
	(0.793)	(1.331)	(1.136)	(1.297)
Spatial effects				
W*Top20_1718	26.405	-40.433	95.909***	36.652
	(23.410)	(39.287)	(33.524)	(38.292)
W*lnGDPpc2018	0.033	1.175	-1.139*	-0.158
	(0.469)	(0.787)	(0.671)	(0.767)
Direct Effect				
Top20_1718			46.729***	
			(12.766)	
lnGDPpc2018			-10.517***	
			(1.136)	
Indirect Effect				
Top20_1718			64.641***	
			(22.595)	
lnGDPpc2018			-767*	
			(0.452)	
Total				
Top20_1718			111.371***	
			(20.629)	
lnGDPpc2018			-11.284***	
			(1.097)	
Observations	181	181	181	181
Wald test	25.94	5.468	29.49	10.43
Prob > chi2	0.000	0.065	0.000	0.005

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A5. Excess mortality and share of people in the top 5% of the income distribution.

Dependent variable:	(1) Excess mortality 2020-2021	(2) Excess mortality first six months 2020	(3) Excess mortality second six months 2020	(4) Excess mortality first six months 2021
Population in the top 5% of the income bracket 2018	124.075***	106.924***	121.528***	147.857***
	(22.356)	(36.880)	(32.208)	(36.173)
lnGDPpc2018	-5.103***	7.358***	-11.201***	-11.514***
	(0.774)	(1.277)	(1.116)	(1.253)
Spatial effects				
W*Top5_1718	92.962	-173.862	278.620***	225.595*
	(74.548)	(122.980)	(107.403)	(120.624)
W*lnGDPpc2018	0.152	1.224**	-0.528	-0.447
	(0.365)	(0.602)	(0.526)	(0.590)
Direct Effect				
Top5_1718		106.924***	121.528***	147.857***
		(36.880)	(32.208)	(36.173)
lnGDPpc2018		7.358***	-11.201***	-11.514***
		(1.277)	(1.116)	(1.253)
Indirect Effect				
Top5_1718		-117.185	187.787**	152.049*
		(82.887)	(72.388)	(81.299)
lnGDPpc2018		0.825	-0.355	-0.301
		(0.405)	(0.354)	(0.397)
Total				
Top5_1718		-10.257	309.315***	299.905***
		(80.560)	(70.357)	(79.017)
lnGDPpc2018		8.183***	-11.556***	-11.815***
		(1.306)	(1.141)	(1.281)
Observations	181	181	181	181
Wald test	28.89	7.049	29.52	14.63
Prob > chi2	0.000	0.0295	0.000	0.000

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A6. Excess mortality and Gini disposable income.

Dependent variable:	(1) Excess mortality 2020-2021	(2) Excess mortality first six months 2020	(3) Excess mortality second six months 2020	(4) Excess mortality first six months 2021
GINI 2018	25.488*	47.027**	11.472	11.441
	(13.404)	(20.759)	(19.100)	(20.852)
lnGDPpc2018	-4.633***	8.440***	-10.110***	-12.428***
	(0.930)	(1.440)	(1.325)	(1.446)
Spatial effects				
W*SILC_LIS_GINI_2018	-24.035	20.132	-10.315	-84.275**
	(23.302)	(36.088)	(33.205)	(36.250)
W*lnGDPpc2018	1.306*	-0.150	1.102	3.035***
	(0.684)	(1.060)	(0.975)	(1.065)
Direct Effect				
SILC_LIS_GINI_2018	25.488*			11.441
	(13.404)			(20.852)
lnGDPpc2018	-4.633***			-12.428***
	(0.930)			(1.446)
Indirect Effect				
SILC_LIS_GINI_2018	-16.181			-56.736**
	(15.687)			(24.404)
lnGDPpc2018	0.879*			2.043***
	(0.461)			(0.717)
Total				
SILC_LIS_GINI_2018	9.306			-45.295**
	(13.817)			(21.494)
lnGDPpc2018	-3.753***			-10.385***
	(0.777)			(1.209)
Observations	198	198	198	198
Wald test	28.68	6.099	23.63	16.27
Prob > chi2	0.000	0.0474	0.000	0.0002

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1