European Committee
of the Regions

NAT

Regional differences in COVID-19 response: exposure and strategy

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List of acronyms

APAs	Advance Purchase Agreements
COVID-19	Coronavirus Disease 2019
ECDC	European Centre for Disease Prevention and Control
ECML	European Crisis Management Laboratory
EID	Emerging infectious diseases
ESI	Emergency Support Instrument
EU	European Union
ICU	Intensive Care Unit
IHR	International Health Regulations
JRC	Joint Research Centre
LRAs	Local and Regional Authorities
NGA	Next Generation Access
NUTS	*Nomenclature des Unités territoriales statistiques*
p.p.	percentage points
PPE	Personal Protective Equipment
TESSy	The European Surveillance System
WHO	World Health Organization

Summary

This study provides the evidence that factors influencing exposure to the COVID-19 pandemic and capability to learn and react to health threats are importantly grounded in regional characteristics such as population density and connectivity, in regional endowment of health resources, and in the optimisation of these resources at the hospital level. **It is at the regional and subregional level that the capacity to learn and react, or resilience, is triggered.** Likewise, this study finds that the **mixed financing of healthcare from the national and the subnational level supports the resilience of health systems**.

One of the research questions of this work was to understand if rural and urban areas were impacted differently by the COVID-19 pandemic and if there were differences in the resilience of their health systems, including from the point of view of vaccination rollout. There is **no evidence of a rural-urban divide in the health impact** caused by the pandemic. Similarly, **the rural-urban dimension does not explain regional health systems' resilience**, and **vaccination rollout results up to the end of May 2021 do not show a rural-urban bias**.

Overall, it is necessary to emphasise **a general regional data failure in the health domain** which has affected this work. Datasets on COVID-19 cases and deaths, hospital bed occupancy, intensive care units and vaccination, just to mention the most important ones, are not compiled by EU institutions at the regional level. For the scope of this study, several of these datasets were created ad-hoc by gathering subnational data from governments' websites. Even if this approach provides a temporary solution to data failure, it is not easily replicable and therefore remains **a one-off exercise**.

The focus of this study is on highlighting differences among regions. These differences are discussed in terms of exposure (Part 1), resilience (Part 2), and progress in the rollout of COVID-19 vaccinations (Part 3). Part 4 concludes highlighting recommendations for enhancing the resilience of regional health systems in line with the creation of a European Health Union.

In Part 1, exposure is analysed in a sample of European regions, namely those of the five clusters with the highest 2020 excess mortality. These clusters are located in Spain, northern Italy, south-eastern Belgium, southern Poland and southern Bulgaria. The analysis refers to health-related influencing factors of exposure such as hospital beds, health staff, incidence of comorbidities and poverty; and territorial characteristics such as a region's rural level and its connectivity level. Proxies to measure influencing factors are used as necessary in order to compensate for the lack of more pertinent data. In addition, as Eurostat rural/urban classification is only available at the subregional level (NUTS3), this work defines

the 'rural level' of a region as the share of 'predominantly rural' area in each NUTS2 region.

Population density, **comorbidities**, **ageing population** and presence of **nursing homes for the elderly** have increased the exposure of regions to COVID-19 infections (cases) and fatalities (deaths). The **connectivity level** of a region is also linked to its exposure. Social and family outbreaks driven by mobility characterise regions that have a concentration of major transport hubs (roads, train stations, airports and ports). Border regions having important shares of foreign citizens had their exposure increased due to the mobility of these individuals across countries, for work or family reasons. Finally, **occupational-driven** transmission has occurred **especially among vulnerable groups and low-income populations** in the agricultural sector and in industry.

Rural areas are characterised by lower population density, lower connectivity and lower use of land for industry than peri-urban and urban areas. This contributes to making these areas less exposed to the impact of COVID-19. On average, in terms of the death toll paid to COVID-19, urban areas were hit harder than rural areas as **2020 excess mortality was 17.2% in 'predominantly urban' areas, 15.1% in 'intermediate areas' and 13.5% in 'predominantly rural' areas**. Still, the analysis of clusters shows exceptions to these averages, especially in **rural areas characterised by high shares of people at risk of poverty and social exclusion**.

The analysis of exposure highlights that among the considered influencing factors, the comorbidity level is the most clearly related to the COVID-19 fatality rate. This, in practice, means that **the healthier the population of a region is, the lower the death toll paid** by that region **to the pandemic**. As comorbidity is not only determined by age but may be influenced by other contextual conditions such as pollution or healthcare shortcomings, this evidence implies the need to intervene on these conditions to reduce exposure. In addition, **there are important health status differences among countries and within countries, in particular between people living in rural and urban areas, that need to be addressed.**

In this study, resilience of regions with respect to the COVID-19 pandemic is defined as the capability of regional health systems to **allow for better public health outcomes** from the first to the last wave of the coronavirus, as a consequence of the systems' learning, adaptation and response. Regions are categorised according to the increase/decrease of their excess mortality occurring between the second and the third wave of the pandemic. Overall, 138 regions (58%) fall in the 'more resilient' category, 78 regions (33%) in the 'stable' category, and 21 regions (9%) in the 'less resilient' category.

In order to understand what is affecting the resilience of a region, the three categories are analysed against four main functions of a health system, namely **governance** (decentralised/centralised management of healthcare), **financing** (national and/or subnational financing of health), **resources** (regional endowment of health infrastructure and workforce), and **service delivery** (treatment capacity of COVID-19 patients in ordinary hospital beds and in intensive care units). Findings highlight a general important role of the regional level in supporting the resilience of health systems.

At the level of health systems' management, there is no evidence of a successful 'management model'. Even if the analysis shows that decentralised health management systems characterise most of the 'more resilient' regions, regions with a decentralised management of the health system also characterise the 'stable' and the 'less resilient' groups.

Evidence of the important role of the subnational level is clearer with respect to funding. In fact, data show that a **shared responsibility for health funding between government levels has contributed to facilitating the resilience of regions.** More than half of the regions (55%) categorised as 'more resilient' have a mixed public health funding model. A multi-level governance of financing is apparently the most effective way to facilitate financial flexibility and re-direction of funds in case of public health threats. Prevailing central funding and prevailing decentralised funding arrangements do not seem to be equally effective.

In terms of human and physical health resources, the analysis highlights **a minimum endowment of health infrastructure and workforce over which the resilience capability of regions increases**. In particular, it is found that 81% of the regions categorised as 'more resilient' have at least 320 hospital beds per 100,000 inhabitants and 80% have at least 4.3% of their total workforce employed in the health sector.

Finally, in terms of service delivery to COVID-19 patients, the analysis finds that 'more resilient' regions are characterised by a relationship between the maximum occupancy rate of hospital beds with COVID-19 patients and the number of available ICUs per 100,000 inhabitants. This relationship is interpreted as the capability of 'more resilient' regions to manage the surge of patients, including the severely affected ones, through **optimal hospital management.**

The last part of the study looks at the progress made by regions in the COVID-19 vaccination campaign. The situation as at 1 June 2021 is considered and mapped for comparative purposes. Vaccination data show that **several capital regions have the lowest vaccination rates in their respective countries**.

In some EU countries, regions are in charge of designing and implementing their vaccination strategy, but even where the health management system is decentralised **a central decision-making approach for the deployment of the vaccination campaign has prevailed**. Priority categories for vaccination are set centrally. Rules for the distribution of doses to regions are also set centrally. However, there was a level of flexibility at the regional level in interpreting and implementing national provisions and this flexibility led to varying degrees of success of regional approaches.

At the regional level, solutions were found, for example, for the logistics related to the storage, transport and distribution of vaccines; the reduction of unused doses; the identification of vaccination places/centres and, in bigger cities/metropolis, of vaccination hubs; the training of healthcare personnel; the setup of mobile units to reach out to the most fragile, the homebound, the homeless and migrants; the organisation of large-scale operations to reach out to rural areas; the mobilisation of general practitioners and pharmacists; and the implementation of information systems for the online booking/management of the vaccination campaign.

Building on the conclusions of the single chapters, recommendations for enhancing the resilience of regional health systems include:

o Taking into account that the exposure is site-specific, **local and regional authorities (LRAs) should be supported in assessing the factors influencing the exposure of their regions to emerging infectious diseases**.

o Upon the evidence that the comorbidity level influences exposure across all European regions, a healthier population and the filling of health gaps across countries and between rural and urban areas should be pursued by EU institutions through the **setting of minimum standards in healthcare for all EU citizens**.

o Since decentralised financing and regional health resources' endowment have the potential to increase the resilience of regions to emerging infectious diseases, **LRAs should be involved in the updating of national preparedness and response plans and be provided with decentralised funding capacity for their implementation at the regional level, possibly in the form of regional plans which take into account cross-border cooperation**.

o Upon the evidence that there are inequalities in healthcare capacity across regions, it is necessary to **define and pursue a 'minimum endowment for healthier regions' in terms of health infrastructure and health workforce**.

o By considering that health resources endowment is optimised through correct hospital management, **training and technology tools to support hospital preparedness at the territorial level should be made available to regions** by national governments.

o As critical factors to vaccination rollout campaigns are similar across regions, the exchange of experiences in this area may indeed help regional authorities in defining the vaccination approach that best suits their territories. **A structured sharing of solutions used by regions to overcome critical factors should be pursued** at the EU level by the European Committee of the Regions.

o Upon the evidence of important data failure at the regional level, **the European Health Data space should be used to fill the gap of health data at the regional level** to better inform regions' resilience and response measures.

These recommendations point to the need of having **a stronger EU in the health policy domain** where minimum binding standards for population health and health endowment of territories are set at the EU level, in line with the creation of a European Health Union. However, they also point to the importance of **better supporting the role of regions in defining their exposure, in planning preparedness and response while cooperating with their border regions, and in building the capacity of hospitals** for the optimal management of public health threats.

Part 1. Health impact of the COVID-19 pandemic at the territorial level: regional differences and health-related factors potentially influencing exposure

This part illustrates key health data related to the COVID-19 outbreak. The focus is on highlighting differences among regions through the analysis of some main health-related factors that possibly influence their exposure.

1.1 Health impact of COVID-19 pandemic at the territorial level

Impact on the territory is measured according to the number of COVID-19 cases and deaths expressed per 100,000 inhabitants. This information at the regional level is not compiled by EU institutions. It is therefore gathered from various sources such as the ECML COVID portal of JRC and national governments' official data. The **cumulated number of cases per 100,000 inhabitants** as at June 1, 2021, is illustrated in Map 1.

Map 1. Cumulated COVID-19 cases per 100,000 inhabitants as at June 1, 2021
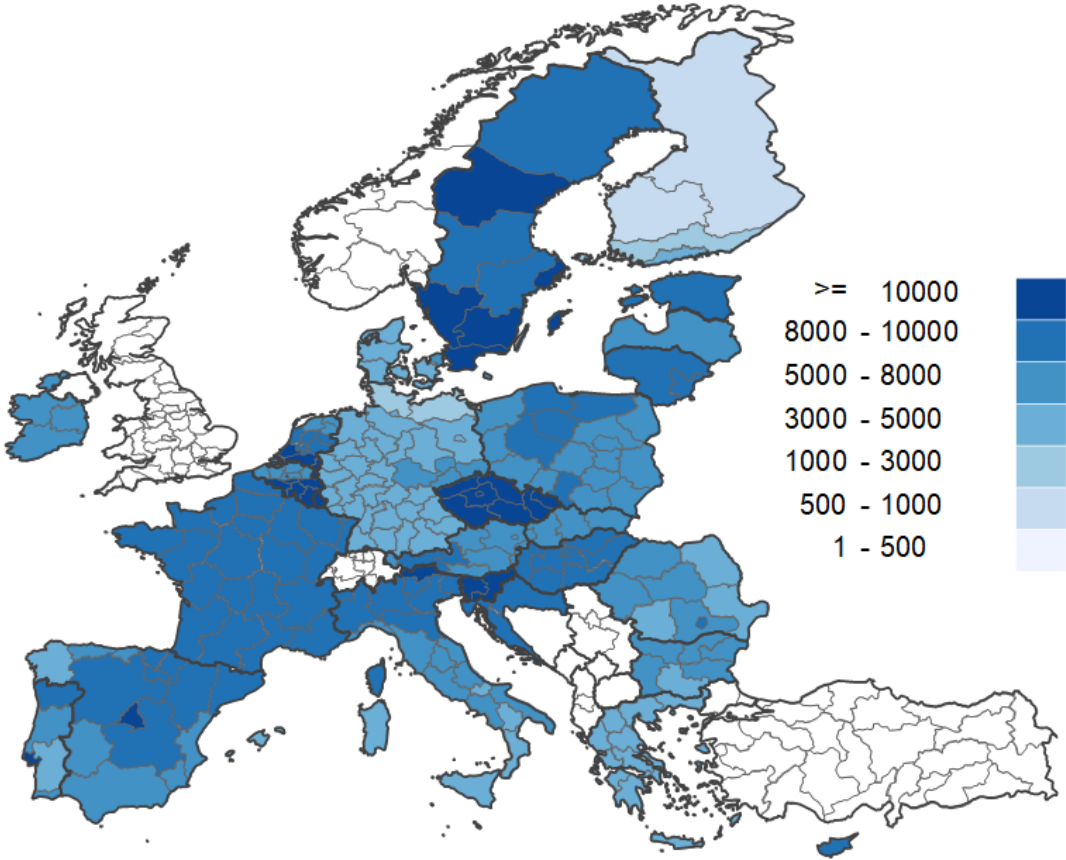
Notes: data for DE are at NUTS1 level. National data for IE, EL, FR, HU and SI.
Data sources: ECML COVID portal of JRC at https://covid-statistics.jrc.ec.europa.eu/, complemented by official national governments' data. Map created by Progress Consulting Srl.

At that date, the European regions with the highest cumulated number of infections since the beginning of the pandemic were Czech regions (country-wise), the Autonomous Province of Bolzano in Italy, Wallonia in Belgium, the Área Metropolitana de Lisboa in Portugal, Luxembourg and Västsverige in Sweden.

Health impact in terms of fatalities at the regional level is also an information which is not compiled by EU institutions and, similarly to cases, had to be gathered from various sources. The geographical distribution of **cumulated COVID-19 deaths** per 100,00 inhabitants as at the beginning of June 2021 is reported in Map 2.

Map 2. Cumulated COVID-19 deaths per 100,000 inhabitants as at June 1, 2021
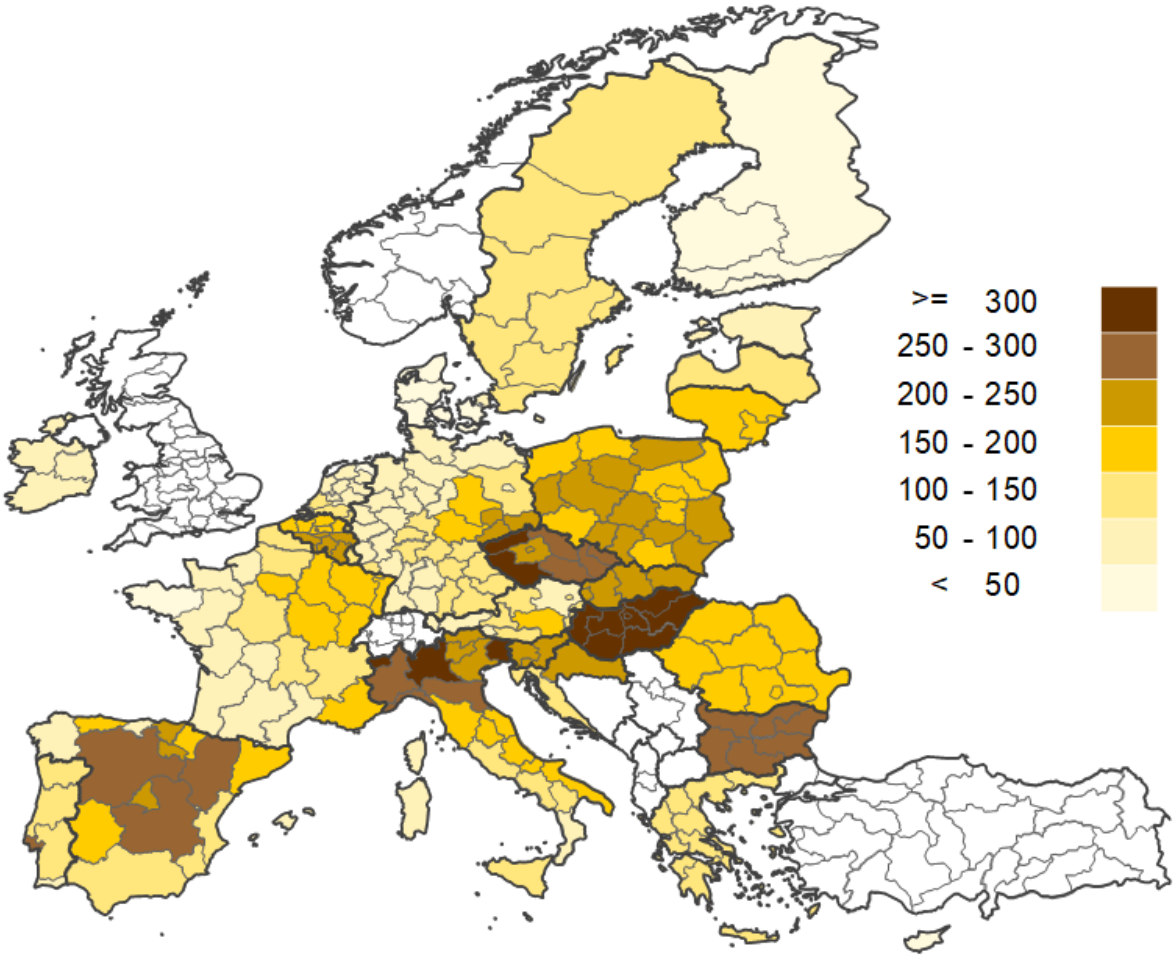
Notes: data for DE and FR are at NUTS1 level. National data for IE, EL, HU, RO, SE, SI and SK.
Data sources: ECML COVID portal of JRC at https://covid-statistics.jrc.ec.europa.eu/, complemented by official national governments' data. Map created by Progress Consulting Srl.

Map 2 highlights a somewhat different geographical distribution of impact in terms of death toll paid by regions since the beginning of the pandemic. The Czech

cluster is confirmed, but new clusters emerge. They are located in Hungary and Bulgaria (country-wise as data for these two countries are only available at the national level), in Spain, and in the north of Italy (Valle d'Aosta, Piemonte, Liguria, Lombardia, Emilia-Romagna and Friuli-Venezia Giulia).

Figure 1 reports the ten most impacted regions in terms of incidence of coronavirus cases (left) and deaths (right). As Eurostat classifies territories as 'predominantly rural' only at the subregional level (NUTS3), the share of 'predominantly rural' areas in each region (NUTS2) is calculated to determine the 'rural level' of a region. This level, expressed as a share of the area (%), is indicated in Figure 1 to the right of each region.

Figure 1. Most impacted regions, cases (left) and deaths (right), per 100,000 inhabitants, June 1, 2021

Region (cases)	Cases	Rural %		Region (deaths)	Deaths	Rural %
Severovýchod	17,994	36%		Valle d'Aosta	377	0%
Strední Cechy	16,354	0%		Severozápad	358	0%
Jihozápad	15,632	100%		Lombardia	335	10%
Strední Morava	14,769	0%		Jihozápad	315	100%
Severozápad	14,694	0%		Friuli-Venezia Giulia	314	0%
Moravskoslezsko	14,468	0%		Hungary (national average)	305	28%
Praha	13,703	0%		Severovýchod	298	36%
Provincia Autonoma di Bolzano	13,689	100%		Emilia-Romagna	295	0%
Jihovýchod	13,462	49%		Moravskoslezsko	292	0%
Slovenia	12,139	73%		Castilla-La Mancha	289	22%

Note: the cells on the right indicate the region's percentage of area classified as 'predominantly rural' by Eurostat. Regions whose rural level is 0% are composed by 'predominantly urban' and 'intermediate' areas only.
Data sources: JRC ECML, official national governments' sources and Eurostat.

Health impact may also be determined by considering the **excess mortality experienced by European territories** in 2020. Excess mortality informs on the additional deaths occurring in a given period compared to a baseline period. It provides a **more objective measure of the impact of the coronavirus disease** than the number of COVID-19 deaths because it also captures collateral fatalities and fatalities which were not COVID-19 certified.

Map 3 illustrates the percentage of excess mortality in 2020 at the subregional level (NUTS3). Excess mortality is calculated by comparing the number of deaths in 2020 to the average number of deaths over the four previous years, from 2016 to 2019. The analysis of excess mortality **highlights new impact clusters** which were not detected by considering data on cases and deaths. In fact, apart from the macro clusters of central Spanish regions and of northern Italian regions, micro clusters are found in the south-eastern part of Belgium, and in the southern parts of Poland and of Bulgaria.

Italy is the country showing the highest variability of excess mortality across regions. For example, the province of Bergamo, in Lombardia, had a 63% increase of deaths in 2020 vs. the province of Catanzaro, in Calabria, that recorded only a 2% increase. Important differences across regions are also found in Spain (from 2% to 44%) and in Greece (from less than 1% to 35%).

Map 3. Excess mortality in 2020 at NUTS3 level, % change compared with the 2016-2019 average
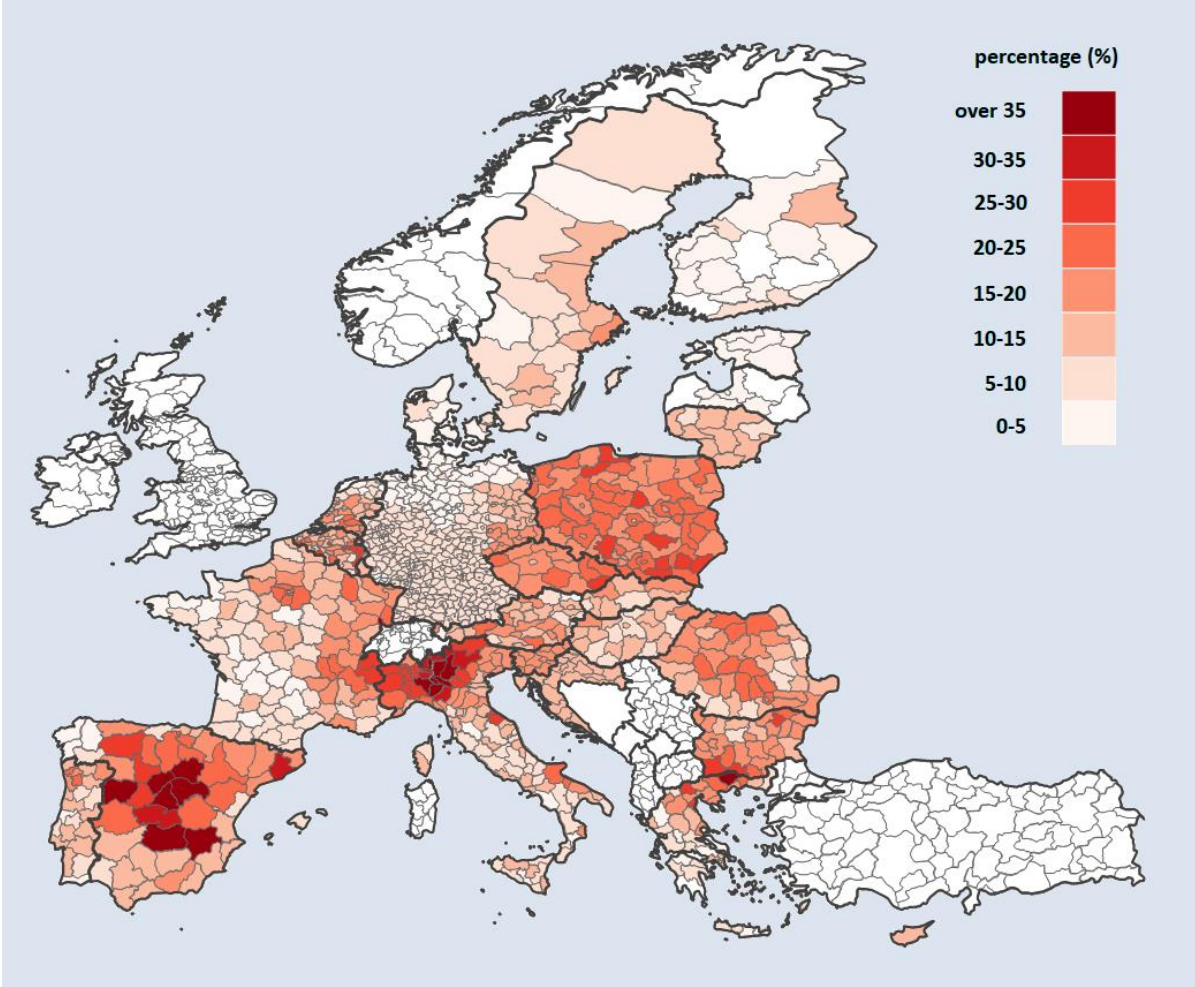
Data source: Eurostat. Map created by Progress Consulting Srl.
Notes: no data for IE. Data for HR and EE are at the national level. Data for DE are at NUTS1 level.

Across national borders, differences are evident for Spain when compared to Portuguese regions in the west and to French regions in the east. Belgian territories show higher excess mortality than their neighbouring German and Luxembourgish territories. Also, Polish territories show higher excess mortality than their neighbouring Slovak territories.

Data also inform that **all European regions experienced some excess mortality in 2020**, although to a very diverse degree. The ten hardest hit regions are reported in Figure 2. With the exception of the French territory of Mayotte and of

Podkarpackie in Poland, the highest mortality is found in Spanish and Italian regions. The worst hit regions are Madrid (44%) and Lombardia (39%).

Figure 2. European regions with the highest shares of 2020 excess mortality, %

	NUTS2 region	%	rural level		NUTS2 region	%	rural level
ES30	Comunidad de Madrid	44	0%	ES41	Castilla y León	29	38%
ITC4	Lombardia	39	10%	ITC2	Valle d'Aosta	28	0%
ES42	Castilla-la Mancha	34	22%	ES51	Cataluña	27	0%
ITH2	P.A. di Trento	32	0%	PL82	Podkarpackie	26	100%
FRY5	Mayotte	32	0%	ITC1	Piemonte	25	47%

Note: the 'rural level' cells on the right indicate the share of the region's area classified as 'predominantly rural' by Eurostat.
Data source: Eurostat.

The above data on health impact do not provide the evidence of a rural-urban divide. As Eurostat rural/urban typology is defined at the NUTS3 level and excess mortality is available at the NUTS3 level, the excess mortality has been calculated by degree of urbanisation. On average, it is found that in 2020, living in a 'predominantly rural' area was safer than residing in a city or in a 'predominantly urban' territory. In fact, **there is an increasing gradient of excess mortality from 'predominantly rural' to 'predominantly urban' areas** (Figure 3). The gap between urban and rural areas is 3.7 percentage points.

Figure 3. Average excess mortality in predominantly urban, intermediate and predominantly rural areas, 2020, %

Notes: the calculation at the NUTS3 level excludes the territories of Croatia, Estonia, Germany, Ireland and Slovenia for which data on excess mortality are not available at NUTS3 level. Excess mortality in 2020 is calculated versus the 2016-2019 average.
Data source: Eurostat.

1.2 Factors affecting the exposure of regional health systems

From the point of view of its health system, the exposure of a territory is primarily determined by the resources which are available to respond to a shock. Hence, health facilities and healthcare workforce are the first aspects to be considered. Other health-related factors which potentially contribute to the exposure of regions are comorbidities, population ageing, presence of socially vulnerable

population and air pollution. These conditions are measured using the best available proxies identified (Box 1), as often regional data needed to compile more appropriate indicators are either missing and/or outdated.

Box 1. Proxies to measure potentially influencing factors of regions' exposure

- **Health facilities**, expressed as the number of hospital beds per 100,000 inhabitants (H.BEDS). Data source: Eurostat.
- **Health workforce**, expressed as the number of medical doctors per 100,000 inhabitants (DOCTORS). Data source: Eurostat.
- **Incidence of comorbidities**, expressed in deaths per 100,000 inhabitants as the crude death rate caused by diseases (all causes minus external causes) (COMORB). Although this information from Eurostat is outdated (2016), it provides an interesting measure of the potential vulnerability of individuals to the coronavirus disease.
- **Ageing**, expressed as the share of people aged 70 years and older. This indicator provides an understanding of the population structure and is derived from Eurostat population data (AGED 70+).
- **Presence of fragile groups**, expressed as the number of long-term care beds in nursing and residential care facilities (CARE.BEDS). Although this dataset from Eurostat has many geographical gaps and most of the information at the regional level dates back to 2015, it is considered important as long-term care facilities have become clusters of cases and fatalities in many EU countries, especially during the first wave of the pandemic (Soldi, 2020).
- **Presence of socially vulnerable groups**, expressed as the share of people at risk of poverty or social exclusion. Data source: Eurostat. Because of their living conditions, these groups are potentially more vulnerable to being infected, for example as a consequence of living and/or working in overcrowded environments where social distancing is not feasible (POVERTY).
- **Air pollution**, proxied through Eurostat indicators of land used for the secondary sector, namely energy production, industry and manufacturing (INDUST). Research on the effects of air pollution on the spread and severity of the coronavirus disease is still considered immature (EP, 2021). On the contrary, there is the scientific evidence that air pollution is correlated to cardiovascular and respiratory diseases, as well as to the occurrence of respiratory infections from a variety of pathogens (EP, 2021).

In order to pursue the scope of this study, it is also essential to analyse the information at the regional level from the point of view of territorial characteristics such as 'rural', 'underpopulated' and 'remote'. Thus, the following potential influencing factors are also included:

- the **rural level** of a region (RUR, expressed as a % of the total region's area) (derived from Eurostat data);
- the **population density** of a territory (DENS, expressed as the number of inhabitants per km^2) (data source: Eurostat);
- the **connectivity level** of a region, measured through the use of the proxy indicator of 'land used for transport' (CONNECT, expressed as a % of land use) (data source: Eurostat).

1.3 Analysis of exposure: regional differences across the main impact clusters

The analysis of differences among European regions focuses on the five most impacted clusters identified according to the data on 2020 excess mortality. These clusters are located in Spain, northern Italy, south-eastern Belgium, southern Poland, and southern Bulgaria. Regions' influencing factors to exposure are discussed by referring to comparative matrixes and to the findings of desk-researched studies and literature.

- *The Spanish cluster: regional differences, including with Portuguese and French bordering territories*

The Spanish cluster is distributed over a relatively high number of provinces in the regions of Madrid, Castilla-La Mancha, Castilla y León, Aragón and Navarra. A micro cluster is also found in Barcelona province, in the Cataluña region. Bordering regions considered in the analysis are the Portuguese Centro and Norte, and the French Aquitaine, Midi Pyrenees and Languedoc-Roussillon, all of which counted fewer fatalities than the Spanish territories.

The sample's influencing factors matrix (Figure 4) highlights that:

o Spanish regions are the most urbanised, with a share of rural area ranging from 0% in Madrid, Navarra and Cataluña to a maximum of 38% in Castilla y Leon.
  o French regions have high shares of rural area and relatively low shares of land used for industry. Portuguese regions are also largely rural, but with a higher concentration of industry.
  o Castilla-La Mancha has the lowest number of hospital beds and doctors in the sample, as well as the highest number of long-term care beds in nursing and residential care facilities and the highest share of socially vulnerable people. Its fatality rate is the highest in the sample (3.1%).
  o The region of Madrid has the highest concentration of transport (connectivity) and the highest population density in the sample, as well as one of the lowest numbers of hospital beds per 100,000 inhabitants.

Figure 4. Matrix of influencing factors and health impact for the ES-PT-FR cluster

		RUR	DENS	H.BEDS	DOCTORS	COMORB	CARE.BEDS	AGED 70+	POVERTY	INDUST	CONNECT	CASES	DEATHS	FAT.RATE
PT	Norte	69	169	320	511	878		15	23	0,4	3,5	9521	150	1,6
PT	Centro	94	79	314	478	1153		18	20	0,4	2,9	5405	136	2,5
ES	Castilla y Leon	38	26	352	453	1117	1142	19	17	0,5	1,7	9637	287	3,0
ES	Aragon	31	28	375	471	1013	1158	16	21	0,2	1,4	9349	264	2,8
ES	Castilla-La Mancha	22	26	233	286	895	2227	14	31	0,2	1,5	9442	289	3,1
ES	Madrid	0	840	274	457	680	816	13	19	0,2	5,5	10627	227	2,1
ES	Navarra	0	63	331	506	848	1039	15	12	0,2	2,1	9519	179	1,9
ES	Cataluña	0	238	388	408	813	869	14	19	0,3	3,6	8002	190	2,4
FR	Languedoc-Roussilon	42	104	660	365	934		17		0,3	3	8883	75	0,8
FR	Midi Pyrenees	86	68	620	347	882		16	0		2,4	8883	75	0,8
FR	Aquitaine	57	84	613	361	921		17		0,2	2,8	8883	62	0,7

Notes: for French regions, national data for cases and NUTS1 level data for fatalities.

Regional differences in the uneven spread of the pandemic across Spanish regions have been investigated by a study commissioned by the Carlos III Health Institute, the main public research centre of the country. The study found five relevant factors causing transmission during the first wave: internal mobility, infected health personnel, concentration of residences for the elderly, mobility from Madrid, and mobility from the Basque Country[1]. In particular, in the Comunidad de Madrid and in Cataluña the spread was importantly influenced by internal mobility and by infected health personnel. In Castilla-La Mancha, infected health personnel was the most important transmission factor, while in Castilla y León it was the concentration of residences for the elderly. The presence of residences for the elderly was also relevant in Aragón, concurrently with the mobility from the Basque Country. Finally, in Navarra, the infected health personnel and the mobility from Madrid represented the major transmission factors although on a moderate level (FdD Covid-19 Project, 2020).

After restrictions and control measures were lifted in June 2020, the second wave in Spain started in the form of localised outbreaks. The same monitoring project found that these outbreaks were occupational-driven ones. In particular, they related to meat-processing activities in Cataluña and to agricultural/seasonal activities in Aragón and in the Ebro valley in general. In this latter case, the coronavirus spread was important across vulnerable groups and low-income populations. From mid-July onwards, occupational outbreaks became less important and were replaced by social and family outbreaks driven by mobility in and around Barcelona and Madrid and then towards Madrid's neighbouring regions (Rosillo *et al.*, 2021).

With regard to Spain's neighbouring countries, there is a general consensus that the first wave did not impact Portugal severely because of the early adoption of control measures (El Pais news dated 11/05/20). Learning from the experience of

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[1] The Basque Country has two large freight ports, Pasajes and Bilbao, and two airports, Vitoria and Loiu-Bilbao.

Italy and Spain, where the spread of the pandemic started earlier, the Portuguese government acted as soon as the first death was recorded in March 2020. Afterwards, it is believed that relaxation of measures during the Christmas holidays and the arrival of the English strain caused by the frequent exchange of visitors between Portugal and the UK made the country prone to a severe second wave of infections in January 2021 (Politico article dated 12/07/21). The lower impact of COVID-19 during the first wave probably explains the lower death toll paid by Portuguese regions up to now, when compared to Spanish regions. In fact, in terms of vulnerability factors the two groups are very similar, with the only exception being the share of rural area (much higher in Portuguese regions).

Instead, French regions do look different in the sample. They have a high share of rural area, a very high number of hospital beds per 100,000 inhabitants, and a relatively low population density. Their fatality rate is below 1%. According to French media, the lower impact of COVID-19 in Occitanie (which includes Midi Pyrenees and Languedoc-Roussillon) when compared to Cataluña is due to the fact that Barcelona is much more connected internationally and has a higher population density than its French neighbours ('France 3' news dated 29/05/20 and 06/05/20).

- *The Italian cluster: regional differences, including with French, Austrian and Slovenian bordering territories*

The Italian cluster is primarily distributed over the provinces of Lombardia but it also covers the territories of Piemonte, Valle d'Aosta and Autonomous Provinces of Trento as well as some provinces in Veneto, Emilia-Romagna, Liguria and Friuli-Venezia Giulia. For comparative purposes, the cluster includes the regions of Zahodna Slovenija on the eastern border of Italy, of Tirol and Kärnten in Austria on the northern border, and of Rhône-Alpes and Provence-Alpes-Côte d'Azur on the western border.

The influencing factors' matrix (Figure 5) highlights that:

o The fatality rate is very high in Italian regions. This appears to be associated with high shares of population aged 70+ years and also with high levels of comorbidities. The only exception is the Autonomous Province of Bolzano where not only is the fatality rate relatively low, but

also the share of people aged 70+ years is only 15% (which is the EU average) and the deaths caused by comorbidities are well below the EU average.

o The majority of the Italian regions in the sample have a high concentration of long-term care beds in nursing and residential care facilities.

o Several of the Italian regions in the cluster have high values of connectivity and industry (Lombardia, Veneto, Emilia-Romagna).

o In most of the cases, in the Italian regions, high population density corresponds to high fatality rates, with the exception of Valle d'Aosta. For example, the Province of Milan (NUTS3 level), in the Lombardia region, has a density of 2,088 persons per km^2.

o The Autonomous Province of Bolzano and Tirol are the most rural regions in the sample. They have low population density and contained fatality rates.

Figure 5. Matrix of influencing factors and health impact for the IT-FR-AT-SI cluster

	RUR	DENS	H.BEDS	DOCTORS	COMORB	CARE.BEDS	AGED 70+	POVERTY	INDUS	CONNECT	CASES	DEATHS	FAT.RATE
AT Tirol	83	60	670	561	729	816	13	16	0,2	1,3	8276	90	1,1
AT Kärnten	79	60	819	481	977	1011	16	17	0,1	1,6	7136	146	2,0
SI Zahodna Slovenija	30	127	523	377	787		14	12		2,5	12139	224	1,8
IT Friuli-Venezia Giulia	0	160	333	403	1105	739	20	14	0,4	2,1	8873	314	3,5
IT Veneto	30	282	323	343	931	739	17	11	1,1	5,4	8678	237	2,7
IT Prov. Autonoma di Bolzano	100	72	388	323	763	755	15	12	0,6	1,2	13689	221	1,6
IT Prov. Autonoma di Trento	0	88	348	331	870	910	17	14	0,1	0,8	8335	249	3,0
IT Lombardia	10	436	346	368	911	693	17	16	1	5,7	8333	335	4,0
IT Valle d'Aosta	0	39	353	355	1034	110	18	8	0,3	1,1	9278	377	4,1
IT Piemonte	47	172	348	366	1118	762	20	17	0,8	3,2	8362	270	3,2
IT Liguria	0	284	337	451	1300	503	22	18	0,4	3,4	6740	284	4,2
IT Emilia-Romagna	0	202	370	419	1067	488	19	16	0,7	4,1	8602	295	3,4
FR Rhône-Alpes	40	151	571	346	724		14		0,3	3,2	8883	141	1,6
FR Provence-Alpes-Côte d'Azur	40	162	703	407	911		17		0,5	2,9	8883	155	1,7

Notes: data for Zahodna Slovenija are national averages. For French regions, national data for cases and NUTS1 level data for fatalities.

A qualitative analysis of the different impact of the pandemic between northern and southern Italy points, besides delayed and/or inappropriate crisis management decisions, to the following potential reasons (Cacciarru and Paesano, 2020): high population density and concentration of the economic fabric in the north which determines high occupational-related mobility/contacts; high number of health facilities and personnel which paradoxically increased the opportunities for the coronavirus to spread in the absence of appropriate protocols and personal protection equipment (PPE); no time to prepare (southern Italian regions, like many other EU regions and countries, were hit by the pandemic after the northern Italian regions); and more ageing people living in residential health facilities.
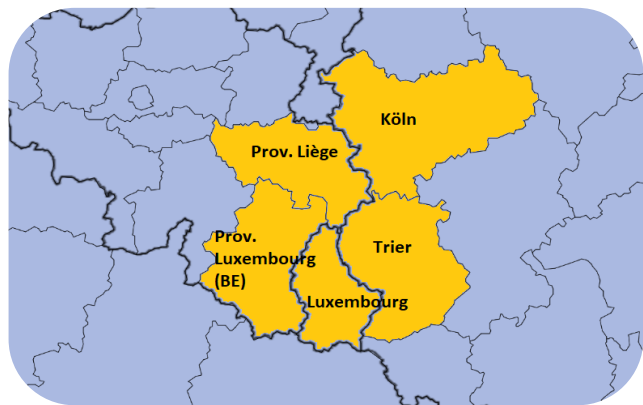
Across the borders, Friuli-Venezia Giulia and Zahodna Slovenija have comparable levels of several of the influencing factors, but a different fatality rate (3.5% in Friuli and 1.8% in Zahodna). In fact, the number of cases is very high in

Zahodna Slovenija but the region has fewer fatalities, a circumstance that may be explained by a lower share of people aged 70+ years (14%) compared to Friuli (20%). The same occurs in the Autonomous Province of Bolzano where a very high number of cases results in a low number of deaths because of the relatively 'young' population. There are not many impact differences between the Autonomous Province of Bolzano and its Austrian neighbouring regions, the main evidence being that Austrian regions have a better endowment of medical doctors and hospital beds but also a high number of long-term care beds in residential facilities.

On the eastern border, there are important impact differences between Italian and French regions. Fatality rates are as high as 4.2% in Liguria, 4.1% in Valle d'Aosta and 3.2% in Piemonte. On the other side of the border, both French regions have fatality rates below 2.0%. The most evident differences across the border relate to the ageing population ('older' in the Italian regions), to the comorbidities' level (much higher in Italian regions), to the health system ('better equipped' in the French regions) and to the share of rural area (higher in the French regions).

- *Differences across the south-eastern border of Belgium with German and Luxembourgish regions*

In Belgium, 2020 excess mortality data highlight a cluster of municipalities in the south-eastern part of the country which does not stand out when considering only cases and deaths. These territories with an excess mortality ranging between 25% and 29% are located in Wallonia, in the Provinces of Liège (Arr. Waremme, Arr. Liège and Arr. Verviers) and of Luxembourg (Belgium) (Arr. Bastogne and Arr. Arlon). Across the Belgian border neither Luxembourg nor the German regions of Köln in Nordrhein-Westfalen and of Trier in Rheinland-Pfalz show such excess mortality levels. For Germany, for which data are available only at the NUTS1 level, 2020 excess mortality was 6% in both Nordrhein-Westfalen and Rheinland-Pfalz. In Luxemburg, excess mortality was 11%.

The influencing factors' matrix (Figure 6) highlights that:

- o Notwithstanding their high excess mortality, the fatality rate of Belgian provinces is comparable to the rate found in the neighbouring German regions.
- o The German regions have the highest shares of population aged 70+ years. The highest fatality rate of the sample is found in the region of Trier which has the highest comorbidity level.

In this sample, where all regions have important connectivity levels, the level of comorbidities seems to be the most influencing factor of exposure.

Figure 6. Matrix of influencing factors and health impact for the BE-LU-DE cluster

		RUR	DENS	H.BEDS	DOCTORS	COMORB	CARE.BEDS	AGED 70+	POVERTY	INDUS	CONNECT	CASES	DEATHS	FAT.RATE
BE	Liège	49	290	566	357	969		13	25	0,3	5,7	11363	249	2,2
BE	Luxembourg (BE)	100	65	409	228	855		12	18	0,8	2,1	11363	249	2,2
LU	Luxembourg	0	240	451	298	640	1161	10	21	0,9	5,6	11184	131	1,2
DE	Köln	0	613	777	439	998	1057	15	20	1,2	6,1	4489	93	2,1
DE	Trier	75	109	796	399	1064	1113	15	21	0,7	5,5	3733	91	2,4

Notes: for German regions, data on cases and fatalities are at NUTS1 level. Data on risk of poverty and social exclusion for Belgian provinces are from Statbel and for Luxembourg are from Eurostat table ILC_PEPS01.

In Belgium, a regression analysis at the municipal level finds that the spread of the pandemic during the first wave was positively correlated with population density, ageing population, presence of care homes for the elderly and income level of inhabitants where the latter was associated with higher mobility of individuals for business and vacation reasons. In addition, if the geographical location of an area close to a national border was not a reason for accelerating transmission, the share of non-Belgian nationals in that area was found to be a significant exposure factor, as it implied higher mobility of people across the borders to join relatives/friends (Verwimp, 2020).

An expert's opinion on the differences between Belgian provinces, reported by rtbf.be, highlights that early in the pandemic deaths were registered according to the place of death and not to the place of residence of the deceased. This explains the high number of deaths registered in places like Brussels where big hospitals are concentrated. Other factors mentioned by the expert include population density, the connectivity level of cities, the presence of nursing homes, and even the presence of fragile socio-economic groups that live in small spaces, do jobs which cannot be executed remotely and are less informed about health risks. Finally, among the reasons hypothesised for Wallonia being more severely affected than Flanders during the second wave are that Wallonia had an earlier start to the academic year and also a sense of relaxation that was not experienced by Flanders due to a summer resurgence of the epidemic in Antwerp (RTBF news dated 23/11/20).

Poland records the highest national average percentage increase of 2020 excess mortality in the EU (21%). In the cluster, in the south of Podkarpackie, Przemyski records 29%, Rzeszowski 27% and Krośnieński 24%; in the south of Małopolskie, Nowosądecki and Tarnowski record 28% each. Across the border, in Slovakia, Prešovský kraj in Východné Slovensko has 18% excess mortality; Žilinský kraj in Stredné Slovensko has even less (13%).

The influencing factors' matrix highlights that (Figure 7):

o All regions in the sample have a relatively young population and a low level of deaths caused by comorbidities.
o All regions in the sample are characterised by an important share of rural area. Podkarpackie is totally rural.
o Notwithstanding the highest population density, industrialisation and connectivity levels in the sample, Malopolskie records the lowest fatality rate.
o All regions have a good availability of hospital beds but, especially in Podkarpackie, there is a low number of doctors (well below the EU average of 382).

Figure 7. Matrix of influencing factors and health impact for the PL-SK cluster

		RUR	DENS	H.BEDS	DOCTORS	COMORB	CARE.BEDS	AGED 70+	POVERTY	INDUS	CONNECT	CASES	DEATHS	FAT.RATE
PL	Małopolskie	58	224	659	246	874	205	11	19	0,5	2,3	6592	171	2,6
PL	Podkarpackie	100	118	704	223	870	181	11	22	0,2	1,5	6057	212	3,5
SK	Východné Slovensko	57	104	632	345	809		9	21	0,3	1,2	6901	226	3,3
SK	Stredné Slovensko	58	83	580	333	922		11	22	0,2	1,2	7148	226	3,2

Notes: for Slovak regions, data on fatalities are the national average.

The low availability of medical doctors may be the reason why Polish regions were impacted more than their neighbouring Slovak regions. In addition, the two Polish regions have a lower accessibility to intensive care compared to the two Slovak regions (Bauer *et al.*, 2020).

An analysis of COVID-19 impact in Poland reports that transmission in the country was driven by infection outbreaks in hospitals, among health workers[2], but also among undiagnosed patients, nursing homes, schools and crowded resorts during the 2020 summer season. The analysis also found a correlation between air-borne particulate matter and COVID-19 incidence (Kowalski *et al.*, 2021). As noted for Bulgaria, initially the most populated and connected areas (Śląskie and Mazowieckie voivodships) were the hardest hit by the pandemic, where the spread of the virus was facilitated by occupational commuting and school attendance.

The last cluster is found at the border between Bulgaria and Greece where Blagoevgrad province in Yugozapaden, Smolyan province in Yuzhen tsentralen, and Drama in Anatoliki Makedonia, show very high levels of excess mortality. An analysis of COVID-19 impact in Bulgaria confirms that excess mortality characterises more peripheral and remote areas than highly populated areas such as Plovdiv, Varna, Burgas and the city of Sofia. In fact, after a first phase where better connected territories were affected more, the spread of coronavirus to peripheral areas put these latter areas under a much greater pressure because of fewer resources '*to test, track and treat COVID-19 patients*' (Rangachev *et al.*, 2020).

In addition, the analysis found that excess mortality in 2020 characterises working-age people and females in particular. This is potentially explained by the fact that several recorded outbreaks occurred at garment, textile and shoe workplaces, i.e. in plants with a mainly female workforce (Rangachev *et al.*, 2020). In Blagoevgrad and Smolyan provinces, where excess mortality was 25% and 27%, respectively, these types of factories represent an important component of the local economy.

Among the drivers of excess mortality, the analysis of Rangachev *et al.* (2020) mentions the limited testing, the delayed adoption of control and restriction measures, the high incidence of comorbidities, in particular related to cardiovascular diseases, and the low availability and/or accessibility of health facilities in remote areas. The data in the influencing factors' matrix (Figure 8)

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[2] Infection of health personnel is reported as high as 17% of the infected (Kowalski *et al.*, 2021).

confirm the high incidence of comorbidities in the two Bulgarian provinces but also highlight very high shares of people at risk of poverty and social exclusion, especially in Yuzhen tsentralen (38% versus an EU average of 21%) where the fatality rate is as high as 5.3%.

Figure 8. Matrix of influencing factors and health impact for the BG-EL cluster

		RUR	DENS	H.BEDS	DOCTORS	COMORB	CARE.BEDS	AGED 70+	POVERTY	INDUS	CONNECT	CASES	DEATHS	FAT.RATE
BG	Yuzhen tsentralen	29	64	824	404	1414	16	15	38	0,1	1,2	4754	254	5,3
BG	Yugozapaden	35	104	714	444	1308	29	14	23	0	1	7535	254	3,4
EL	Anatoliki Makedonia, Thraki	33	43	404	497	1161		18	35	0,6	1,7	3753	113	3,0
EL	Kentriki Makedonia	63	101	451	625	1049		17	32	0,5	1,9	3753	113	3,0

Notes: for Greek regions, data on cases and fatalities are the national average.

Across the borders of Blagoevgrad and Smolyan, in Greek regions, the situation does not differ much although the information is flattened by the use of national averages for COVID-19 cases and deaths, as these data are not available in Greece at the regional level. Anatoliki Makedonia and Kentriki Makedonia also have high shares of people at risk of poverty and social exclusion but their population appears healthier even if it is older than neighbouring Bulgarian regions. The two Greek regions have higher connectivity compared to the Bulgarian regions, a circumstance that may have increased their exposure to COVID-19 transmission.

1.4   Conclusions on impact and exposure differences among regions

- Excess mortality detects impact situations caused by the pandemic which are not evident by referring only to COVID-19 certified cases and deaths.
- Population density, comorbidities, ageing population and presence of nursing homes for the elderly have increased the exposure of regions to infections (cases) and fatalities (deaths).
- The connectivity level of a region is linked to its exposure in terms of transmission of coronavirus. Social and family outbreaks driven by mobility characterise regions that have a concentration of major transport hubs (roads, train stations, airports, ports).
- External border regions which have important shares of foreign citizens had their exposure increased due to the mobility of these individuals across countries, for work or family reasons.
- Occupational-driven transmission has occurred importantly among vulnerable groups and low-income population in the agricultural sector (e.g. seasonal workers or workers in the informal economy) and in industry (e.g. workers that could not perform their jobs through teleworking).

Rural areas are usually characterised by lower population density, lower connectivity and lower industrial use of land than peri-urban and urban areas. This

contributes to making these areas less exposed to the impact of COVID-19. However, there are exceptions to this general rule. For example, the analysis of the Bulgarian-Greek micro cluster shows that exposure increases when the prevalence of rural areas is associated with high shares of people at risk of poverty and social exclusion. In addition, a spatial analysis of intensive care capacity carried out over 14 European countries concludes that low geographical access to intensive care beds is associated with higher fatality rates (Bauer *et al.*, 2020).

Each of the vulnerability factors considered in this analysis was individually plotted versus the fatality rate. The only **influencing factor which is found to be related to the fatality rate is the comorbidity level.** This relationship widens the understanding of exposure because comorbidity is not only determined by age but may be influenced by other contextual conditions such as pollution or healthcare inadequacies. Chart 1 represents this correlation across the regions analysed in the clusters, where the size of the bubble represents the share of rural area of each region (the bigger the bubble, the more rural the region). Chart 2 shows the correlation when all European regions are plotted in the chart.

Chart 1. Relationship between comorbidity level and COVID-19 fatality rate in the clusters' regions
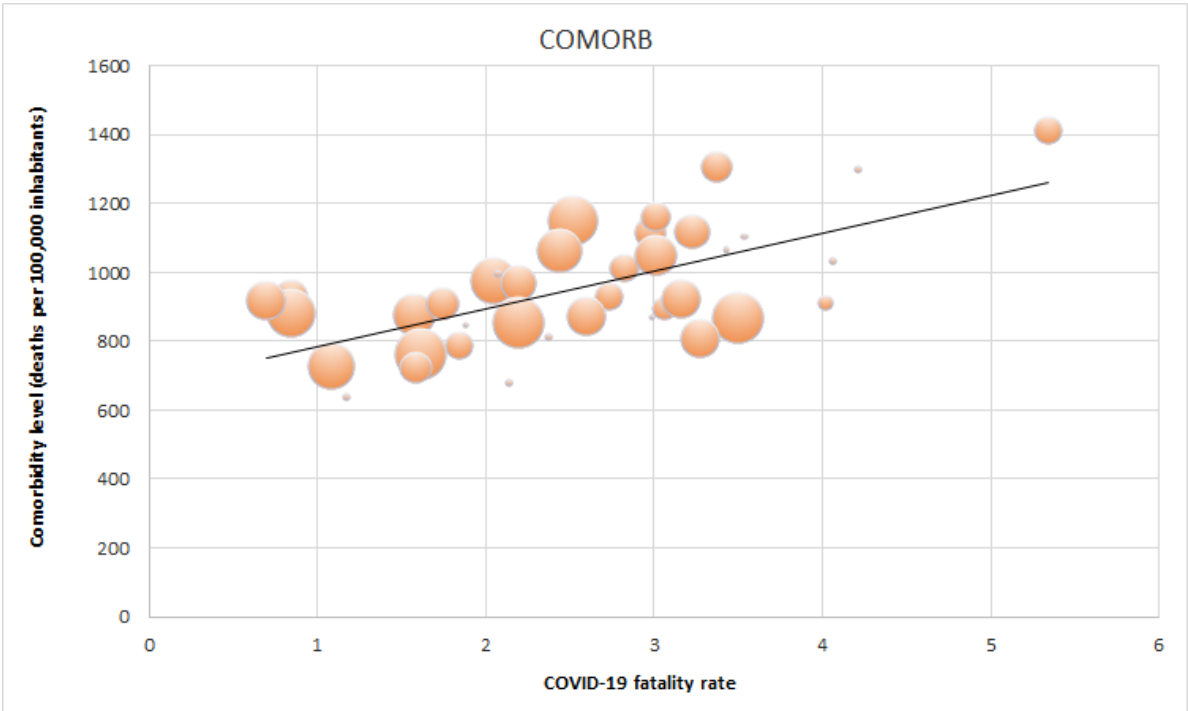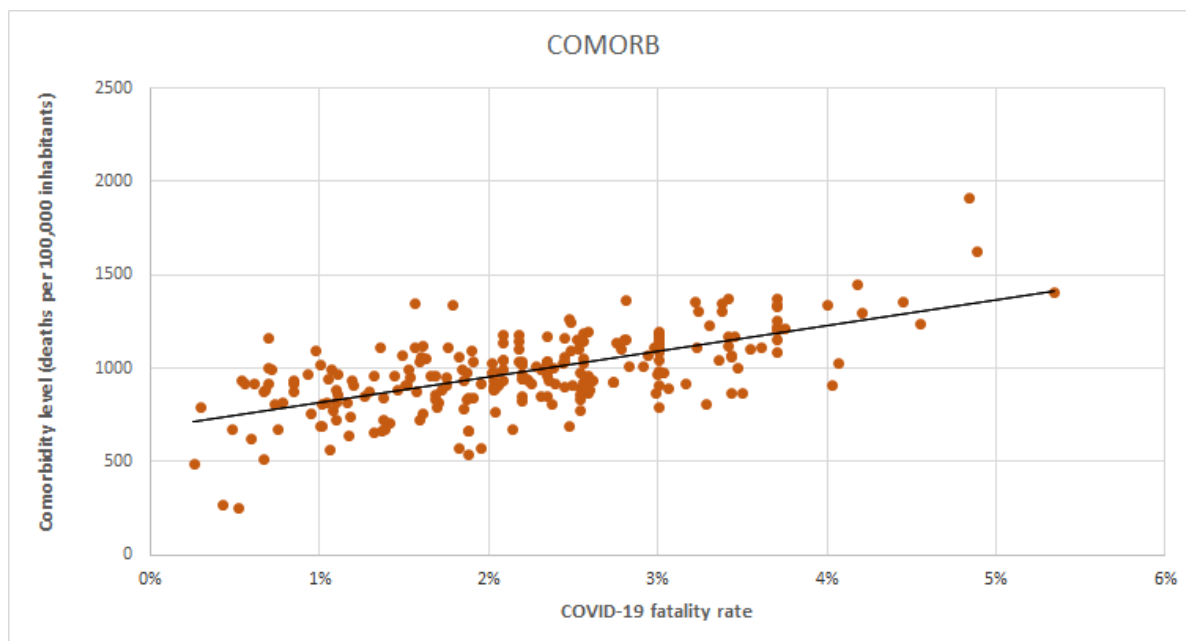
Chart 2. Relationship between comorbidity level and COVID-19 fatality rate in European regions


Data sources for Chart 1 and 2: Eurostat table hlth_cd_ycdr2, ECML COVID portal of JRC and official national governments' data.

In practice, the two charts show that **the healthier the population is, the lower the death toll paid by a region to COVID-19.** Since the same relationship does not exist between the regional fatality rate and the share of people aged 70+ years, this means that the health status of a region's inhabitants is a factor that may be influenced by health and social policies through for example the improvement of living and working conditions (healthier environments) and/or the provision of better-quality healthcare.

Data on long-standing illnesses or health problems show that in some countries population health status is comparable in rural and urban areas (e.g. in Belgium, Germany, Ireland, Italy, Hungary, Croatia, Slovenia and Slovakia). **But in some countries, people living in rural areas are indeed less healthy than those living in cities, towns and suburbs** (Chart 3).

Examples of countries where the rural-urban gap is important are Bulgaria and Luxembourg (9 percentage points each of difference), Lithuania (8 p.p.), Cyprus (7 p.p.), Sweden (6 p.p.), and France, Portugal and Finland (5 p.p. each) (Chart 3).

Chart 3. Share of people (%) having a long-standing illness or health problem, by degree of urbanisation
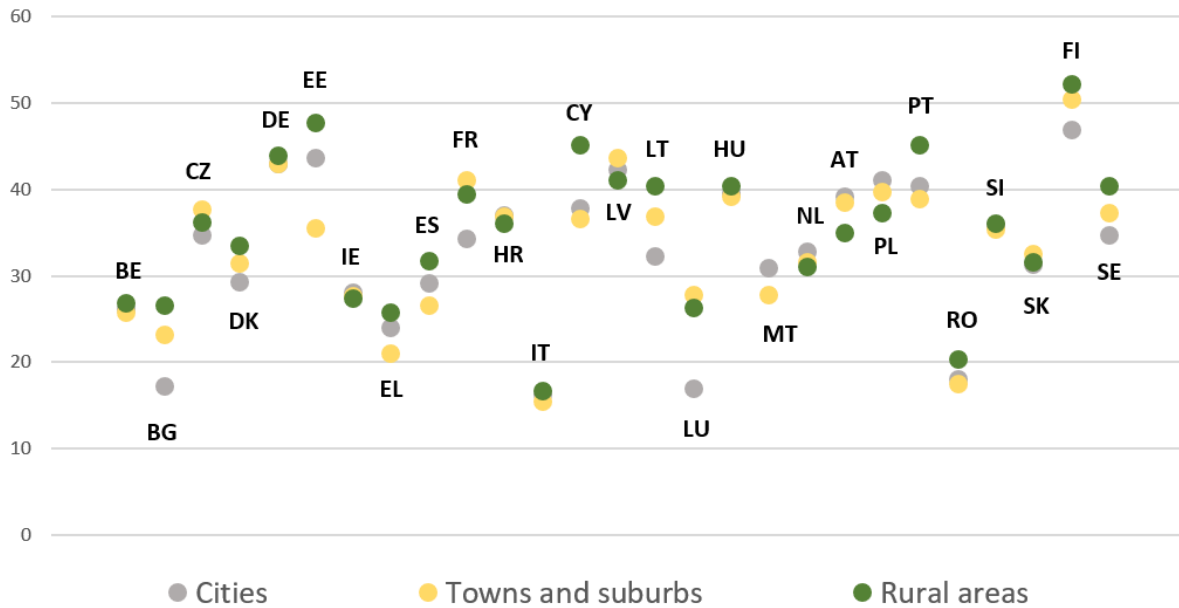
Data source: Eurostat table hlth_silc_19.

Another important information derived from Chart 3 is that even if some countries do not show a rural-urban divide, they have very high shares of people having a long-standing illness or health problem. Examples in this sense include Croatia, Germany and Latvia.

Part 2. Resilience of regions in fighting the COVID-19 pandemic

Further to the analysis of impact and vulnerability factors, in this part the focus is on investigating the resilience of regions in terms of their capability to cope with the COVID-19 pandemic. The scope of this exercise is to highlight differences among regions and factors explaining these differences.

2.1 Categorising regions according to resilience: a working hypothesis

The capability of a region to cope with a health threat is determined by many factors, but the most important ones are governance and the technical capacity (of its health system) to respond (WHO, 2021). Health system resilience is defined as '*the ability to prepare, manage (absorb, adapt and transform) and learn from shocks*' (WHO, 2021). Aligned with this definition, **in this study the working hypothesis** is that a resilient health system **has allowed for better public health outcomes from the first to the last wave of the coronavirus**. Also as part of the working hypothesis, public health outcomes are expressed in terms of **excess mortality** which, as discussed in Part 1, is considered an objective measure of the health impact caused by COVID-19. Thus, the assumption is that a regional health system is to some extent resilient if it was able to prepare, adapt and transform in order to save more lives from the first to the successive waves of the pandemic. In fact, the examined change is between the **second wave** ('wave 2') and the **third wave** ('wave 3') because during the first wave impact was very much asymmetric across the EU (Figure 9), and for the fourth wave data on excess mortality are not yet available for all regions at the time of writing (May 2021).

**Figure 9.** **Trend of COVID-19 infections in Europe since January 2020**
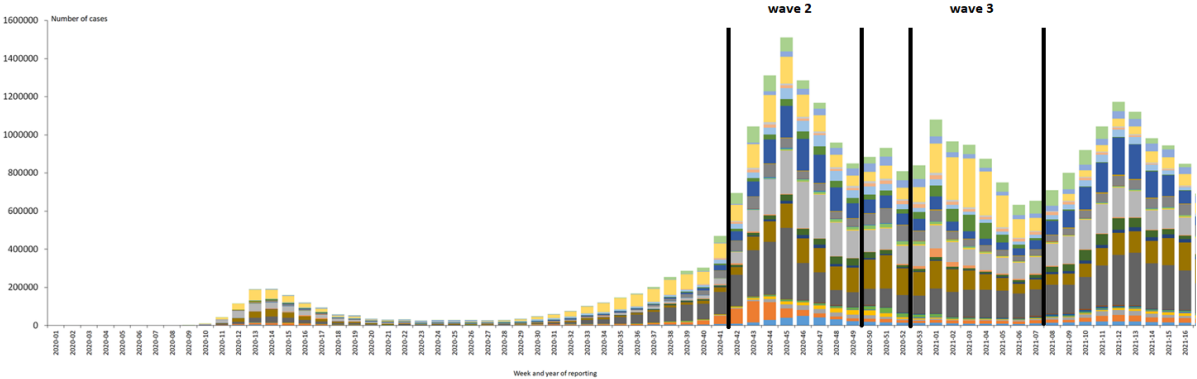
Source: extracted from ECDC website at https://www.ecdc.europa.eu/en/cases-2019-ncov-eueea in April 2021 and modified to delimitate wave 2 and wave 3.

Figure 9 clearly shows the wider geographical coverage of waves 2 and 3 compared to the first wave, and the fact that wave 3 is characterised by a lower

number of infections than wave 2, which should reasonably be reflected into lower mortality levels.

The reference periods for comparison purposes cover two 8-week intervals: the first is from mid-October 2020 to the beginning of December 2020 (wave 2); the second is from the end of December 2020 to mid-February 2021 (wave 3). By calculating and comparing the excess mortality over waves 2 and 3, it is found that in some regions excess mortality decreased in wave 3 with respect to wave 2 while in other regions it remained more or less (+/- 10%) the same, or increased (Map 4). Still, it should be noted that comparability across regions may be biased by differences in the timing of COVID-19 waves.

Map 4. Trend of excess mortality between wave 2 and wave 3 as a proxy of resilience of regions from the point of view of public health outcomes, percentage points
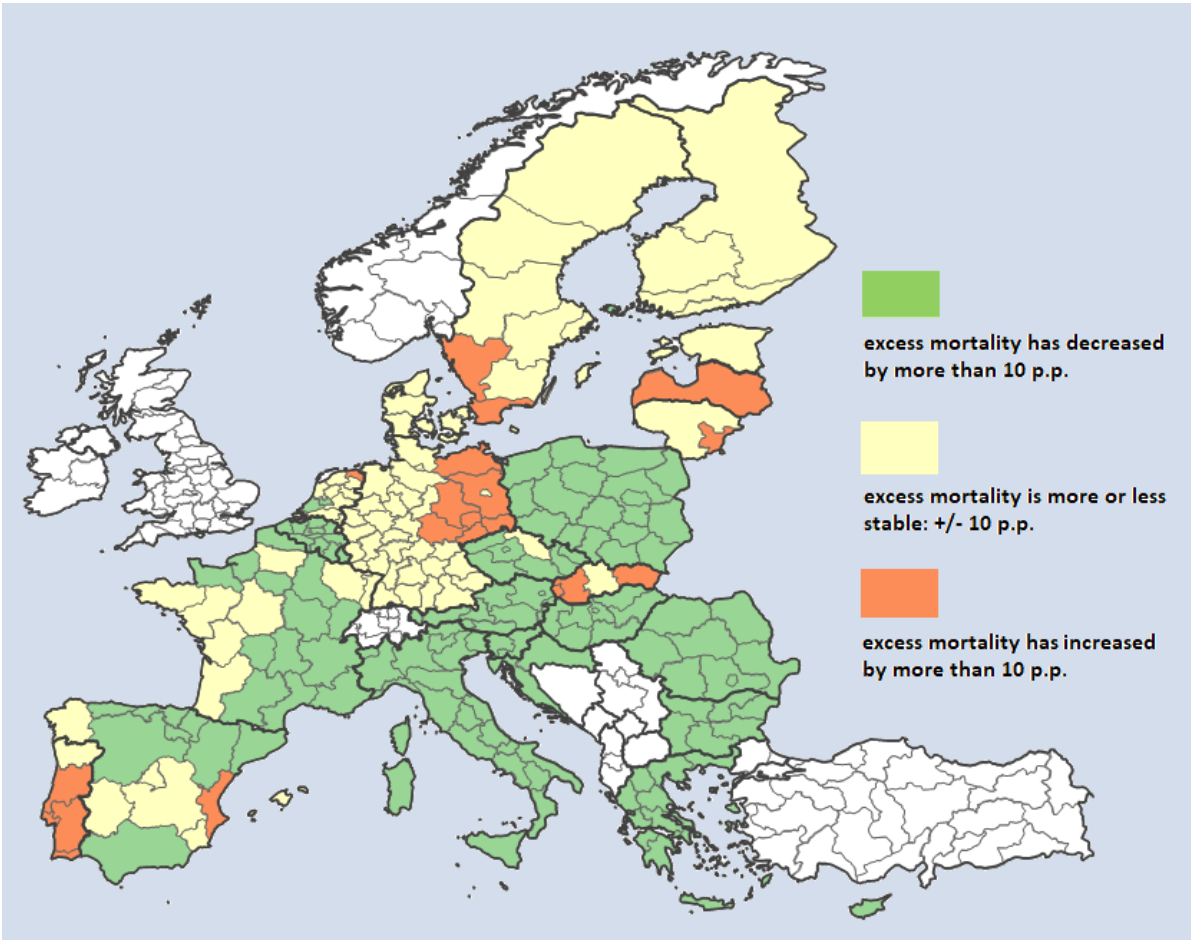

Notes: no data for IE. Data for HR and EE are at the national level. Data for DE are at NUTS1 level.
Data source: Eurostat. Map created by Progress Consulting Srl.

According to this proxy and to the working hypothesis, from wave 2 to wave 3 some regions are more resilient (green in the map) than others from the point of view of public health outcomes (orange), while a third group of regions remains more or less stable (yellow). In particular, 138 regions are categorised as more

resilient, 78 regions are categorised as stable, and 21 regions are categorised as less resilient.

There are 145 regions in the EU in which some of their area is classified as 'predominantly rural' by Eurostat: 60% of these regions are categorised as more resilient, 32% as stable and the remaining 8% as less resilient. There are 92 regions in the EU classified as 'predominantly urban' and/or 'intermediate' areas: 55% of these regions are categorised as more resilient, 34% as stable and the remaining 11% as less resilient. These proportions are represented in Figure 10.

Figure 10. Resilience of regions according to their rural level
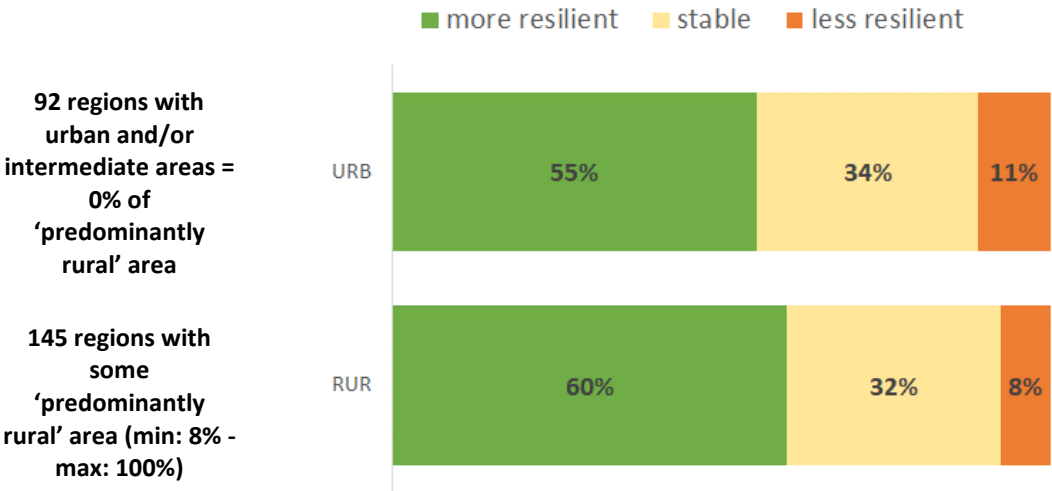
Data source: elaborated on the basis of Eurostat data.

The conclusion is that **the rural-urban dimension does not explain the resilience level of a region**.

2.2   Analysis of categories

The three categories of regions above (i.e. 'more resilient', 'stable', and 'less resilient') are analysed in this section against a set of indicators that may potentially explain differences. These indicators are identified by taking into account the concept of health system resilience defined in recent works. In particular, the 2020 report by the EU Expert Group on Health System Performance Assessment 'Assessing the resilience of health systems in Europe', the 2020 report 'Strengthening health systems resilience: key concepts and strategies' by the European Observatory on Health Systems and Policies of the World Health Organization (Thomas *et al.*, 2020) and the 2020 Eurohealth paper on COVID-19 and health system resilience: lessons going forward provide definitions and suggestions for assessment purposes.

Strategies to enhance resilience are characterised according to **four main functions of a health system: governance, financing, resources, and service delivery**. Under each function, there are key aspects to be measured and very specific indicators that may be helpful to the scope. For example, under resources, the 'existence of strategic inventory reserves for pharmaceuticals and medical devices' informs on the system's reaction capacity to unexpected health threats. This type of detailed information is not available when it comes to comparing all European regions. In fact, there is a limited availability of regional data in the health domain and even basic information such as the number of hospital beds, nurses and medical doctors is outdated and has many geographical gaps. As a consequence, **the characterisation of functions in this study can only be broad and rely on proxies. This narrows the scope of the exercise and results must be interpreted with care.**

> **Governance.** This function is usually analysed in terms of adequate and effective leadership, effective coordination, effective communication systems and flows, and surveillance capacity for the early detection of shocks and impact (Eurohealth, 2020).

Part 1 has highlighted the importance of health and crisis management in coping with the emergence of an infectious disease. There is evidence that prompt crisis management by governments (and in particular early/late adoption of containment measures and decisions on people mobility/aggregation) has impacted the exposure of regions to the COVID-19 pandemic. Regions that could learn from the lessons of other regions, in particular those of Italy and Spain, could then react in time and mitigate the impact of the first wave of the pandemic. In addition, inappropriate health management leading to the infection of health personnel and to the spread of the coronavirus disease in hospitals as well as in residences for the elderly (caused, for example, by the lack of PPE, hospitalisation of undiagnosed patients and absence of contingency plans) has increased COVID-19 transmission and infections.

From a subnational perspective, in the governance function area this study investigates if the decentralised/centralised governance of a health system has influenced the reaction capacity of a region. The proxy used is the planning and implementation responsibilities of LRAs in the management of health systems as determined in a previous study carried out in 2017 for the European Committee of the Regions (Soldi and Odone, 2017).

Decentralisation distinguishes between the planning level and the implementation level. Table 1 shows how many regions across the three categories of resilience have a decentralised/centralised management.

Table 1. Resilience vs. centralised/decentralised health management

		more resilient regions	stable regions	less resilient regions
Planning level	centralised	42%	31%	48%
	decentralised	58%	69%	52%
Implementation level	centralised	25%	24%	10%
	decentralised	**75%**	**76%**	**90%**

Evidence shows that decentralised management is the most frequent management type across the three resilience groups and that, overall, **the type of decentralised/centralised management was not determinant in making a system resilient**.

> **Financing.** This function is usually analysed in terms of sufficient funds provided to the health system, flexibility in reallocating financial resources, including for procurement purposes, and comprehensiveness and accessibility of the system (Eurohealth, 2020).

Besides the level of spending on health, this function looks at the capacity of channelling financial resources where they are most needed in case of changing needs. From a subnational perspective, this study investigates if regional health systems funded by local and regional authorities have benefitted from a higher flexibility in reallocating and using financial resources to fight the pandemic than nationally-funded health systems.

Public expenditure on health by government level is used to proxy this function. This information is only available on a country level. It is expressed as a percentage of GDP and is sourced from Eurostat. Health expenditure refers to medical products/equipment, outpatient services, hospital services, public health services, health R&D and 'other'.

Analysis of data for the three categories of regions' resilience is reported in Table 2. The group of more resilient regions is characterised by the prevalence (55%) of a mixed funding for health, from the central (national government and/or social security funds) and the subnational level (federal states and regions/municipalities). It is also noted that the majority (76%) of less resilient regions rely on central government/social security funding.

Table 2. Resilience vs. national and subnational funding of health (2019)

	more resilient regions	stable regions	less resilient regions
Prevailing central funding	36%	69%	**76%**
Mix funding	**55%**	17%	19%
Prevailing decentralised funding	9%	14%	5%

Source: elaborated on the basis of Eurostat data, table gov_10a_exp.

It may be concluded that a **shared funding responsibility of public health between governments at the national and subnational level has facilitated regions' resilience.**

> **Resources.** This function is usually analysed in terms of appropriate level and distribution of human and physical resources, ability to increase capacity, and presence of a motivated and well-supported workforce (Eurohealth, 2020).

Infrastructures and workforce are the two key indicators used to assess the level of resources available to respond to a health threat. Eurostat health data at the regional level in these two dimensions are poor. Data on hospital beds are not updated (2018, and 2017 for Germany) although their geographical coverage is good (regional data are missing only for the Netherlands). On health workforce, data have many gaps. Instead, a unique dataset on health workers expressed as a share of total workers, made available online by Eurostat as part of a special data collection exercise, is used. Although data for Germany are not available (and have been proxied by calculating a national average related to the year 2018), this dataset is interesting because it refers to the third quarter of 2020, thus when most of the health systems were under pressure.

Analysis of data for the three categories of regions is reported in Table 3. These data show that in the more resilient group, the share of better equipped regions is higher (81% for hospital beds and 80% for health workers) than in the other two groups. These results **define a minimum endowment of health infrastructures and workforce over which the resilience capability of regions increases**. This minimum endowment is found to be 320 hospital beds per 100,000 inhabitants and a health workforce of at least 4.3% of the total workforce.

According to the latest available Eurostat data, 26% of the European regions are below the threshold of 320 hospital beds per 100,000 inhabitants.

Table 3. Resilience vs. resources endowment

	threshold	more resilient regions	stable regions	less resilient regions
		share of regions which are over the threshold		
Hospital beds	320 per 100,000 inhabitants	**81%**	68%	62%
Health workers	4.3% of total workforce	**80%**	59%	60%

Notes: there are no data on health workers for Germany in 2020; a national average related to the year 2018 has been used as a proxy.

> **Service delivery.** This function is usually analysed in terms of capability to implement new care pathways and deliver services safely (Eurohealth, 2020).

The analysis of this function is made by considering two pandemic-driven healthcare needs. The first is the treatment in hospitals of patients affected by COVID-19, as ordinary hospital bed management was suddenly disrupted by the admission of people with an infectious disease. The second need derives from the necessity of treating severely affected patients in ICUs. It is well known that most of the countries and regions had to increase the number of these units in order to cope with the surge in severely affected patients. This increase was sometimes kept flexible, meaning that ICUs were organised according to needs. In other cases, the change or part of the change was structural and is likely to be maintained at least up to the end of the emergency.

There are no consolidated data available at the regional level on the number of hospital bed occupancies for COVID-19 patients. The same applies to the number of available ICUs in regions. For the scope of this study these data were collected from publicly available government sources.

For the group of the more resilient regions a relationship is found between the maximum occupancy rate of hospital beds with COVID-19 patients and the number of available ICUs per 100,000 inhabitants. This relationship is represented in Chart 4. The same relationship is not found in the groups of stable and less resilient regions.

Optimisation of the use of hospital beds, number and efficient use of ICUs, availability of intermediate care beds to adjust the flow of patients in and out of ICUs are only some of the complex aspects of hospital management. The relationship represented in Chart 4 is interpreted as the **capability of more**

resilient regions to properly manage the surge of patients, including severely affected individuals, through optimal hospital management.

Chart 4, which distinguishes urban regions (blue points) and regions with a share of predominantly rural areas (green points), indicates that there is no rural-urban divide with respect to the delivery of these COVID-19-related services.

**Chart 4. More resilient regions: COVID-19 hospital beds and ICUs**
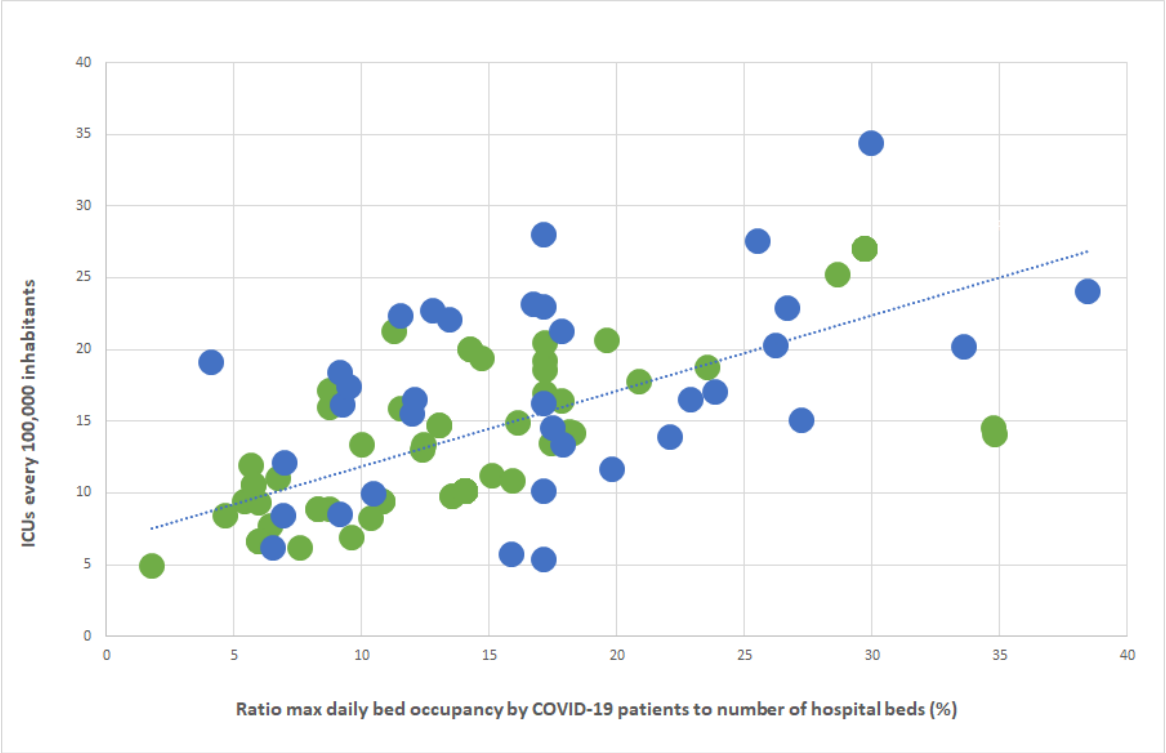
Note: blue points represent regions with urban/intermediate areas (0% of 'predominantly rural' area), green points represent regions with a share of their area classified as 'predominantly rural' by Eurostat.
Data sources: national governments' official websites.

Map 5 shows the information gathered on available ICUs across the EU in May 2021. Because of the lack of an agreed definition of 'ICU bed', data harmonisation across countries was not implemented. In addition, information was not found for several European regions. For the following countries, data are at the national level: Bulgaria, Croatia, Finland, Greece, Ireland, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia and Sweden. In other countries, data are missing (Hungary, Latvia, Lithuania, Malta). For Germany and France data are at NUTS1 level.

Available data show that the highest number of ICUs per 100,000 inhabitants are found in regions of Bulgaria, Germany and Spain. The lowest number is found in Finland. High variability characterises Italy, Spain, Belgium and Czechia.

Map 5.   ICUs per 100,000 inhabitants, by region
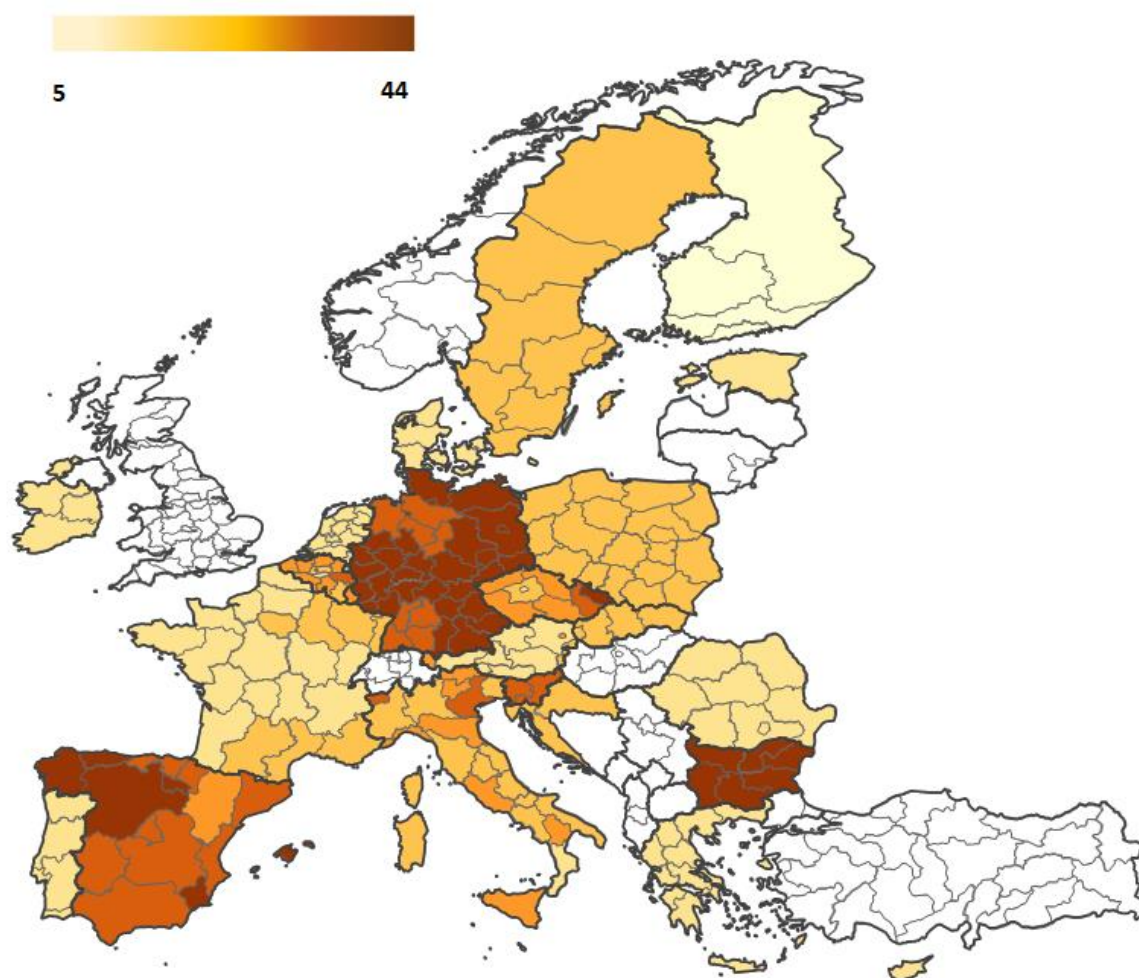
Data sources: national governments' official websites and other official sources accessed in May 2021. Map created by Progress Consulting Srl.

2.3   Conclusions on factors increasing the resilience of regions

The categorisation of regions according to their resilience level is based on the working hypothesis that a resilient health system has allowed for better public health outcomes from the second to the third wave of the coronavirus, where public health outcomes are measured in terms of excess mortality. The three identified groups of regions (more resilient, stable and less resilient) do not highlight the existence of a rural-urban divide.

In order to understand what is affecting the resilience of a region, the three identified categories have been analysed against the four main functions of a health system, namely governance, financing, resource endowment and service delivery.

Eurohealth (2020) reports that governance is the key factor for a resilient response to an emerging disease. This conclusion principally refers to the central government level which was indeed determinant, even in countries with a decentralised health system. This study does not find evidence of an optimal health system management model for responding to a crisis situation. Regions with a decentralised health system management are frequently found in all three resilience groups.

Resilience is facilitated by the injection of new financial resources or by the timely reallocation of existing funds where they are most needed. Purchasing flexibility and re-direction of funds to meet changing needs is one of the strategies outlined by Thomas *et al.* (2020) for strengthening health systems resilience. The evidence from this study highlights that a **shared responsibility for health funding between government levels has contributed to facilitating the resilience of regions**. In fact, the multi-level governance of financing is apparently the most effective way to facilitate financial flexibility and re-direction of funds in case of public health threats. Prevailing central funding and prevailing decentralised funding arrangements do not seem to be equally successful.

Another important conclusion derived on the health system function of human and physical resources is that thresholds seem to exist **above which the frequency of more resilient regions increases**. Preliminary results from this work indicate that the majority of the more resilient regions have at least 320 hospital beds per 100,000 inhabitants and at least 4.3% of their total workforce employed in the health sector.

Finally, with respect to the service delivery function of health systems, more resilient regions show a **correlation between their maximum hospital bed occupancy rate by COVID-19 patients and the number of available ICUs** for the treatment of severely affected patients. Apparently, more resilient regions are characterised by a balanced management of hospital resources for the delivery of COVID-19-related services which does not seem to exist in stable and less resilient regions. This highlights the importance of **hospital management in the response and resilience of regions, including those that are the worst hit.**

Part 3. Vaccination progress and strategies in regions

This part reports on the performance of the vaccination campaign across the EU in terms of vaccine uptake at the regional level. The focus is on highlighting differences across Member States and regions of a same country and on understanding the involvement of regions and their approaches to vaccination.

## 3.1   Progress of the vaccination campaign at the regional level

The vaccination campaign was officially started across the EU on 27-28-29 December 2020. The so called 'vaccination days' only had a symbolic meaning because on that occasion very few doses were actually distributed from the Belgian manufacturing plant of Pfizer (BioNTech) to EU Member States. The EU strategy for COVID-19 vaccines is based on the central purchase of vaccines by the EC. The EC enters into Advance Purchase Agreements (APAs) with individual producers on behalf of EU Member States (EC, 2020). The upfront costs implied by this type of agreement are funded through the Emergency Support Instrument (ESI). In line with the subsidiarity principle, **vaccination policies remain a responsibility of Member States**. Each EU country decides the types and quantities of vaccines to be purchased and the vaccination strategy.

On 19 January 2021, the Commission set the non-binding target to have 70% of the adult (aged 18+) population vaccinated against COVID-19 by the summer. Still, delayed supply and even cuts to vaccine deliveries by producers have caused an important slowdown of vaccine uptake across EU countries and regions. Another factor which has importantly disrupted vaccination strategies is the decision by some countries to suspend, stop or restrict the use of AstraZeneca and Johnson & Johnson vaccines to specific age/gender categories of people.

Map 6 and Map 7 show the status of the vaccination campaign at the regional level on June 1, 2021. Map 6 presents the share of the total population having received 1-dose. Map 7 shows the share of the total population vaccinated with 2-dose. The two maps highlight major difference across EU countries. Within individual countries, differences among regions are particularly evident in Sweden, Austria, France and Spain.

Vaccination data suggest that **there is no concentration of vaccination campaigns in urban areas**. The only exception is found in Slovakia where the capital region of Bratislava (classified as 'predominantly urban') has the highest vaccination rate of its population (22%) compared to the more rural regions of Západné, Stredné and Východné (whose vaccination rates range between 15% and 16%).

Map 6. COVID-19 vaccination at the regional level: 1-dose, 1 June 2021, % of total population
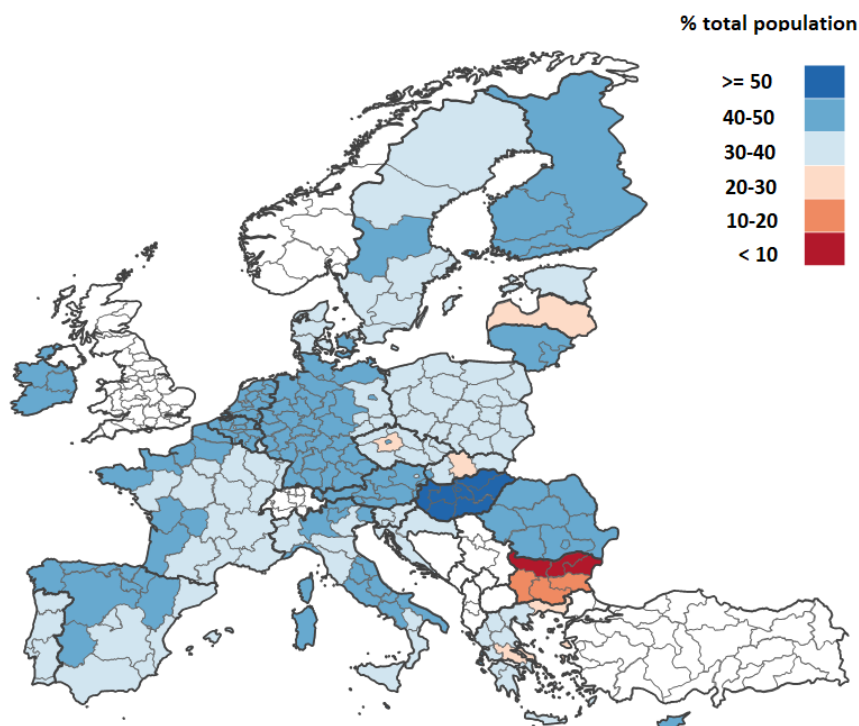

Map 7. COVID-19 vaccination at the regional level: 2-dose, 1 June 2021, % of total population
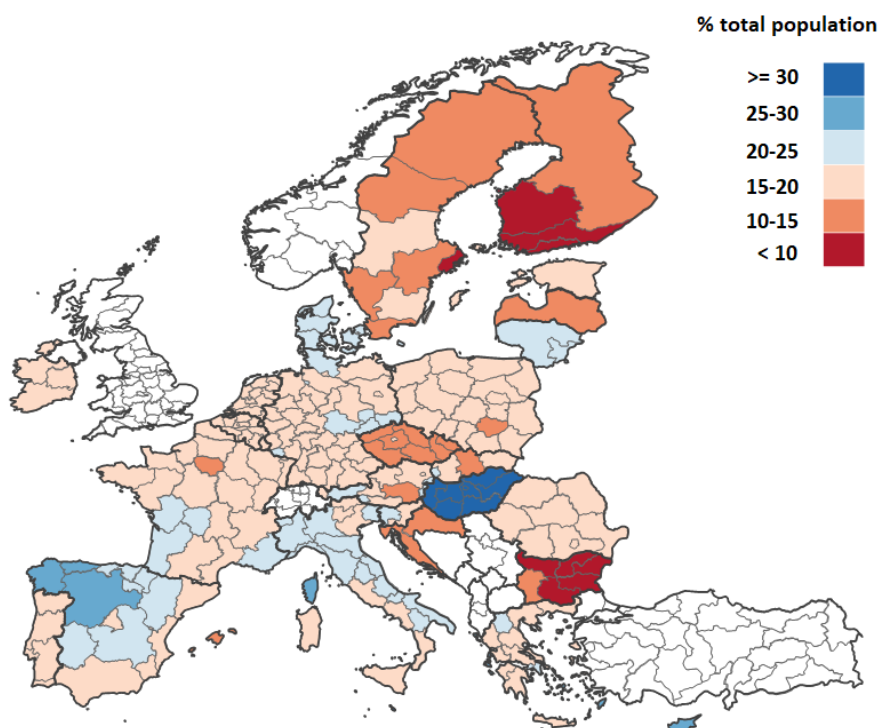
Data sources for Map 6 and Map 7: official national governments' sources with the excpetion of CY, HR, HU, IE, LT, LV, NL for which ECDC vaccine tracker data are used. For these countries, vaccination info is overestimated because ECDC calculates the share versus the population aged 18 years and over. Maps created by Progress Consulting Srl.

Rather, it appears that **several capital regions which are classified as 'predominantly urban' have the lowest vaccination rates in their respective countries**. This is the case for Brussels, Helsinki, Stockholm and Île-de-France (Paris). Madrid has also the lowest rate among the continental regions of Spain. Chart 5 compares the vaccination performance of capital regions (blue dots) with those of rural regions (i.e. classified as 100% 'predominantly rural', green dots[3]). Vaccination performance of European rural regions is not only comparable to those of capital regions, but in some cases it is also better.

Chart 5. Vaccination rollout in capital regions (blue) and rural regions (green)
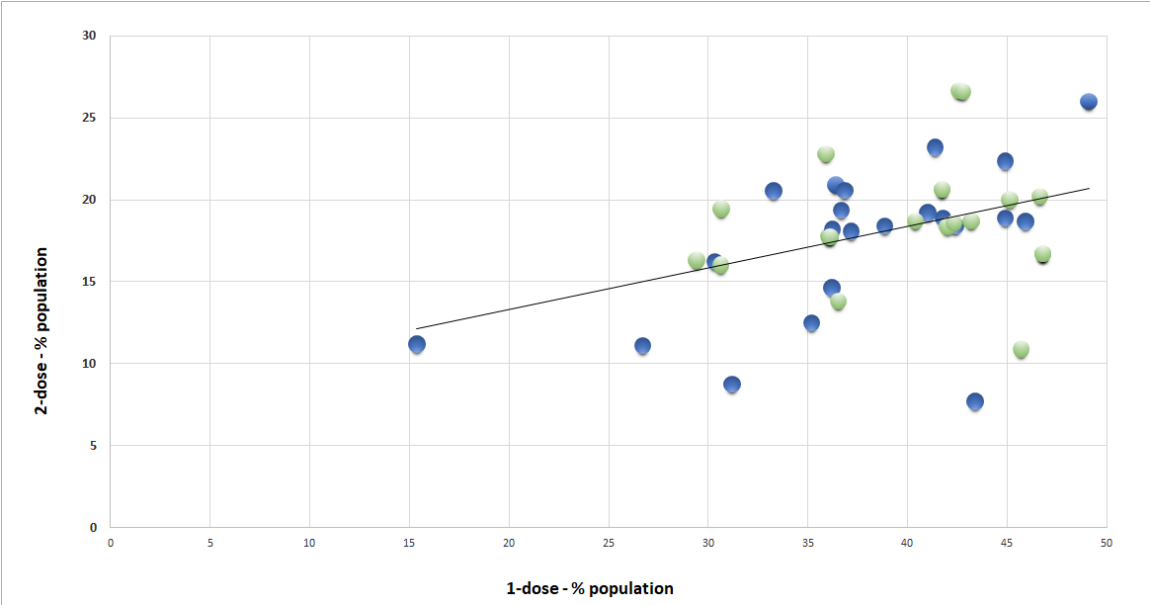
Data sources: as indicated for Map 6 and Map 7.
Note: the two outliers, Malta (for La Valletta) and Budapest, are not represented in the chart.

The vaccination campaign in the Regione Lazio, the Italian capital region, is considered successful even if the region, with 19% of its population vaccinated (2-dose) as at 1 June 2021, is not among the best EU performers. An interview with the regional councillor for health discloses how the Region developed its strategy for the vaccine rollout by learning from the successful example of other countries (Politico news dated 22/04/21). More specifically, from Israel, the Region learned the importance of setting up hubs where massive vaccination can be carried out all day long; the USA inspired the drive-in model; whereas the involvement of pharmacists was suggested by the approach used in the UK. The Region was the first in Italy to develop an app for booking. Its user-friendly information system for COVID-19 manages three different booking channels

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[3] There are 19 regions at NUTS2 level which are 100% 'predominantly rural' according to Eurostat classification.

(web, app and call centre) and involves the work of some 70-80 people, including internal staff and external collaborators (Regione Lazio news dated 27/04/21).

Figure 11 reports the best 15 performing regions in terms of share of vaccinated population (2-dose) as at 1 June 2021, and Figure 12 the least 15 performing ones at the same date. In both rankings, the rural level of the region is indicated in the column on the right.

Figure 11. Vaccination: best 15 performing regions, 1 June 2021, % of total population

	2-dose	RUR
Hungary	42,6	28
Malta	40,9	0
Principado de Asturias	27,8	0
Castilla y León	27,4	38
Ionia Nisia	26,6	100
Notio Aigaio	26,6	49
Corse	26,6	100
Cyprus	26,0	0
Galicia	25,6	58
Lithuania	23,2	14
Basilicata	23,1	65
Sjælland	23,1	89
Extremadura	23,0	0
La Rioja	23,0	0
Dytiki Makedonia	22,9	82

Figure 12. Vaccination: least 15 performing regions, 1 June 2021, % of total population

	2-dose	RUR
Guadeloupe	4,0	0
Mayotte	5,2	0
Severen tsentralen	6,9	36
Severoiztochen	7,0	19
Yuzhen tsentralen	7,1	29
Yugoiztochen	7,2	0
Severozapaden	7,4	16
Helsinki-Uusimaa	7,7	0
Guyane	8,1	0
Stockholm	8,8	0
Martinique	9,1	0
Länsi-Suomi	9,4	77
Etelä-Suomi	9,9	0
La Réunion	9,9	0
Västsverige	10,4	0

Notes: Hungary and Lithuania only have national data from the ECDC vaccine tracker.
Data sources: as indicated for Map 6 and Map 7.

The highest vaccination shares are found in Hungarian regions and in Malta. The fast rollout of the vaccination campaigns in these two countries is grounded in their governments' decisions. **Hungary** is the only EU Member State using Russian and Chinese vaccines which have not been (yet, at the time of writing) approved by the European Medicines Agency (EMA), and for which the country concluded direct contracts with the vaccines' suppliers early in 2021[4].

Malta, on the other hand, took full advantage of the centralised EU joint procurement mechanism and ordered double the quantity it would have needed to vaccinate its entire population, and from a variety of suppliers. This purchasing strategy, a good network of community health centres and the relatively easy logistics of a small country boosted the process (France24 interview to Malta

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[4] Slovakia also made an individual purchase of the Russian Sputnik V vaccine and received a batch of doses in March 2021. However, the Slovak State Institute for Drug Control has delayed the authorisation for the rollout of the Russian vaccine which at the time of writing is still being debated.

Health Minister dated 16/02/21). Other reported facilitating factors of the country-region are a limited vaccine hesitancy among the population and the fact that the government did not take suspension decisions when safety concerns were raised on AstraZeneca and Johnson & Johnson vaccines (Times of Malta news dated 11/03/21 and 16/04/21).

Finland, Latvia and Bulgaria are among the countries lagging behind. In early February 2021, **Finland** decided to apply a 12-week interval between the administration of the first and second dose of the Pfizer vaccine. This explains its relatively high vaccination rates for 1-dose and the low rates for 2-dose (other countries have decided to widen the time gap between the first and second dose). **Latvia**'s low rate of vaccination is partially due to its procurement strategy which relied massively on the AstraZeneca vaccine and allowed for little flexibility when this vaccine's use was put on hold for safety reasons. Still, the country has, by admission of its government, also faced distribution problems (BNN news dated 13/04/21). The same procurement strategy has been pursued by **Bulgaria**. This country also relied heavily on the AstraZeneca vaccine and therefore was importantly affected by its under-deliveries. In addition, vaccination is importantly slowed down by a low willingness to get vaccinated together with management and distribution problems (Politico news dated 17/05/21).

The level of hesitancy or low willingness to take the COVID-19 vaccine has been surveyed by Eurofound in February-March 2021 (Figure 13). The survey's results show that vaccination delays in Latvia and Bulgaria may indeed be justified by high levels of vaccine scepticism as the two countries are the most sceptical across the EU, according to the results of Eurofound survey.

Figure 13. Likeliness to take COVID-19 vaccine: Eurofound's survey
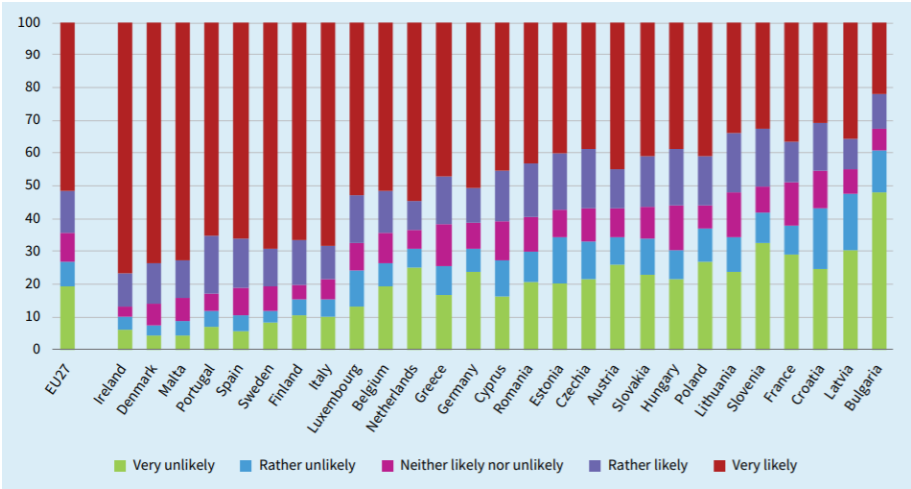
Source: chart extracted from Eurofound (2021).

Instead, still according to the survey results, delays in Finland cannot be explained with vaccine hesitancy.

3.2 Highlighting and understanding differences across regions

According to Map 7 on 2-dose vaccination, differences among regions of the same country are found in Sweden, Austria, France and Spain. In particular:

- in Sweden, Stockholm is the region with the lowest administration rate of 2-dose vaccine (9%), the highest vaccination rate being found in Norra Mellansverige (16%);
- in Austria, the lowest is in Steiermark (14%), the highest in Tirol (22%);
- in continental France, the lowest is in Île de France (15%), the highest in Corse (27%);
- in Spain, the lowest is in the Balearic Islands (13%), the highest in Asturias (28%).

In Sweden, the vaccination campaign has been defined at the national level into four phases, but its implementation is the responsibility of regions that are opening up vaccination slots differently to the various risk groups during each phase. The capital region, **Stockholm**, has experienced low demand situations. Among the possible reasons for this are limited opening hours of the vaccination centres and the possibility that digital booking is an obstacle for a share of the older population. Reuters also reports on criticisms made to the regional authority for not adapting the booking process to those who do not use digital technologies (news dated 16/04/21), as a consequence of which the regional coordinator for Stockholm was planning to send out invitation letters at least to those aged 75+ years (Expressen news dated 05/04/21). Earlier in the year, Swedish regions also reported on the lack of a national vaccination communication campaign to support their efforts (in their signed agreement, communication is a shared responsibility between the regions and the central government).

According to local media, differences in vaccination rates across Austrian regions are due to registration problems. In **Styria** (Steiermark), a relevant number of vaccinations administered by general practitioners were apparently not properly documented in the system. In **Salzburg** (16% of the population vaccinated), vaccination numbers are affected by the delay (up to 7 days) occurring between the administration of vaccines and their registration. Instead, **Wien** has vaccinated over 60,000 healthcare and school workers who were actually from Lower Austria and Burgenland and this implies discussion of compensation of doses across the different regions (Wiener Zeitung news dated 28/04/2021).

France records high scepticism levels on vaccination but the slow rollout of its vaccination campaign is due to two main political decisions: to strictly prioritise the vaccination of the elderly aged over 75 years and/or residing in nursing homes/chronic care facilities, and to limit the administration of AstraZeneca in the early months of 2021 to people aged less than 65 years (Financial Times news dated 03/03/21). Still, one of the best EU performers is found in France: **Corse**. The island has an older than average population and because of this it was well endowed with doses of the Pfizer vaccines from the start of the campaign. In addition, the vaccination of healthcare personnel gave a clear sign of trust to the population and created a snowball effect among its inhabitants. Apart from two main hubs in major cities and vaccination centres in micro-regions, twenty large-scale operations were organised to reach out to rural areas (Le Parisien news dated 04/05/21). Administration is provided by general practitioners, nurses and midwives but from as early as mid-March it was also made available in pharmacies. In **Île-de-France** the situation is different. The capital region is the youngest and most populated region of France and towards the end of March more than three-quarters of its population were still not eligible to receive a vaccination, according to the criteria set by the central government (all adult population became eligible on 31 May 2021). Other problems at that time related to the lack of large vaccination hubs (which started being opened shortly thereafter) and to the heterogeneous socio-economic conditions of the capital's departments which would have required different rollout strategies. In particular, the suburb of Seine-Saint-Denis, hardly hit by the pandemic, would have benefitted from giving priority to the vaccination of workers as most of the jobs there cannot be done in a remote modality (France24 news dated 23/03/21).

The **Principado de Asturias** takes third place in the ranking of Figure 11 with almost 28% of its population vaccinated and 49% having received the first dose as at 1 June 2021. Early in the year, the region was already mentioned as a good example in continental Spain because while it had administered its first batch of vaccines in full, Madrid, in contrast, was at 6% of its doses and Catalonia 16%. The Region's strategy was to use all available doses and not to set aside any doses for the second shot. It also started planning the logistics and coordination of its vaccination campaign very early and trained vaccination teams in advance. When vaccines arrived, the campaign rollout was immediate and based on non-stop administration with the target of exhausting all vaccines before the arrival of the next batch. The Region followed the vaccination priorities set by the central Government and began by targeting health personnel and the elderly in the most crowded residential facilities (eldiario.es news dated 07/01/21). Instead, the **Balearic Islands** still have a low share of fully vaccinated population notwithstanding the pressure on the regional government to speed up the process and the use of mobile health workers to vaccinate homebound people in villages (AP news dated 08/05/21). The island has a relatively young population (only

11% of its inhabitants are aged over 70 years) and this may have slowed down the vaccination campaign.

3.3   Understanding critical and success factors of regions' approaches

In some EU countries, regions are in charge of designing and implementing their own vaccination strategy, but even where the health management system is decentralised (e.g. Spain and Italy), a central decision-making approach for the deployment of the vaccination campaign has prevailed. Priority categories for vaccination are set centrally. Rules for the distribution of doses to regions are also set centrally. The evidence analysed in this study demonstrates that there is a certain level of flexibility at the regional level in interpreting and implementing national provisions. This flexibility has sometimes led to individual courses of action. For example, Galicia, in its regional health law, has made the refusal to receive the vaccination subject to the payment of fines; the law was objected to by the Spanish central government and while a decision is awaited from the Constitutional Court, the concerned articles of the law are temporarily suspended (RT news dated 06/04/21). In Italy, flexibility led to changes in the prioritisation of categories when the focus had to be on the vaccination of fragile populations such as the elderly. The Regione Toscana, for example, prioritised other categories such as lawyers, judges and university professors (AP news dated 03/04/21). On 9 April 2021, the Italian central government had to issue a new order obliging the use of the age criterion by all regional governments.

In some cases, deviations on distribution have been specifically authorised or sought by central governments. For example, in Austria, the government secured an additional set of doses from the EU to target a cluster of cases in the Tyrolian district of Schwaz. The German government also formalised the possibility of deviating from the agreed-upon order of eligibility in case of high-incidence areas. In France, distribution varied in order to supply more doses to the most exposed regions (ECDC, 2021a).

Overall, **it is evident that the ranking of a region is equally determined by national government's decisions and by the region's rollout strategy, if any**. Generally, national governments' decisions had a major importance in the first months of the vaccination campaign (Jan-Apr 2021) whereas regions' strategies, where available, have more influence on the implementation of the campaign from April 2021 onwards.

For example, a country's vaccine purchasing strategy has importantly influenced the vaccination campaign in its early stages. When delays or cancellation of vaccine delivery occurred, countries (and hence regions) with a diversified vaccine portfolio were less affected. Having more types of vaccines available also

helped in increasing the flexibility of administration when some vaccines were put on hold for safety reasons or removed from the vaccination programme. A second important decision made at the central level was the criterion used to distribute vaccines to regions. In some countries, distribution was based on the size of the priority categories, in others on the share of the population. In the first case, regions seem to have experienced fewer problems (e.g. Corse). Instead, regions with high shares of aged population that received their doses according to the population size criterion may have experienced temporary shortages of doses (e.g. Wien). In terms of priority groups, all central governments prioritised healthcare workers and/or fragile categories such as the elderly and people living in residential care facilities, with only a few exceptions (i.e. in Bulgaria and in Czech Republic politicians got the first doses) (Euronews update of 28/05/21).

At the regional level, decisions concern the logistics for vaccine storage, transport and distribution; the identification of vaccination places/centres and, in bigger cities/metropolis, of vaccination hubs; the training of healthcare personnel; the setup of mobile units to reach out to the most fragile; the mobilisation of general practitioners and pharmacists; and the contribution to communication campaigns. As time passes, vaccine supply is less critical and logistics are consolidated, but communication becomes increasingly important.

The ECDC reports on a survey on vaccination challenges that was carried out in March 2021. The results of the consultation among Member States accurately reflect the challenges faced by regions which were mentioned above. In fact, countries reported difficulties related to: limited vaccine supply; change in delivery time of vaccines; different characteristics of vaccines which require different logistics for storage, transport and administration of doses; effective strategies for tackling zero waste of doses; staff shortage; untrained staff; equipment shortage (e.g. syringes); difficulties in reaching out to some target groups; misinformation and disinformation about vaccination; and IT difficulties in setting up an immunisation information system and a system for vaccination booking and scheduling (ECDC, 2021).

Regional and local solutions to the above critical factors are reported in Table 4.

Table 4. **Critical factors faced by regions in the rollout of their vaccination campaign and examples of solutions**

Critical factor	Examples of response
Limited vaccine supply	Some regions did not administer all of the doses in a batch in order to keep reserves. The example of **Asturias** demonstrates the success of the opposite strategy, i.e. to use all doses as soon as they are received and preferably before the arrival of a new

	batch. Some other regions delayed the administration of the second dose of some vaccines such as Pfizer. The state-region of **Malta** placed very high orders (double the needed quantity) from a wide portfolio of suppliers and did not suffer from a scarce supply.
Change in delivery time of vaccine and suspension decisions on some vaccines	This requires flexibility in the vaccine rollout strategy.
Different characteristics of vaccines	Planning logistics (i.e. storage, transport and doses' administration) in advance is essential. **Asturias** started planning its strategy as early as November 2020.
Waste of doses	In several regions there are reserve lists for the administration of unused doses. In **Greece**, unused doses are administered to the armed forces (ECDC, 2021). In **Lazio**, people booked in the nearby dates are contacted to ask their availability to anticipate the shot with unused doses. In **Latvia**, unused doses are made available to people in the next priority group (ECDC, 2021). Unused doses in **Lithuanian municipalities** are passed on to vaccination centres in major cities ([Health System Response Monitor](#)).
Staff shortage	In **Malta**, additional staff has been hired on a temporary contract basis (ECDC, 2021). In **Lazio**, pharmacists have been involved in the vaccination campaign. In **Corse**, general practitioners are vaccinating their patients.
Untrained staff	Asturias trained vaccination teams well before the inception of the vaccination campaign. **Ireland** launched a COVID-19 vaccinator recruitment initiative centrally for both registered professions and students (HSE [news](#)).
Lack of vaccination delivery sites	**Malta** added new vaccination centres to the existing network of healthcare centres. **Regione Lazio** and **Île-de-France** established hubs for massive vaccination and drive-in vaccination arrangements. **Corse** has established hubs in its two main cities and vaccination centres in micro-regions. The **City of Sofia**, in collaboration with the Sofia Regional Health Inspectorate, has established 'green corridors', i.e. vaccination places in gardens. It has also established mobile delivery sites in shopping malls and cultural centres and a mobile vaccination bus (bnt.bg [news](#)). **Romanian cities** are running 'vaccination marathons' where vaccines are administered without prior booking, 24 hours a day for 2-3 days (Timisoara, Bucharest, Deva), as well as drive-through vaccination centres (Cluj, Arad) (rri.ro [news](#) dated 27/04/21).
Difficulties in reaching out to some target groups	**Corse** organised twenty large-scale operations to reach out to rural areas. **Stockholm** sent out letters to the older share of the population who may not be able to access digital booking. In Spanish regions, healthcare workers reached out to villages

	prevalently inhabited by fragile categories such as homebound (e.g. the **Balearic Islands**), including through the use of mobile units (Reuters [news](#) dated 19/01/21). The state-region of **Luxembourg** used mobile teams to vaccinate the elderly at their homes and in nursing homes ([Health System Response Monitor](#)). Each **Lithuanian municipality** has nominated a vaccination coordinator who is responsible for the administration of vaccines across the municipality. Mobile teams were already made compulsory at the municipal level since November 2020 to attend fragile people in their homes or in social care homes ([Health System Response Monitor](#)). In early June 2021, in **Ile-de-France**, the regional health authority asked Médecins Sans Frontières to launch a vaccination campaign for the homeless and migrants. The NGO's teams move around the region with their mobile clinics. Single-dose vaccines are used (as long as they are age-compatible) in order to reduce the problem of reaching out again to these same individuals (MSF [news](#) dated 09/06/21). Vaccination in **Greek Aegean and Ionian islands** was prioritised with the twofold scope of avoiding having to travel back and forth to each island to vaccinate the different target groups, and to prepare for the forthcoming summer tourist season (Politico [news](#) dated 22/05/21).
Difficulties in the setup of an IT system for vaccination booking and immunization monitoring	**Regione Lazio** has a COVID-platform which manages three different booking channels (web, app and call centre). The regional IT immunization system involves the work of some 70-80 people. In smaller countries like **Ireland**, the IT system was centrally set since January 2021 (the Journal.ie [news](#) dated 29/01/21).
Hesitancy, low willingness to take the vaccine, misinformation and disinformation about vaccination	Running of communication campaigns. Trusted categories of stakeholders set the example (e.g. the general practitioners in **Corse** took the vaccine before they began administering it to their patients) or are invited to set the example (e.g. in Stuttgart, the City ran a campaign to increase vaccination among healthcare providers, city's [news](#) dated 10/03/21). Provide comprehensive information on the web: 57% of the websites of **Italian regional authorities and of other public entities at the regional level** are found to provide adequate information on their home pages (PS [news](#) dated 18/05/21).

In the end, the most important factors for a vaccination campaign at the regional level to be successful include:

- Early planning and preparation for the vaccination campaign, including the logistics of storage, transport and distribution of doses.
- Training of the healthcare personnel involved.
- Using all available doses and minimising their waste by vaccinating categories which are readily available (e.g. military forces, police).

- Respecting the vaccination priorities set centrally, which for the most part implied the vaccination of the most fragile categories.
- Organising mobile units to reach difficult target groups such as the elderly, the homebound, the homeless and migrants, if appropriate by cooperating with associations of the third sector.
- Establishing mass vaccination points in urban areas.
- Implementing large-scale operations to reach out to rural areas.
- Setting up digital immunization and booking/monitoring information systems.
- Communicating, including through the use of traditional outreach means such as letters.

Part 4. Recommendations for enhancing the resilience of regional health systems

The following recommendations are drawn from the findings of the previous chapters. Recommendations 2 and 4 point to the need of having a stronger EU in the health policy domain where minimum standards for population health and health endowment of territories are set at the EU level, in line with the creation of a European Health Union. Recommendations 1, 3 and 5 highlight the importance of having the role of regions better supported in defining their exposure, in planning preparedness and response, and in building the capacity of hospitals for the optimal management of public health threats.

Recommendation 1. Exposure is site-specific: **LRAs should be supported in assessing the factors influencing the exposure of their regions** to emerging infectious diseases (EID).

The health impact caused by an EID is in the first instance determined by the exposure of a territory. Whereas building resilience may be a joint effort by several government levels, the understanding of exposure and of its determinants is ideally made at the local and regional level.

The exposure of a region depends on the region's characteristics, the majority of which are structural and not adaptable in the short or medium term. Examples include population density (which relates to social mobility), ageing population (which relates to fragility and comorbidities), transport infrastructures (which relate to connectivity and commuting) and industry aggregates (which relate to air pollution and occupational mobility). Other structural characteristics determining exposure such as health infrastructure and workforce are more flexible to changes and therefore become very relevant in building a region's resilience.

The **understanding of exposure's determinants** is key in supporting governments in taking the most strategic decisions when an emerging infectious disease occurs. Evidence collected in this study confirms the complexity of the factors involved and their diversity across regions. **Determinants of impact are site-specific** and local and regional authorities are indeed the best placed to **assess the exposure of their territories** when a disease outbreak alert is issued by the competent authorities.

Recommendation 2. Comorbidity level is the most evident exposure factor across all regions: pursuing a healthier population and filling health gaps across countries and between rural and urban areas through the **setting of minimum standards in healthcare for all EU citizens** should be prioritised by EU institutions.

There is a correlation between the comorbidity level of a population in a region and the fatality rate caused by COVID-19. This correlation is even more interesting because the comorbidity level is not necessarily linked only to population ageing (the same correlation is not found between the share of people aged 70+ years and the COVID-19 fatality rate).

This means that pursuing a healthier population represents one important way to reduce the impact of emerging infectious diseases on human lives, and on health systems.

Data show that in several EU countries the share of people having a long-standing illness or health problem is very high, often above 35%. **Population health status differences across EU countries are high and would fully justify an EU intervention in terms of setting minimum standards for a healthier population**, for example with regard to quality affordable healthcare and healthcare accessibility (distance, waiting times, cost).

In addition, **some 30% of the EU countries have an important rural-urban divide with respect to the health status of their population** and high priority should be given in these countries **to fill the health gap between rural and urban areas.**

Recommendation 3. Decentralised financing and regional health resources' endowment have the potential to increase the resilience of regions to emerging infectious diseases. **LRAs should be involved in the updating of national preparedness and response plans** and be provided with decentralised funding capacity for their implementation at the regional level, **possibly in the form of regional plans which take into account cross-border cooperation**.

Decision No 1082/2013/EU of the European Parliament and of the Council of 22 October 2013 on serious cross-border threats to health requires Member States to have preparedness and response plans in place. Starting from 2014 and repeating every three years, Member States have to update the Commission on the status of their preparedness and response planning at the national level. This planning also has to comply with the requirements of the WHO International Health Regulations (IHR). WHO IHR are legally-binding on its 196 State Parties among which are also found all EU Member States.

A WHO Review Committee on the functioning of the IHR during the COVID-19 response found that shortcomings occurred in several countries worldwide. The final findings of the WHO Review Committee published in early May 2021 (WHO, 2021) not only call for the setup of a compliance mechanism to ensure

that countries meet their obligations with respect to the IHR but also state that '*States Parties should ensure adequate and sustained financing for IHR implementation at the national and subnational levels*' (WHO, 2021).

Decision No 1082/2013/EU does not mention the territorial dimension of exposure. The EC Communication COM(2020)724 on 'Building a European Health Union' proposes a truly necessary EU audit process on national level capacities (EC, 2020a), but continues to not refer to the regional level, including when it comes to the support to improve the resilience, accessibility and effectiveness of health systems.

Still, the importance of the regional dimension emerges very clearly from the findings of this study and it is also accompanied by the evidence that a shared public health funding responsibility between governments at the national and subnational level facilitates the resilience of regions. For all these reasons, LRAs should contribute to the updating of national preparedness and response plans and be provided with financial resources for their implementation at the regional level, **eventually against regional preparedness and response plans which also take into account cross-border collaboration.**

Recommendation 4. There are inequalities in healthcare capacity across regions. It is **necessary to define a minimum endowment of infrastructure and health workforce** which facilitates resilience.

This study has highlighted the existence of a minimum regional endowment of hospital beds (320 beds per 100,000 inhabitants) and health workforce (4.3% of total workforce) over which the share of resilient regions is high (80%).

The existence of a 'minimum endowment for healthier regions' which supports resilience capability for the majority of regions in case of a cross-border health threat **should be investigated further and eventually be used to define minimum European standards for health resources.**

Recommendation 5. Health resources endowment is **optimised through correct hospital management.** Training and technology tools to support hospital preparedness at the territorial level should be made available to regions by national governments.

More resilient regions appear to have found an equilibrium between the care of COVID-19 infected patients admitted and cured in ordinary hospital beds, and the capacity to cure severely affected patients, expressed in terms of the number of available ICUs per 100,000 inhabitants. The relationship found in this study has

been interpreted as the existence of management capacities able to ensure correct hospital management.

Effective operation and management capability in case of surges caused by EID may be supported by providing decision-making tools, managing technologies (e.g. software, response systems), and innovative solutions to hospitals, as well as by facilitating capacity building and simulation exercises. These needs may be funded through the EU4Health programme, the Structural Funds and Horizon Europe.

Recommendation 6. Critical factors to vaccination rollout campaigns are similar across regions. This is an area where the exchange of experiences may very well help regional authorities in defining the best vaccination strategy according to the features of their territories. A **structured sharing of solutions used by regions to overcome critical factors should be pursued at the EU level by the European Committee of the Regions.**

Vaccination campaigns have been carried out for a long time. There is little to invent apart from the fact that nowadays these campaigns can be supported by innovation and technologies. Still, there is evidence of some good practices implemented by regions which deserve being disseminated in order to provide inspiration to other regions.

The ECDC started collecting countries' vaccination rollout experiences and periodically shares these experiences through regular reports. This reporting collects feedback from countries on difficulties faced and solutions developed. It is based on the Integrated Situational Awareness and Analysis (ISAA) report data collection process, under the Integrated Political Crisis Response Mechanism (IPCR) of the Council of the European Union. There is no similar mechanism for regions to share their experience and knowledge with other regions.

The European Committee of the Regions could fill this gap through the establishment of a platform, similar to the one developed for the sharing of experiences on COVID-19, but where reporting by regions is limited by replying to specific questions on challenges and solutions related to their vaccination rollout. This would make the sharing of experiences by regions comparable and the knowledge-sharing easily available to other regions, for example by critical factor.

Recommendation 7. The European Health Data space should **fill the gap of health data failure at the regional level** to better inform resilience and response measures of regions.

The COVID-19 crisis had the effect of initiating new data collection processes on health-related indicators at the national level. This was mainly driven by the need of national and regional governments to communicate the pandemic's development to citizens, to build trust in institutions, and to ensure the largest possible up-take of response and recovery measures.

Although delayed, some of these national data collection processes have been channelled into European mechanisms, such as The European Surveillance System (TESSy) of the ECDC or the European Crisis Management Laboratory of the JRC. Still, there are several shortcomings related to health data as Member States continue to have their own record modalities, for example on deaths and bed occupancy, and their priorities in the variables to be measured. This importantly affects comparability. From the perspective of LRAs, there is a **huge data failure** as the information made available by European institutions at the regional level is scarce. For the scope of this study, several datasets were created ad-hoc by gathering data from government websites.

In addition, it is noted that long-standing Eurostat data collection processes on health variables at the regional level are outdated (for example, hospital beds and medical doctors) and have many geographical gaps. In the digitalisation era, **it is time to modernise data collection processes and make information available when it is needed and not years later.**

The creation of a [European Health Data Space](#) **should be the opportunity to make the information and benchmarks they need available to policymakers at the subnational level in order to make the most relevant decisions.** The European Committee of the Regions should ensure that the data space will also be tailored to the needs of LRAs.

The EC Communication on 'Building a European Health Union' (EC, 2020a) calls for more detailed and timely reporting requirements for Member States on healthcare data and performance (e.g. hospital beds availability, specialised treatment and intensive care capacity, number of medically trained staff, contact tracing). As national authorities compile their data on the basis of the information they receive from their regions, **the fact that Member States are asked only to report on national level data is a missed opportunity.**

Annex I. Bibliography

Bauer, J., Brüggmann, D., Klingelhöfer, D. *et al.* (2020), *Access to intensive care in 14 European countries: a spatial analysis of intensive care need and capacity in the light of COVID-19*, 'Intensive Care Med' **46,** 2026–2034 (2020). https://doi.org/10.1007/s00134-020-06229-6

Cacciarru, A. and Paesano, A. (2020), *Explanations for the Uneven Impact of COVID-19 in North and South Italy*, *EuropeNow* Daily, September 8, 2020. Accessed April 21, 2021. https://www.europenowjournal.org/2020/09/08/explanations-for-the-uneven-impact-of-covid-19-in-north-and-south-italy/

European Centre for Disease Prevention and Control (2021), *Rollout of COVID-19 vaccines in the EU/EEA: challenges and good practice*, Technical Report, 29 March 2021 https://www.ecdc.europa.eu/sites/default/files/documents/Rollout-of-COVID-19-vaccinations-in-the-EU-EEA-challenges-good-practice-errata.pdf

European Centre for Disease Prevention and Control (2021a), *Overview of the implementation of COVID-19 vaccination strategies and deployment plans in the EU/EEA*, Technical report, 14 June 2021. https://www.ecdc.europa.eu/sites/default/files/documents/Overview-of-the-implementation-of-COVID-19-vaccination-strategies-and-deployment-plans-14-June-2021.pdf

European Commission (2020), Communication from the Commission, *EU Strategy for COVID-19 vaccines*, COM(2020) 245 final, Brussels, 17.6.2020. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1597339415327&uri=CELEX:52020DC0245

European Commission (2020a), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *Building a European Health Union: Reinforcing the EU's resilience for cross-border health threats*, COM(2020) 724 final, Brussels, 11.11.2020. https://ec.europa.eu/info/sites/default/files/communication-european-health-union-resilience_en.pdf

Eurofound (2021), *Living, working and COVID-19 (Update April 2021): Mental health and trust decline across EU as pandemic enters another year*, authors: Daphne Ahrendt, D., Mascherini, M., Nivakoski, S., Sándored E., published 10 May 2021 https://www.eurofound.europa.eu/publications/report/2021/living-working-and-covid-19-update-april-2021-mental-health-and-trust-decline-across-eu-as-pandemic

Eurohealth (2020), *COVID-19 and health system resilience: lessons going forward*, 26(2). https://apps.who.int/iris/bitstream/handle/10665/336290/Eurohealth-26-2-20-24-eng.pdf

European Parliament (2021), *Air pollution and COVID-19*, Policy Department for Economic, Scientific and Quality of Life Policies Directorate-General for Internal Policies, Author: Bert BRUNEKREEF *et al.*, PE 658.216 - January 2021. https://www.europarl.europa.eu/RegData/etudes/STUD/2021/658216/IPOL_STU(2021)658216_EN.pdf

Kowalski, P.A., Szwagrzyk, M., Kiełpinska, J., Konior A. and Kusy, M. (2021), *Numerical analysis of factors, pace and intensity of the corona virus (COVID-19) epidemic in Poland*, Ecological Informatics, 2021, 101284, ISSN 1574-9541, https://doi.org/10.1016/j.ecoinf.2021.101284. https://www.sciencedirect.com/science/article/pii/S1574954121000753

Rangachev, A., Marinov, G.K. and Mladenov, M. (2020), *The demographic and geographic impact of the COVID pandemic in Bulgaria and Eastern Europe in 2020*, medRxiv 2021.04.06.21254958, doi: https://doi.org/10.1101/2021.04.06.21254958. Made available under a CC-BY-NC-ND 4.0 International license.

Rosillo, N., del-Águila-Mejía, J., Rojas-Benedicto, A., Guerrero-Vadillo M., Peñuelas, M., Mazagatos, C., Segú-Tell, J., Ramis, R. and Gómez-Barroso D. (2021), *Real Time Surveillance of COVID-19 Space and Time Clusters During the Summer 2020 in Spain,* Research, Version 1, Posted 11 Jan, 2021.
https://www.researchsquare.com/article/rs-141409/v1

Soldi, R. and Odone, C. (2017), *The management of health systems in the EU Member States The role of local and regional authorities*, European Committee of the Regions, Commission for Natural Resources
https://cor.europa.eu/en/engage/studies/Documents/management-health-systems.pdf

Soldi, R. (2020), *Regional health policy responses to the COVID crisis*, European Committee of the Regions, Commission for Natural Resources
https://cor.europa.eu/en/engage/studies/Documents/Regional%20Health%20Policy_Covid.pdf

Thomas, S., Sagan, A., Larkin, J., Cylus, J., Figueras, J. and Karanikolos, M. (2020), *Strengthening health systems resilience: key concepts and strategies*, Policy Brief 26, Copenhagen: European Observatory on Health Systems and Policies, 2020.
https://apps.who.int/iris/bitstream/handle/10665/332441/Policy-brief%2036-1997-8073-eng.pdf?sequence=1&isAllowed=y

Verwimp, P. (2020), *The Spread of COVID-19 in Belgium: a Municipality-Level Analysis*, Working Papers ECARES 2020-25, ULB - Universite Libre de Bruxelles.
https://ideas.repec.org/p/eca/wpaper/2013-309398.html

World Health Organization (2021), *WHO's work in health emergencies - Strengthening preparedness for health emergencies: implementation of the International Health Regulations (2005)*, Seventy-fourth World Health Assembly A74/9 Add.1, Provisional agenda item 17.3, 5 May 2021.
https://cdn.who.int/media/docs/default-source/documents/emergencies/a74_9add1-en.pdf?sfvrsn=d5d22fdf_1&download=true

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