Maurizio Indirli
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An analysis of Italian resilience during COVID-19 pandemic: first phase from January to June 2020

Il Sileno Edizioni

Open Access
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Geographies of the Anthropocene

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is a monographic volume of the Open Access and peer-reviewed series
"Geographies of the Anthropocene"
(Il Sileno Edizioni), ISSN 2611-3171.

www.ilsileno.it/geographiesoftheanthropocene/

Cover: Image by iXimus (2020, Pixabay)

Scientific and Cultural Association "Il Sileno", VAT number: 03716380781.
Via Piave, 3/A, 87035 - Lago (CS), Italy, e-mail: ilsilenoedizioni@gmail.com

ISBN 979-12-80064-21-9
September 2021
(First Edition)

ISSN 2611-3171

Geographies of the Anthropocene

Open Access and Peer-Reviewed series

Website: www.ilsileno.it/geographiesoftheanthropocene;

The book series "Geographies of the Anthropocene" edited by Association for Scientific Promotion "Il Sileno" (Il Sileno Edizioni) will discuss the new processes of the Anthropocene epoch through the various worldviews of geoscientists and humanists, intersecting disciplines of Geosciences, Geography, Geoethics, Philosophy, Socio-Anthropology, Sociology of Environment and Territory, Psychology, Economics, Environmental Humanities and cognate disciplines.

Geoethics focuses on how scientists (natural and social), arts and humanities scholars working in tandem can become more aware of their ethical responsibilities to guide society on matters related to public safety in the face of natural hazards, sustainable use of resources, climate change and protection of the environment. Furthermore, the integrated and multiple perspectives of the Environmental Humanities, can help to more fully understand the cultures of, and the cultures which frame the Anthropocene. Indeed, the focus of Geoethics and Environmental Humanities research, that is, the analysis of the way humans think and act for the purpose of advising and suggesting appropriate behaviors where human activities interact with the geosphere, is dialectically linked to the complex concept of Anthropocene.

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Abstract

This work adopts the concept of resilience and its attributes (*safety*, *robustness*, *adaptive capacity*, *sustainability*, *governance*, and *anamnesis*) developed in a previous work (Indirli, 2019) to analyze the COVID-19 pandemic, with specific reference to Italy during the first phase, from January to June 2020. The aim is at assess the main features of this pandemic and suggesting a suitable tool to evaluate the capability of the Italian system to manage such catastrophe. Before discussing the Italian situation, a general overview about the current COVID-19 outbreak is presented, with special focus on selected countries worldwide, which adopted different intervention strategies such as exclusion, elimination, suppression, mitigation, and no substantive strategy.

With regard to Italy, an in-depth overview of the first COVID-19 phase (January - June 2020) is provided, together with detailed original lethality studies *ad hoc* developed. The evaluation of the resilience's attributes is based on index values ranging from 1 to 5, using the Likert scale. A Global Resilience Index (GRI), suitable to provide a sense of direction (built or reduced resilience) is calculated, resulting for Italy 2.50, i.e. between poor (2.0) and medium (3.0), but far from very good (5.0). The pointed-out unpreparedness (a non-updated pandemic plan, almost forgotten before the COVID-19 crisis), inexperience (the absence of serious outbreaks in recent years), and inadequate timing (delayed decisions between February and March 2020) are discussed as main sources of such low resilience score. The Italian approach (as many other Western countries) shifted from denial to normalization of the risk, under-reaction, and finally to recognition and reframing. Worth stressing, healthcare system's response, analyzed under *safety* and *robustness*, resulted weak especially at the outbreak beginning due to institutional International and National drawbacks and intrinsic vulnerability aggravated over time, despite the commendable efforts of the entire personnel. Furthermore, *anamnesis* and *sustainability* resulted dramatically low, while *adaptive capacity* and *governance* resulted a little bit better, mainly due to the lockdown phase and people's behavior during the confinement.

In conclusion, the Italian performance against COVID-19 represents an example of "*un-resilience*", i.e. a situation where *emergency-after-disaster* replaces *prevention-before-disaster*, as already shown in the case of other important hazards, such earthquakes, for example. This lack of resilience is therefore a tragedy itself, considering the fact that big crises are hitting the whole world more and more frequently and hardly, intermingling political, economic, social, technological, regulatory, and environmental issues. In this context, the COVID-19 pandemic is impacting every aspect of the human and the planet existence, not only peoples' health and wellbeing.

This pandemic is also calling into question some assumptions of the democratic societies. We wish that COVID-19 pandemic would be a lesson able to push governments and citizens to be better prepared against possible emergencies of the

future, many of which related to climate changes. A proactive action from public health agencies is urgent to protect populations, adopting a sustainable behavior in time of global warming and COVID-19 pandemic in all the human activities. Humanity has short time to operate effective choices and COVID-19 has been a hard test.

Indeed, in our analysis comes again the fork (Indirli, 2019) between 'engineering resilience' (*homeostatic*) and 'ecological resilience' (*autopoietic*) described at the starting point of this paper: will the humanity be able to govern the next changes or shall withstand a new mass extinction, leading to a drastic collapse of the Earth biodiversity? Our analysis focused on the pandemic outbreak that is still ongoing, not yet resolved and expected to be long and complex. Therefore, it is not yet possible to provide decisive answers to this question. However, we believe we have identified a useful tool to evaluate the system's resilience to the present crisis and be prepared for possible future ones. It will be interesting to apply our methodology to the subsequent COVID-19 pandemic phases, to evaluate the effectiveness of the measures adopted, including the impact of the vaccination campaign.

Keywords

Resilience, COVID19 pandemic, SARS-CoV-2 pandemic, multi-hazard scenarios, multilevel networks, socio-ecological and sustainability systems, risk management.

1. Introduction

Nowadays the concept of resilience is largely adopted by scientists of several disciplines and often by representatives of public or private organizations in the field of disaster/risk assessment, mitigation, sustainability, and adaptive capacity to cope with catastrophic multi-hazard scenarios. Resilience, however, is frequently used with increasing ambiguity about its properties and attributes. The term comes from the Latin classic culture (rĕsĭlīre: the act of rebounding, i.e. to rebound/recoil, from "re-" back + "salire" to jump, leap). Several meanings and definitions of resilience have been proposed, according to the various disciplines. Medicine, psychology and social sciences contributed to analyze individual and collective shocks or stresses, driving to the resilience definition as the intrinsic capacity of a person, system, community or society to adapt and survive (for a detailed discussion see Indirli, 2019; and references therein). In addition, two views are particularly challenging, however conflicting. The first, the 'engineering resilience', has been used to describe by quantitative means (i.e. with formulae) the behavior of structures and materials in engineering, for instance during a mechanical stress; later, the concept broadened to the measure of an infrastructure's seismic resilience under a hazardous event. Oscillations around the initial steady state, and elasticity properties to 'bounce-back', are crucial features of this *homeostatic* approach. The second, the 'ecological resilience', has been used to describe the ability of natural systems to absorb changes, for instance the species persistence or probability of extinction. This approach (neither deterministic nor quantitative) points out the adaptive capability to challenge 'irreversible shifts' towards a new equilibrium, evolutionary and 'ductile' as *autopoietic* (again Indirli, 2019; and references therein). If embraced without rigidity, both these views - going back to a previous state versus adapting to new scenarios - can be useful to study complex phenomena where natural and anthropogenic hazards are combined, such as global warming as well as epidemics/pandemics.

Infectious disease pandemics are excellent examples of complex catastrophic events on a global scale. They are characterized by some epidemiologic features, such as: wide geographic extension, disease movement, high attack rates and explosiveness, minimal population immunity, novelty, infectiousness, contagiousness and severity (Morens et al., 2009). The stochastic nature of pandemic outbreaks and the lack of experience in the case of novelty, make it problematic to prevent and manage the range of possible outcomes and the specific steps that should be taken to reduce the catastrophic risks. Worth stressing, the intermingling of biological with social occurrences (public safety and health policies, economy, national security, democracy and ethics) requires to manage pandemics with a multidisciplinary approach and the capability to dissect the many components of the issue. The recent spread of coronavirus disease 2019 (COVID-19), caused by the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has reached the necessary epidemiological criteria to be declared a pandemic (Callaway, 2020).

In this paper, in the light of the resilience approaches above mentioned, we aim at analyzing the current COVID-19 disease with specific reference to Italy during the first phase, January - June 2020, to portray such pandemic and suggest tools for managing its mitigation. Within this framework, we question if the crisis caused by the novel coronavirus can be regarded: as an elastic oscillation around an already established way of living capable to go back to its identity; or as an irreversible shift towards an unknown future carrier of new threats and challenges for the whole planet. We've chosen to adopt a qualitative analysis combined with a prompt quantitative valuation, with particular regard to statistics reports and diagrams, with an overall philosophical meditation on the Anthropocene destiny. To accomplish our analysis, we adapt to the case of COVID-19 pandemic the grid of resilience's attributes previously elaborated for describing natural/human-made disasters across climate/social changes (Indirli, 2019), namely: *safety*, *robustness*, *adaptive capacity*, *sustainability*, *governance* and *anamnesis*, as shown in Table 1.

Table 1: Attributes for a pluralistic but holistic view of resilience for COVID-19.

attributes	description	focus
safety	*protection of human life from COVID-19 pandemic*	*guidelines and protocols*
robustness	*adequacy of the healthcare system, state-of-the-art of scientific knowledge*	*medical welfare and personnel, science and research*
adaptive capacity	*ability to respond to pandemic spread, lockdown and subsequent phases, return to stability or irreversible changes*	*individuals, social groups and professional skills*
sustainability	*links to the environment*	*virus and pollution, sudden environmental changes*
governance	*emergency management, effectiveness of political decisions, reliability of scientific community, consensus versus conflict, democracy versus control, communication*	*risk management, social-cultural response*
anamnesis	*individual and collective memory of pandemics*	*preservation of experience, loss of elder groups*

In order to evaluate the resilience's attributes of the Italian system during the COVID-19 pandemic first phase (January - June 2020) as presented in the Table 1, we used the Likert scale, where the index values, ranging from 1 to 5, are defined in Table 2. The respective scores will be displayed at the end of each related Section further ahead. The Global Resilience Index (GRI), suitable to provide a sense of direction (built or reduced resilience in Italy), is given by the weighted average of equation (1); GRI will be calculated and discussed in Section 7.

Table 2: Definitions and indices of the values of COVID-19 resilience's attributes.

	very poor	**poor**	**medium**	**good**	**very good**
	x=1	**x=2**	**x=3**	**x=4**	**x=5**
values of the six resilience's attributes: *safety, robustness, adaptive capacity, sustainability, governance, anamnesis.*	Absence of stability; the system cannot undergo the requested amount of change, shifting towards a much worsened scenario.	Lack of stability; the system shows few points of resistance against the disaster, with serious outcomes and heavy damages.	Average stability; the systems shows some relevant weakness points and saturation levels, but the main functions are still ensured.	Good stability; the system works generally well, but it reveals some delimited discrepancies if under heavy pressure.	High stability; the system withstands well an extreme event, with small oscillations around the initial state, with a quick 'bouncing-back' recovery.
	Failure of preparedness to cope with catastrophes.	Lack of preparedness to cope with catastrophes.	Average preparedness to cope with catastrophes.	Good preparedness to cope with catastrophes.	High preparedness to cope with catastrophes.

$$\text{GRI} = \frac{w_1x_1+w_2x_2+w_3x_3+w_4x_4+w_5x_5+w_6x_6}{w_1+w_2+w_3+w_4+w_5+w_6} = \frac{x_1+x_2+x_3+x_4+x_5+x_6}{6} \quad (1)$$

w_i weights of the six resilience's attributes, with w_i all taken equal to 1;
x_i values ranging from 1 to 5.

After the introduction (Section 1), before reporting our analysis to the Italian case, we provide a necessary overview of the origin of the pandemic and its spread on the basis of the literature (Section 2). Then, we focus on the effects of the pandemic in some countries selected as paradigmatic worldwide (Section 3). Finally, we examine in-depth the Italian situation during the COVID-19 pandemic first phase (January - June 2020). After a general overview on the Italian case (Section 4), we propose our original study on the virus lethality in our country (Section 5). We then address the analysis of the above described resilience attributes (Section 6), providing the calculation of the GRI overall score (Section 7). The concluding remarks are reported in Section 8.

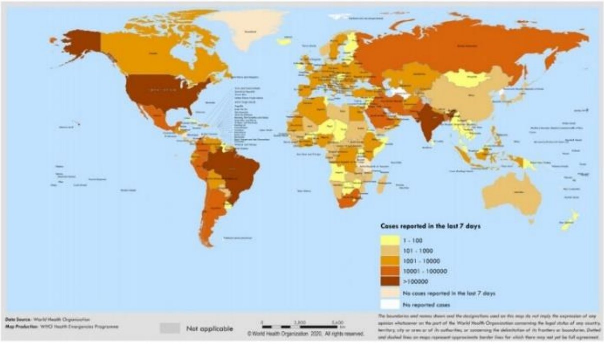
2. A new virus is spreading around the world

Coronaviruses are enveloped, positive-sense, single-stranded RNA viruses (27-32 kb genome length) belonging to the

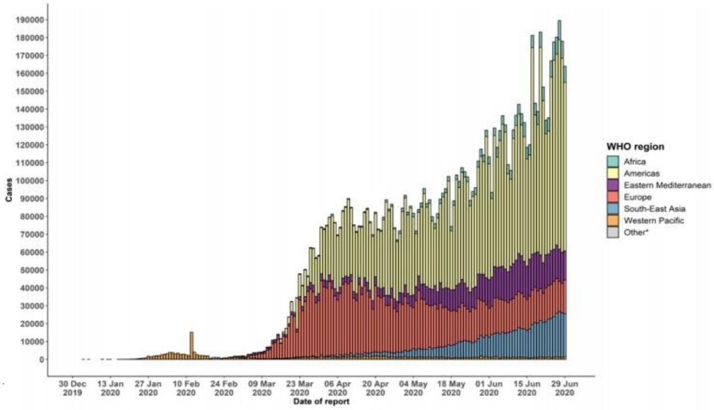
Nidovirales order, *Coronaviridae* family, *Orthocoronaviridae* sub-family, which cause infection in the respiratory and intestinal tracts. *Orthocoronaviridae* are classified into four genera, namely alpha, beta, gamma, and delta coronavirus. The first two genera infect the mammals, and the latter two the birds. To date, seven coronavirus species have been identified as human pathogens, namely *HCoV-229*, *HCoV-NL63*, *HCoV-HKU1*, *Betacoronavirus1* (with the sub-genera *HCoV-OC43*), *SARS-CoV*, *MERS-CoV*, as well as the 2019 novel coronavirus *SARS-CoV-2*. According to phylogenetic analysis, SARS-CoV-2 virus is located in the *Betacoronavirus* genus (Assadi et al., 2020, and references therein: Nguyen et al., 2020; Wu A. et al., 2020; Sahin et al., 2020; Lai et al., 2020; ECDC, 2021).

On 30 December 2019, Dr. Li Wenliang, oculist at the Wuhan Central Hospital (Hubei Province, China), sounded the alarm about a cluster of pneumonia cases of unknown aetiology, resistant to conventional medical treatments. He recognized the disease being ‘SARS coronavirus’, as reported by Dr. Ai Fen, director of the emergency room of that facility. The possible outbreak was located at the Huanan fish market, because two-thirds of the initial 41 hospitalized cases had frequented the place (Li Q. et al., 2020; Guan et al., 2020; Chan et al., 2020). Some days later (January 3, 2020), Li Wenliang was summoned, warned, and relieved by the local police, due to spreading of false news on social networks. Back to work, he was infected by a patient and died on February 7, 2020 (Zhou, 2020; see also Fang, 2020).

On 9 January 2020, the Chinese Center for Disease Control and Prevention (China CDC) reported the novel coronavirus, named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2, formerly 2019-nCoV), which is phylogenetically in the SARS-CoV clade (Čivljak et al, 2020), as the causative agent of this outbreak, named COVID-19 disease[1]. It causes severe respiratory tract infection and is highly contagious; the transmission route is mostly through close contact, respiratory droplets, and persistence of the virus on inanimate surfaces (Huang et al., 2020; Zhu et al., 2020). After several WHO (World Health Organization) initiatives, on January 12, China made available the virus full genetic sequence (WHO, 2020a). Only on January 20, China's central government sent to Wuhan the country's most accredited epidemiologist Zhong Nanshan to evaluate the tragic consequences of the rising pandemic, since it was covered by the local officials in spite of the seriousness of the outbreak. Then, the national government reacted in force and, three day after, Wuhan was locked down (Pérez-Peña and McNeil Jr, 2020). A WHO-China Joint Mission (16-24 February 2020; WHO, 2020b) on Coronavirus Disease 2019 produced a report, in order to enhance understanding of the evolving situation, share knowledge, generate recommendations, and establish priorities for a collaborative programme. After a first inconclusive meeting of the WHO Emergency Committee (January 22-23; WHO, 2020c), only in the subsequent one (January 30; WHO, 2020d) WHO declared the SARS-CoV-2 outbreak to be a PHEIC (public health emergency of international concern). The WHO Director General defined SARS-CoV-2 a global pandemic 12 days after (March 11; WHO, 2020e). A third meeting took place on 30 April 2020 (WHO, 2020f). By the end of February 2020, several countries were experiencing local transmission, including Europe (European Centre for Disease Prevention and Control; ECDC, 2020a-n). The situation of the disease spread (until 30 June 2020) is depicted in Figure 1 (WHO, 2020g).



by country, territory or area



by date of report and WHO region

Figure 1: Number of confirmed COVID-19 cases, WHO (2020g) report, from December 30 through June 30, 2020.

During the last 40 years, numerous zoonotic diseases have emerged, e.g. HIV, Lyme disease, bovine spongiform encephalopathy (BSE), avian influenzas, Nipah virus, West Nile virus, Sudden Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS), Zika, Ebola and latest the pandemic SARS-CoV-2 coronavirus (Holm, 2020). SARS-CoV-2 genome is closest to that of SARS-related coronaviruses from horseshoe bats (Li W., Shi Z. et al., 2005), and its receptor-binding domain is closest to that of pangolin viruses (Andersen et al., 2020). Its origin and direct ancestral viruses are still under identification. Having some of the early case-patients visited the Huanan Seafood Wholesale Market (Wuhan), where wildlife mammals are sold, a zoonotic origin of this virus is suggested (Lau et al., 2020). According to some literature, the inextricable links between human societies and nature, food, and health (Volpato et al., 2020), as well as the coexistence of archaic habits with a wireless globalization created the favorable context for the virus spread. This short circuit is the amazing recurring contradiction between nature and civilization. Other studies suggested that the SARS-CoV-2 virus was originated/escaped in the course of research in the laboratories of the Wuhan Virology Institute (working jointly with a majority team from the University of North Carolina at Chapel Hill, USA) and then released accidentally, although lead scientist Shi Zhengli ferociously denied that possible escapee (Sørensen et al., 2020; Yan et al., 2020). Whatever the origin, seventeen years after the severe acute respiratory syndrome-SARS, a novel pandemic hit China again as well as the whole world.

3. An overview of the COVID-19 pandemic in selected crucial countries worldwide

3.1 Foreword

The COVID-19 pandemic struck in a quite different way the world's countries, depending on a number of factors, including geographical, political/societal differences, fighting strategies, changes in behavior habits, and so on. Table 3 and Figure 2 give some figures about the maximum deaths per 100,000 inhabitants (related to population amount, state surface, population density) for six sets of nations with a democratic system: a) Pacific Region; b) Central Europe Region; c) North Europe/Scandinavian Region; d) North America/UK Region; e) South America Region; f) Latin/Mediterranean Europe Region. Furthermore, the various strategies implemented to fight the infection are shown in Table 4 (Baker et al., 2020d; Anderson et al., 2020).

Table 3: Population, surface, density, and maximum total deaths per 100000 inhabitants from January 1 to June 30 in various countries (with different scales; elaboration from: WHO, 2020m).

COUNTRY	POPULATION	SURFACE [km²]	DENSITY [people/km²]	max deaths per 100,000 inhabitants
a) Pacific Region				
Japan	126,476,461	377,915	334.67	0.77
South Korea	51,269,185	100,210	511.62	0.55
New Zealand	5,002,100	268,021	18.66	0.48
Australia	25,499,884	7,692,000	3.32	0.42
b) Central Europe Region				
Switzerland	8,654,622	41,285	209.63	19.42
Germany	83,783,942	357,386	234.44	10.71
Austria	9,006,398	83,879	107.37	7.81
Czechia	10,708,981	78,866	135.79	3.25
Slovakia	5,459,642	49,035	111.34	0.51
c) North Europe/Scandinavian Region				
Sweden	10,099,265	450,295	22.43	54.22
Denmark	5,792,202	42,933	134.91	10.65
Finland	5,540,720	338,440	16.32	5.88
Norway	5,421,241	385,207	14.70	4.59
d) North America/UK Region				
United Kingdom	67,886,011	242,495	279.95	59.42
USA	331,002,651	9,826,675	33.68	38.44
Canada	37,742,154	9,985,000	3.78	22.58
Mexico	128,932,753	1,964,375	65.64	20.67
e) South America Region				
Chile	19,116,201	756,950	25.25	29.16
Peru	32,971,854	1,285,000	25.66	28.26
Brazil	212,559,417	8,516,000	24.96	27.11
Argentina	45,195,774	2,780,000	16.26	2.75
f) Latin/Mediterranean Europe Region				
Spain	46,754,778	505,990	92.40	63.57
Italy	60,461,826	301,340	200.64	57.57
France	65,273,511	643,801	101.39	45.55
Portugal	10,196,709	92,212	110.58	15.38
Greece	10,423,054	131,957	78.99	1.83

3.2 Japan, South Korea, New Zealand and Australia

Nevertheless high differences in population density (Table 3) among Japan/South Korea and Australia/New Zealand are evident, the COVID-19 epidemiological impact has been relatively moderate in these four countries selected for the Pacific Region (Figure 2a), where the disease has been rather easily fought in most of the Pacific Island countries and territories with an exclusion strategy (Table 4). In general, they showed effective preparedness and response to the pandemic, resulting in a lower number of cases/deaths compared to those recorded in Western countries.

The Japanese paradox speaks about limited fatality (0.77 deaths per 100,000 inhabitants; see Table 3 and Figure 2a) despite loose restriction, i.e. a very specific *mitigation*[9,11] strategy (Table 4; see Anderson et al., 2020).

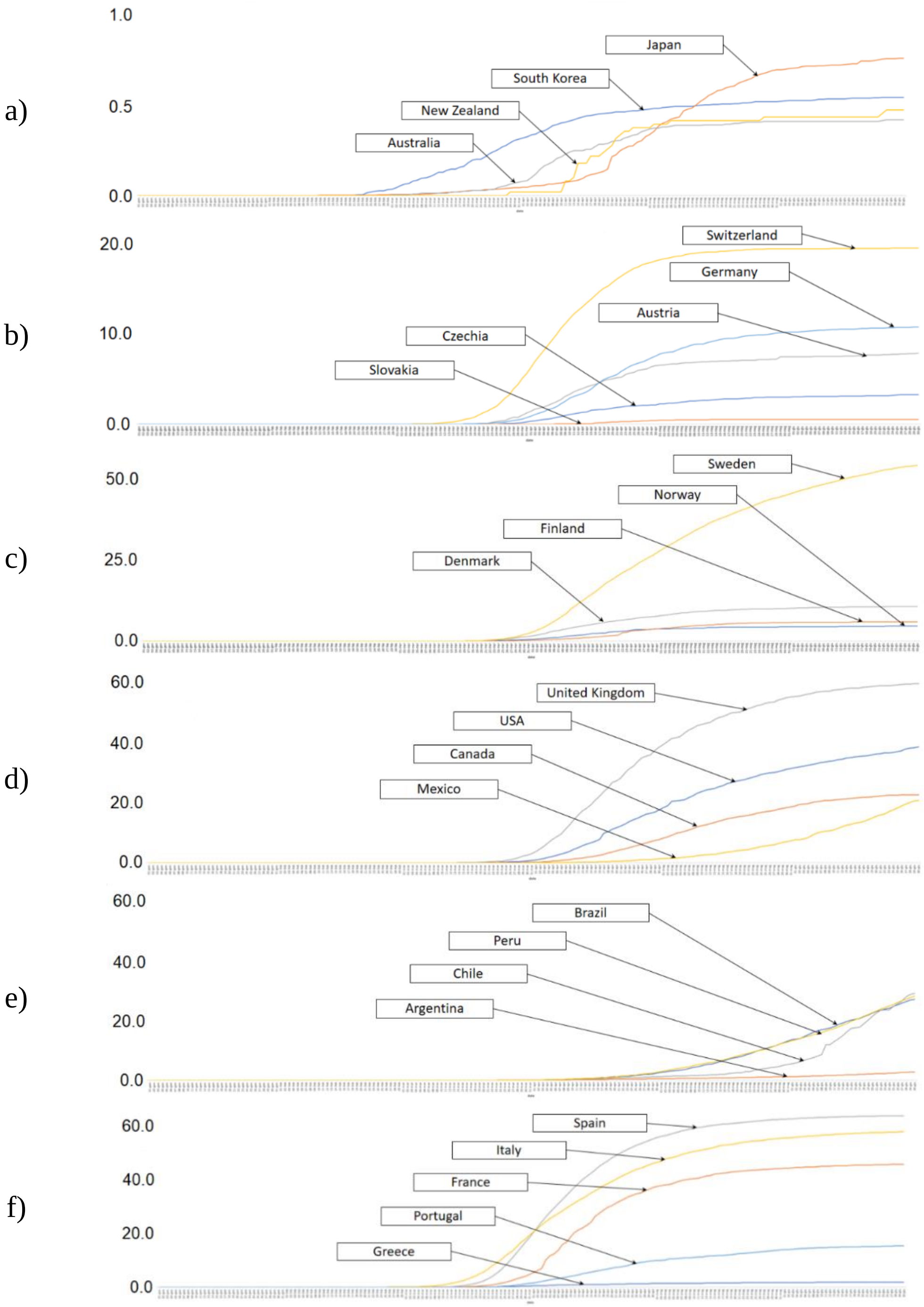


Figure 2a-f: Total deaths per 100,000 inhabitants from January 1 to June 30 in various countries; (with different scales; elaboration from: WHO, 2020m).

Table 4: Pandemic intervention strategies (elaboration from: Baker et al., 2020d; see also Anderson et al., 2020).

select pandemic response strategy	*implement pandemic strategy*	*exit path*
i) assess threat; ii) choose strategy; iii) select interventions; iv)implement surveillance/evaluation; v) fine tune mix of interventions*; vi) communicate/coordinate actions.	*a) exclusion strategy*	
	maximum action to exclude disease (some Pacific Island countries and territories)	*return to carefully managed 'new normal' with persisting quarantine at borders until effective vaccine and/or antimicrobial interventions*
	b) elimination strategy	
	maximum action to exclude disease and eliminate community transmission, or containing the pandemic at an early stage (China, Taiwan, New Zealand, Hong Kong, South Korea)	
	c) suppression strategy	*prolonged control measures until effective vaccine and/or antimicrobial interventions*
	the goal is to flatten the epidemic curve without expecting to end community transmission; action increased in stepwise/targeted manner to substantial lower case numbers and outbreaks (most countries in EU and North America)	
	d) mitigation strategy	*pandemic spreads through population until 'herd immunity' and/or effective vaccine and/or antimicrobial interventions*
	the pandemic is allowed to go ahead at a controlled rate until herd immunity, keeping the number infections to a minimum for as long as possible; action taken to 'flatten the peak' to avoid overwhelming health services and protect the most vulnerable (Japan, UK and Sweden at least initially)	
	e) no substantive strategy	
	largely uncontrolled pandemic wave (some lower income countries)	
*** pandemic interventions**: border controls to "keep out"; testing, contact tracing, case isolation and contact quarantine to "stamp out"; improved hygiene behaviors and use of masks; physical distancing; movement restrictions; combinations including "lockdown"; vaccines; antimicrobials.		

This nation (one of the most aged societies in the world with high population density, big cities, and crowded trains) announced its first COVID-19 case on 16 January 2020, after the China outbreak and Thailand; the first fatality occurred on February 13. On the day 27 of the same month, the Prime Minister requested the nationwide school closure. The Tokyo governor suggested a lockdown only on March 23, while the postponement of the Tokyo 2020 Olympics/Paralympics was decided the day after. The state of emergency was declared with a certain delay (April 7, then extended until the end of May). A localized outbreak occurred on the Diamond Princess cruise ship docked in Yokohama, put in quarantine from February 3 (Russel et al., 2020).

The government imposed travel restrictions (all arrivals subjected to 14-day quarantine; denied entry for travelers from selected countries; if allowed for exceptional reasons, subject to testing) and revised health pandemic laws; restaurants and bars suspended their businesses, without any forcing initiative to close down.

Why does the Japanese death rate result so low with a weaker lockdown (never obliged with penalties) than those enforced elsewhere? Teleworking and voluntary stay-at-home on weekends were encouraged, unimportant trips dissuaded; but, above all, the avoidance of *3Cs* (closed spaces, crowded places, and close-contact settings) played a key role, with a non-mandatory two-meter distancing; in fact, approximately 80% of the infected people did not pass the infection to others. The authorities succeeded in the detection of clusters and investigation of linkages between clusters in the earliest phase of the pandemic (*trigger or cluster-based approach*[3,4]), suggesting voluntary quarantine and social distancing. The basic policy was to early detect the source of infected symptomatic individuals, isolating and treating them immediately rather than carrying out general testing of the country's entire population. Japan has a high standard health care system, with centers even in rural areas. The enormous threat of cluster-infection sources in the hospitals, due to overflowing patients, was prevented, equipping designated hotels for those requiring no oxygen therapy, and asking the non-critical people to stay at home. Allocation and coordination of the optimal use of medical facilities was organized at the community level.

Furthermore, the Government released a tracing App for Android/IOS phones named "*COCOA*". Japanese lifestyle was fundamental: general hygiene practice of the population, with a high tradition of handwashing; customs such as a low inclination to shake hands, embrace or kiss, with a smaller production of droplets; lower prevalence of co-morbidity (obesity, diabetes, and other risk factors), thanks to healthy eating and exercise habits; absence of relevant vitamin D deficiency; an established culture of a wide facemask use, especially in the winter grip season.

Finally, Japanese people followed with high self-discipline the requested constraint rules. Maybe past influenza epidemics have inoculated the Japanese people with sufficient antibodies to fight off COVID-19; perhaps the reason may even lie in some specific Japanese medical practices. Certainly Japan benefited from a remarkable number of experts with experience in fighting polio, SARS, and the 2009 H1N1 influenza. Japan decided not to eradicate COVID-19, but the objective was to stop the spread of the disease and to keep the number of patients to a minimum, although implementing a low rate of testing (Han et al., 2020; Inoue, 2020; Lu et al., 2020; Sayeed and Hossain, 2020; Suzuki, 2020).

On the other hand, the main criticism regards quite the inadequate check of asymptomatic people, with the consequent lack of laboratory testing. Moreover, some researchers argue that the behavior modification campaigns were not effective in the pandemic early phase, because most people did not change their attitudes promptly. Other negative remarks focus on: i) the insufficient effectiveness of the government’s communication strategy; ii) the tension between politics and science; some opinions believing the expert committee insufficiently independent to provide truly impartial advice; iii) the lack of accountability and transparency by government, especially about the decision to postpone the Tokyo 2020 Olympics/Paralympics, taken abruptly without any explanation; iv) finally, the inadequacy of human resources and personal protective equipment (*PPE*) of the Japanese healthcare system, pushed to near collapse in late April (Shimizu et al., 2020; Shimizu and Negita, 2020). Japan entered a second state of emergency in January 2021 following an exponential rise in COVID-19 confirmed cases. Therefore, a clear, consistent exit strategy became critical (Shimizu, Tokuda and Shibuya, 2021).

The COVID-19 outbreak started very soon in South Korea, where the first confirmed case was reported on 20 January 2020. Prior to February 14, most of the cases were directly or indirectly imported from abroad. In the following days (February 23), a local transmission cluster was identified among the “*Shincheonji Church of Jesus*” religious group in the Daegu metropolitan area of the North Gyeongsang province. This place and the Cheongdo County were both declared special management regions on February 29. Small-scale cluster infections occurred in nursing homes and education facilities. The pandemic was put under control in the second half of March, increased again in May especially in the Seoul Metropolitan Region, dropped off in mid-June with a new upsurge in August, linked mostly to a church in Seoul. Measures for all travel arrivals were temperature screening, testing, and 14-day quarantine, together with the submission of a health declaration form and the installation of a mobile phone app.

An aggressive "*find, test, trace, isolate*" elimination strategy (see Table 4) was implemented in high-incidence areas, in addition to strong social distancing measures (including 2 m physical distancing practice, staying at home for two weeks, and voluntary reduction in movement in the most infected clusters, with a *trigger or cluster-based approach*[3] and a *three-level physical distancing scheme*[5]), but avoiding a rigid national lockdown. Furthermore, mass testing capacity was rapidly expanded until a rate of 20,000 PCR tests per day in 638 screening centers and 118 public and private facilities, including: at drive-through and walk-through stations; records from medical facilities; global positioning system; credit card transaction history; closed-circuit television used to supplement manual contact tracing; by mid-August, around 1.7 million tests had been carried out. Initially, testing was addressed only to symptomatic individuals with a history of travelling in areas with known infections; tracing policy quickly included symptomatic individuals with close contacts of confirmed cases. Mass testing has been used in high-risk facilities such as hospitals and care homes in high incidence areas; then, this practice was broadened to people at risk regardless of symptoms. With the best information and communications technology (ICT) infrastructure in the world, an amazing cloud-based mobile environment (example: the "*Jeju Safety Code*" App), and a citizens' high tolerance for personal data-sharing, early contact tracing was another successful factor to fight the disease. It can be separated into: i) cluster investigation utilizing targeted mass testing of hospitals and communities; ii) identification and follow-up of individual cases and their contacts. Isolation of cases and self-quarantine of contacts has been another consistent feature of the South Korean response, with a great expansion of "*Untact*" (non-face-to-face) services. Based on the severity and risk factors, confirmed cases were either isolated in a hospital, at home, or in a residential treatment center (RTC).

With a higher population density than Japan (Table 3), the casualty rate (Figure 2a) was lower (0.55 deaths per 100,000 inhabitants). As in Japan, mask wearing was widely practiced before COVID-19 pandemic (i.e. mainly to protect others from seasonal viruses or as a reaction to air pollution). Masks and sanitizers were made available on public transport soon after the first patient was confirmed. Through the Korea Center for Disease Control and Prevention (KCDC), government used transparent communication methods to secure public cooperation, including detailed reporting of new cases via websites, mobile phone Apps, and text alerts. South Korea was, of course, not immune from COVID-19 waves and containment risks; however, its fundamental approach (a rigorous response is better than a late and slow response) seemed to be quite effective from a global perspective. This country benefited of historical experience, when it was heavily affected by the Middle East Respiratory Syndrome (MERS) in 2015 and responded poorly, despite its robust public health system with universal health care coverage in place since 1989. The background with MERS provided broad support amongst the public and people increased readiness to comply with government regulations, producing important effective social mobilization, solidarity and trust.

During the COVID-19 disease, South Korean people showed a strong spirit of community and unity and proved mature civic consciousness, as an essential trait to ensure social compliance with the imposed measures. Finally, the presence of a strong government leadership with a regulatory state, due to the presence of an authoritarian regime and military rule until 1988, probably resulted significant in understanding the proactive and relatively successful COVID-19 crisis management response: 86% of South Koreans approved the Government's behavior against the disease (Dighe et al., 2020; Han et al., 2020; Hur et al., 2020; Klingebiel and Tørres, 2020; Lee and Lee, 2020; Lu et al., 2020).

Despite Aotearoa/New Zealand's geographic isolation, the introduction of SARS-CoV-2 was due to the large numbers of tourists and students arriving in the country each summer mainly from Europe and China. New Zealand's first COVID-19 case was diagnosed on February 26, 2020. By mid-March, it was clear that community transmission was occurring and that the country didn't have sufficient testing and contact-tracing capacity to contain the infection; the public health infrastructure was at a low point after decades of neglect. Until early March, the response followed the existing pandemic plan, based on a *mitigation*[9,11] approach for managing H1N1 influenza. However, on 23 March, the Prime Minister Jacinda Ardern announced the adoption of an explicit COVID-19-tailored elimination strategy (i.e. the eradication of an infectious disease at a country or regional level, aiming to bring its incidence to zero), instead of the *suppression*[10,,11] method largely applied in EU and North America (Table 4; see Anderson et al., 2020). The essential elements of this approach, escalating the stringency of control measures to extinguish chains of transmission, were: i) border controls with high-quality quarantine of incoming travelers; ii) rapid case detection identified by widespread testing, through a high performing surveillance system, followed by prompt case isolation, with swift contact tracing and quarantine for contacts; iii) intensive hygiene promotion (cough etiquette and hand washing), provision of hand hygiene facilities in public settings, and mandatory use of masks; iv) intensive physical distancing, with a *four- level alert system*[6]; level 4 alert meant a lockdown (started on 26 March, together with the declaration of national emergency), including school and workplace closure, movement and travel restrictions, and stringent measures to reduce contact in public spaces; population was asked to stay within so-called "*bubbles*"; v) a well-coordinated communication strategy to inform the public about control measures and about what to do in case of disease. The intense lockdown suppressed transmission and gave the country time to expand border controls, improve contact tracing, and undertake large scale testing. The coming out of lockdown began progressively after 28 April. Passed 5 weeks, and with the number of new cases declining rapidly, New Zealand moved to Alert Level 3 for an additional 2 weeks, resulting in a total of 7 weeks of what was essentially a national stay-at-home order. In early May, the last known COVID-19 case was identified in the community and the person was placed in isolation, which marked the end of identified community spread. On June 8, the government announced to enter the Alert Level 1, thereby effectively declaring the pandemic over in New Zealand. 103 days after the first identified case, public life has returned to near normal and many parts of the domestic economy re-operated as at the pre-COVID-19 levels (Baker et al., 2020a-d; Han et al., 2020; James et al., 2020; Jefferies et al., 2020; Lu et al., 2020). With a scarce population density (respectively 18 and 27 times less than Japan and South Korea, see Table 3), the casualty rate (Figure 2a) was 0.48 deaths per 100,000 inhabitants.

With an area more than 50% larger than Europe, Australia has one of the lowest population densities in the world (Table 3). Nearly 90% of the population live in urban areas concentrated along the eastern seaboard, and two thirds are settled in one of the state capital cities. Australians are living in good health, with a high life expectancy than ever before. They are eligible to be treated in a public hospital free of charge under the Medicare health insurance scheme. State Governments are responsible for accrediting, running, and funding public hospital and community health services, although they do receive commonwealth contributions to these services. During the COVID-19 pandemic, Australia was suffering catastrophic fires, extreme flooding and brutal drought. Anyway, the country's response has been characterized by effective actions, policies, and leadership practices, implemented through strong collaboration between the public and private sectors. A key feature has been the ability to coordinate a unified national response through the National Cabinet, while at the same time allowing states to retain autonomy and decision-making powers.

The first confirmed cases in Australia were identified on 25 January 2020 in Victoria (a man returned from Wuhan) and New South Wales (three adult males, two travelers from Wuhan, and one after a direct contact with a confirmed case from Wuhan). COVID-19 events and responses took place at different times and with different levels of restrictions in the Australia’s territories (Parliament of Australia, 2020): Queensland (state of emergency declaration: January 29; first case: January 29; first death: March 3); Western Australia (state of emergency declaration: March 15; first case: February 21; first death: March 1); Victoria (state of emergency declaration: March 16; first case: January 25; first death: March 26); Australia Capital Territory (state of emergency declaration: March 16; first case: March 12; first death: March 30); Northern Territory (state of emergency declaration: March 19; first case: March 4; first death: no casualties recorded until September 2020); Tasmania (state of emergency declaration: March 19; first case: March 2; first death: March 30); South Australia (state of emergency declaration: March 22; first two cases: February 1; first death: April 7); New South Wales (no state of emergency declaration; cancellation of major events: March 15; first case: January 25; first death: March 3).

After imposing the closure to travelers coming from Iran (March 1), South Korea (March 5) and Italy (March 11), Australian borders were definitively closed to all non-residents on 20 March; returning residents were required to spend two weeks in supervised quarantine hotels. Furthermore, a ban was imposed on Australians travelling overseas, with limited exceptions. Many states and territories closed their borders to varying degree, some of them until late 2020. The number of COVID-19 cases initially grew sharply during the March first wave; then levelled out, starting to decrease rapidly at the beginning of April. A second wave emerged in Victoria during May/June, largely localized to Melbourne, much more widespread and deadlier than the first. Since the mid of March, social distancing rules, non-essential services closure, and lockdowns were imposed. These restrictions were limited in space and time (Tasmania: isolation of two hospitals; Western Australia: 5-day lockdown in metropolitan Perth and Peel region) or very heavy and long (Victoria: a first 50-day shutdown in Melbourne from March 12; then a reinforced lockdown until August 2020).

A very dangerous outbreak occurred in the Ruby Princess cruise ship, arrived in Sydney harbor (New South Wales) on 18 March with 2,700 people, obliged to enter self-isolation. Within five weeks, at least 662 passengers were tested COVID-19 positive and 21 died. Police effectives saw an enforcement, in order to ensure the respect of the containment measures. Individuals who did not self-isolate when required and businesses flouting social distancing laws would have been fined (respectively 1,000 and 5,000 AUD $).

Australia's success in containing the COVID-19 pandemic (casualty rate: 0.42 deaths per 100,000 inhabitants, Figure 2a) can be attributed in part to structural advantages as including the country's position as an island nation, and the low population density (Table 3). Furthermore, Australia benefited of an updated pandemic plan, reorienting relevant influenza pandemic response strategies toward this new pathogen. The new legislation made contact tracing faster and effective. The public acceptance of the "*COVIDSafe*" mobile App, created for the purpose and released by the federal government, was strongly encouraged. Several drive-through COVID-19 testing facilities were quickly opened in the country, in order to increase testing capacity. Last but not least, a large majority of Australians have, for the most part, adhered to the policies and solutions put forward, such as physical-distancing, hotel-quarantine practices, lockdown measures, mask wearing, good hygiene, and rapid testing (Chang et al., 2020; Child et al., 2020; Cook et al., 2020; Lu et al., 2020; Moss et al., 2020). The Australia's healthcare system adopted a strategy defined *aggressive suppression*[10,11] (Table 4; see Anderson et al., 2020), considering the New Zealand "*elimination strategy*" (Baker et al., 2020d) as unrealistic (Coatsworth, 2020).

3.3 Germany, Austria, and Switzerland

The DACH Region (Germany, Austria, and Switzerland) shares common borders in Central Europe and has substantial cultural, historical and economic ties. Population density (see Table 3), almost commensurate between Germany (234.44) and Switzerland (209.63), is a little lower in Austria (107.37). These countries share comparable systems of federalism: the role of the central governments, that normally is only a regulatory administration duty, changed significantly in response to the COVID-19 pandemic crisis. Similarities can also be found in the healthcare systems with mandatory universal health insurance for all citizens. In the last decades, Switzerland experienced a twenty-year trend of hospital capacity reduction; in contrast, Germany invested in more ICU capacity, and Austria hired more physicians in recent years. DACH countries faced similar epidemiological situations, with enough success in containing the COVID-19 disease during the first wave. These nations experienced low mortality in the earliest stages of the pandemic (until June 2020, deaths per 100,000 inhabitants: Switzerland, 19.42; Germany, 10.71; Austria, 7.81; see Table 3 and Figure 2b).

The first case in Germany was reported on January 27 in Bavaria, but the infection remained contained, being the contacts rapidly tracked down and transmission interrupted. The DACH major outbreak began in late February, linked to the heavily impacted Italian regions of Lombardia and Veneto. From there, the spread proceeded to the Swiss canton of Ticino (exacerbated by over 60,000 cross-border workers from Lombardia; first imported case from Milan, February 25) and the Austrian province of Tyrol. A short time later, the virus arrived to the Southern German states of Bavaria and Baden-Wurttemberg. By March 2020, the number of cases started to increase exponentially in Germany, reaching the maximum in mid-March, with an almost doubled peak in Switzerland; after a surge, a rapid slowdown was evident in the DACH Region from the second half of March onwards. The three countries took very comparable approaches to contain and treat the virus, following a *suppression*[10,11] strategy (Table 4; see Anderson et al., 2020). Adopting a *trigger-based approach*[3,7], the German government and the federal states agreed to impose lockdown measures on 22 March until 3 May 2020; universities, schools and nurseries were closed, and mass events cancelled; to reduce public contact, gatherings of more than two people were prohibited; additional measures regarded the closure of public spaces, churches, mosques and synagogues, restaurants, shops, hairdressers, theatres and libraries. In this time interval, the measures were largely accepted by the population. Following the easing of restrictions (April-May), the DACH daily new cases slowly started to grow again (June), but with much lower levels.

In Germany, the warm and dry summer, encouraging outdoor activities, probably contributed to keep the infection down; however, when people returned from holidays in Autumn, together with some super-spreading events (e.g. in the German meat industry), COVID-19 rates increased again. Despite the cold season approaching and no vaccine still available, public discussion and political action were centered on further relaxing control measures. At the same time, large-scale social gatherings and private parties continued, despite early warnings of experts about a possible rapid second wave. By October, COVID-19 cases were again increasing exponentially, causing the rapid development of a second epidemic wave, followed by a rapid exhaustion of the capacity of the local health departments. Therefore, contacts of cases could no longer have been effectively traced, due to the impossibility to test all people with symptoms. This resulted in largely uncontrolled transmission in most parts of Germany, leading to another, even rather moderate, lockdown at the beginning of November 2020. However, in contrast to the first wave, there was a consensus deterioration in the German society about the epidemic control measures. Moreover, an increasing number of outbreaks were seen again in nursing homes, ICU cases reached an unprecedented high level, and daily death rates exceeded 500. As a consequence, a stricter lockdown started in mid-December.

The first major divergence among the DACH countries was in how their federal governance structures adapted to the crisis. When Switzerland and Austria declared a National State of Emergency on March 16, the normally highly independent states and cantons ceded many of their decision-making powers to the central governments, with a uniform implementation of restriction measures. In Germany, the absence of binding nation-wide actions led to an uneven policy landscape. Another point of divergence regarded the health system response. With a detailed National Pandemic Plan before the COVID-19 outbreak, Germany already had 34.0 critical care beds per 100,000 inhabitants, compared with 9.7 in Spain and 5.2 in Japan; during the pandemic, the ICU capacity quickly expanded from 28,000 to almost 40,000 beds, providing an effective protection for inland citizens and even patients coming from overwhelmed areas of France and the Netherlands. In contrast, the Austrian and Swiss plans were based more on repurposing resources than creating new ones. These measures helped to keep COVID-19 mortality relatively low, but putting in sufferance patients with other health issues. In Switzerland, the ICU capacity was considerably stressed in the most heavily impacted cantons, due to a combination of high infection rates and low numbers of beds.

All the DACH countries implemented technological solutions in order to minimize the pressure on the healthcare services, as the widespread use of telehealth and hotlines. The implementation of testing strategies was somewhat delayed and there was considerable divergence in testing efficiency across the three countries, both during the early stages of the pandemic and following economic re-opening. Germany extended gradually the testing coverage until asymptomatic people and all the persons admitted to nursing homes and hospitals. Austria tested at the highest rate among the DACH countries, although the testing policy regarded only people showing symptoms, or in contact with a confirmed case, or travelling through a high-risk area. In late March, Switzerland limited tests to vulnerable populations and people requiring COVID-19 hospitalization, but in April testing was expanded to every person showing symptoms. In early March, 130 researchers from across Europe began the "*Pan European Privacy-*

Protecting Proximity Tracing Initiative (Pepp-PT)” with the goal of developing Europe’s digital solution for tracing chains of infection. Anyway, this technology was the source of considerable controversy in the DACH region about government control and privacy. Therefore, new technological models were developed (Germany: “*Corona Warn App*”, 16 June 2020; Austria: “*Stopp Corona App*”, 25 March 2020; Switzerland “*Swiss PT App*”, 25 June 2020), with a delayed usage, especially in Germany and Switzerland.

Another relevant factor that may have played a role against the pandemic could have been the DACH populations’ trust in government, which is among the highest in the world, together with the intense science-oriented information in the media, and the unified political leadership (Desson et al., 2020a; Giachino et al., 2020; Han et al., 2020; Hartl et al., 2020; Huber and Langen, 2020; Lu et al., 2020; Moshammer et al., 2020). Furthermore, a German study proved that the mandatory use of face masks in public reduced the COVID-19 daily growth rate of reported infections by around 47% (Mitze et al., 2020), a beneficial result already found for influenza (Saunders-Hastings et al., 2017).

3.4 Czechia and Slovakia

Czechia and Slovakia are Central Europe countries, belonging to the socialist bloc before 1989, with extremely fragmented local self-governments (6,200 and almost 3,000 municipalities respectively). With a comparable medium population density (see Table 3), they showed low (3.25) and very low (0.51) deaths per 100,000 inhabitants until June 2020 (Table 3 and Figure 2b). During the first COVID-19 pandemic wave, their response was recognized as an undeniable success, both adopting an aggressive *suppression*[10,11] strategy with early lockdowns (Table 4; see Anderson et al., 2020). In the following upsurge of Autumn 2020 and Winter 2021, the situation became very critic.

In the Czech Republic, the first three infection cases were confirmed on 1 March 2020 (first death: 23 March); a classical exponential increase peaked at the end of March, and then the number of new cases started to decrease gradually; from the end of April, it remained low until June.

In Slovakia, the first case was diagnosed on 6 March; the father of a tourist, coming back from a 14-to-16 February trip to the Venetian carnival, resulted infected (first two death: 7 April). Strict anti-pandemic measures (including border surveillance, controlled entry and mandatory quarantine for returnees from abroad) started in both countries in early March. In Czechia, from the evening of 10 March (8 days after the first three COVID-19 confirmed case and 13 days before the first death), the Health Ministry begun with the first lockdown (lasted until 24 April) measures: ban of all cultural and sporting events (with more than 100 people) and closure of schools. The Slovak Crisis Crew adopted similar measures on 9 and 12 March, initially restricted only to hospitals, social care establishments, and prisons. In Czechia, the government declared a 30-day state of emergency (12 March), extended several times until its end (17 May). In Slovakia, a state of emergency was announced on 11 March (5 days after the first confirmed case and one month before the first death); it lasted 90 days and was not extended; the slogan "*Stay at Home*" was promoted and accepted. In the further part of March, really comprehensive sets of anti-pandemic measures were taken in both the nations, mirroring the successful approaches made by China and other Asian countries, aimed at trying to limit the spread of the virus as much as possible, and crucial for the subsequent COVID-19 low rates: restrictions on the free movement of people; suspension of administrative activities; restrictions on transport services; closure of sports facilities, libraries, galleries, shops, markets, services and retail sales. All shops were required to provide disinfectant or gloves at the entrance. A distance of a minimum of two meters was to be respected, including at the checkout area. Slovakia also decided to declare a short blackout during the Easter holidays. Slovakia, with the best pandemic figures, implemented core measures soon after day zero; Czechia, with a minor performance, reacted with some delay.

In Slovakia, the national elections took place on February 29, 2020, just before the outbreak of the pandemic, with the victory of the opposition parties, which came into power in the midst of the crisis. The resultant change of the government didn't affect the strength of the anti-COVID-19 policy, which saw an early reaction of the Pellegrini leaving government first, followed by additional specific measures of the new Matovic majority.

The obligatory wearing of masks outdoors was implemented very early by Czechia and Slovakia (since the first days of the pandemic), helping very much to stop the spread. In Czechia, the lack of face protection masks was quickly resolved by thousands of volunteers, who produced large amounts of textile masks in a few days. In Slovakia, people struggled heavily in the first few weeks with the lack of *PPE* (personal protective equipment); small companies changed quickly their focus on mask tailoring and alcohol disinfection; in the following period, face masks were used regularly, even in July in most indoor spaces.

In Czechia, COVID-19 testing was made widely available with drive-through locations from 14 March; from 27 March anyone with a fever, dry cough or shortness of breath was eligible for a free test; from 13 April onwards, COVID-19 testing capacity significantly surpassed demand; through the mobile App “*eRouška (eMask)*”, contact tracing included voluntary disclosure of mobile phone position, debit card payments data for previous days, and the quarantining of identified contacts.

The Slovakia Public Health Office started tracking the COVID-19 infected people’s movements, including those in compulsory quarantine, with their consent, using data from telecom operators, when the parliament passed the so-called ‘lex corona’ bill. Covid19 “*ZostanZdravy*” was the App currently used by Slovakia's National Health Information Centre, recently working on the smart quarantine project “*e-Karantena*”, launched for Slovak residents returning from abroad.

In Czechia, hospitals restructured quickly (before the first death in the country occurred), with enough beds for COVID-19 therapies; public health and epidemiology services in every region immediately started tracing all positive patients; over 2000 medical students as volunteers were mobilized. In Slovakia, selected hospitals were identified to construct drive-through points to test people in their cars for COVID-19. Specialized hospitals to treat COVID-19 were established in all regions (Chubarova, Maly, and Nemec, 2020; Donicova, 2020; Kouřil and Ferenčuhová, 2020; Nemec, 2020; Nemec and Spaček, 2020; Widimsky, Benes, and Celko, 2020).

Both countries started easing the COVID-19-related restriction in mid-April. They returned to an almost standard way of life in late May, with the exception of international travel and special protective measures in public spaces. In mid-June, the number of cases in both countries slightly increased, partly because of the import of cases, and partly because of local focal points. In Czechia, after the anti-pandemic measures were relaxed, the number of new cases quickly rose between June 27 and 29 back to the levels similar to those in April. Also in Slovakia, in early July, the number of new cases started to rise again (mostly imported cases from the Czech Republic and United Kingdom). In fact, not everything was perfect in Slovakia and Czechia. The critical negative specifics were connected with the COVID-19 second phase spread. Despite the experience with effectively managing the first outbreak, both governments in early Autumn (in relaxed regimes when the disease almost disappeared) argued that everything was under control, and the newly growing number of cases fully manageable. Only when the numbers of infected achieved record numbers and contact tracing system was overwhelmed, the Prime Ministers announced the return to hard anti-pandemic measures. Because this renovated restrictive policy started too late and people were not ready to comply, in both countries the second wave became uncontrolled, with numbers of infected and deaths several times higher compared to spring. Despite weeks of a near-lockdown, the rate of new cases didn't show a clear decrease (Löblová, 2020; Nemec et al., 2020). In order to face the pandemic upsurge, the Slovakian government decided to conduct a mass testing of its entire population, aged 10-65, on the two weekends of October 30 - November 1, and November 6 - 8; 3.6 million people were tested. The testing was voluntary, but anyone not participating must have stayed self-isolate in their homes for 10 days. Mass testing has been considered a key tool in reversing the upward trend in infections. Anyway, the results were of difficult evaluation, because mass testing was done in combination with lockdown (Holt, 2020; Mahase, 2020; Slovakia Testing Report, 2020).

3.5 Norway, Denmark, Finland, and Sweden

In the Scandinavian region, variation in government and public health policies has resulted in different COVID-19 trajectories. Sweden's public health responses, based on recommendations from the Public Health Agency (PHA, "*Folkhälsomyndigheten*") and with great emphasis on individual responsibility, were less restrictive and instituted more slowly than neighboring nations of Norway, Denmark, and Finland, with comparable demographic and economic profiles, age distributions of the population, public infrastructures, healthcare, and educational/political systems. Broader similarities between these four Nordic countries enable useful comparisons to determine the relative impacts of the differences in public health responses. Moreover, they have similar levels of urbanization and fractions of total population in their capitals. However, Denmark's national population density (Table 3) is 5 (Sweden) to 10 times (Norway, Finland) higher, and Copenhagen is the densest capital city.

The first COVID-19 case was confirmed in Finland on 29 January 2020, when a Chinese tourist visiting Ivalo (Lapland) from Wuhan tested positive (first death: 21 March); the situation spread only in early March, boosted by travel to the Alps during the winter holidays in February. The virus reached Sweden on 31 January 2020, again on a woman back from Wuhan (first death: 11 March). Norway confirmed the first cases on a patient returned from China on February 26, and the day after on three Norwegian vacationers back from skiing in northern Italy and Austria (first death: 12

March). On February 27, the virus was found in Denmark on an individual after a skiing vacation in Italy (first death: 12 March). Thus, International flight connectivity has largely been responsible for spreading cases to the Nordic region: return from winter holidays in central Europe may have driven early initial cases upwards. Daily COVID-19 incidence varied across Nordic countries, first growing up in Norway, followed by increasing incidence rates in Denmark, Sweden, and Finland.

Norway, Denmark, and Finland enacted strict and early government regulations prior to observing COVID-19 cases and associated deaths upsurge.

In Norway, the government hesitated until March 12, but on that day draconian lockdown regulations were implemented by the Norwegian Health Directorate ("*Helsedirektoratet*"): quarantine for people entering the country; domestic and international travel restrictions; closure of all kindergartens, schools, colleges, universities and other academic institutions; closure of day care centers, physiotherapists, psychologists, hairdressers, swimming pools, training centers, restaurants, hotels, movie theatres, pubs, night clubs and bars; ban of all sporting and cultural events; restrictions on internal movements, discouraging travelling to work by public transport, except key professionals; the government urged the population to stay at home if possible, keeping social distancing, and limiting gatherings to not more than five people; contacts with health care services were encouraged only if absolutely necessary. Violations were punishable by fines or imprisonment for up to six months, but there have been very few cases of the authorities issuing fines. The recommendations on the use of facemask in public transportation around Oslo were announced only on 14 August 2020, because NIPH-FHI (Norwegian Institute for Public Health-"*Folkehelseinstituttet*") doubted on their effectiveness for those without symptoms.

On February 27, 2020, the Danish Minister of Health added COVID-19 to the list of the contagious diseases covered by the Danish Epidemics Act; on March 11, Danish Prime Minister Mette Frederiksen announced several restrictions; the government banned large public gatherings, closed all unnecessary venues across its cities, heavily discouraged the use of public transportation; daycares, schools, universities, libraries, theaters, and museums were very quickly shut down, public events cancelled, air travel severely restricted and borders closed; all public sector employees in non-essential functions were ordered to stay home and private workers to work from home if possible, with the exception of vital sectors; public assemblies of more than ten people became illegal. After a period of doubt, Denmark changed its view recommending the use of facemask in some circumstances.

The epidemic landed in Finland late compared to many other countries; authorities and politicians had enough time to learn from the other experiences. On March 16, 2020, the Finnish Government declared the state of emergency and, the day after, Prime Minister Sanna Marin introduced to the Parliament the Emergency Powers Act, which passed rapidly almost without opposing voices. It outlined a number of restrictions (with a minuscule resistance) on the constitutional rights and everyday lives of individuals; they included closures of schools, universities, museums, restaurants, libraries, sports and public places, the self-isolation of elderly and other risk-group citizens, as well as restrictions on gatherings (of more than ten people) and travelling. Ten days later, these measures were followed by a lockdown of the Helsinki Metropolitan Area and the closure of the Uusimaa province for a limited period of time in order to prevent the spread of the virus. In fact, until June 2020, 61% of all recorded infections in Finland were within the Helsinki city-region. The use of facemask was voluntary for public, and recommended in transportation only from 13 August.

In Sweden, on March 3, 2020, the risk of transmission was upgraded to moderate; a week after, PHA (The Public Health Agency of Sweden, *Folkhälsomyndigheten*) reviewed the alert level to high. Whereas Denmark, Finland, and Norway introduced strong social distancing procedures, Sweden chose a much less intrusive strategy, with voluntary measures, several days or weeks later than its neighbors; kindergartens, elementary schools, daycare centers, training facilities, movie theatres, restaurants and bars, gyms, hair salons, and other businesses were kept open; children’s sports continued; no mandatory measures were taken to limit cultural events crowds on public transport, in shopping malls, or in other crowded places, while recommending a limit of 50 people for gatherings as of March 29, 2020. Sweden did not restrict border crossing. Therefore, the Swedish strategy against COVID-19 received intense international attention and criticism, notably because of the high level of deaths per 100,000 inhabitants until end June 2020 (Table 3 and Figure 2c): Sweden 54.22; Denmark 10.65; Finland 5.88; Norway 4.59. Denmark, Finland, and Norway followed the *suppression*[10,11] strategy, while Sweden the *mitigation*[9,11] strategy, at least initially (Table 4; see Anderson et al., 2020), as discussed forward. The Swedish authorities did not recommend wearing face masks outside hospitals; on August 18, PHA announced an ongoing investigation into the use of facemasks in public; on September 1, it declared that facemasks may be recommended in certain settings, such as restricted geographical areas with local outbreaks; on August 12, the Karolinska Institutet suggested the facemask use on its campus in certain situations when physical distancing was deemed impossible, but none of the other Swedish universities followed this recommendation; facemasks were introduced on public transportation only from January 7, 2021.

After three weeks of draconian measures, in mid-April, Norway became the first European country to claim that the situation was under control; with the highest number of hospital beds in general, the ICUs capacity could have been upgraded until 500 units, cancelling planned activity and reallocating resources; on 29 May, this country initiated a new policy phase, scaling back movement controls. The Norwegian healthcare system reacted in a robust manner thanks to competent politicians, and a high-trust society with reliable and professional bureaucracy; however, the crisis revealed that the necessary resources had not been invested in preparedness for an epidemic; the main bottleneck was a lack of infection control equipment, respirators, and testing equipment in many hospitals and health care facilities at the beginning of March. Norway's technology response was primarily focused on track and trace, due to the existing highly developed electronic technology; the "*Smittestopp*" App was released on 16 April, collecting anonymized data about movement patterns and close contacts with a COVID-19 infected persons; by 19 March, more than 1.5 million people downloaded the app.

In Denmark, the infection lowered in mid-May. The health care system, equitable and free for everyone, was initially equipped by an insufficient number of ICUs, but was able to prioritize and reorganize medical departments, isolation wards, and hospital beds, as well as doctors and nurses; the pre-existing ICUs increased by 75% with flexible adjustments and rapid re-location of equipment. Phone psychological support lines were set up. The surge of ICU patients peaked in the last week of March 2020, where 25 persons were admitted to an ICU per day; from mid-April, the number of new ICU admissions declined rapidly to a very low level. This country quickly implemented a broader testing strategy to prevent transmission (daily testing rate 3 to 4 times its neighbors since mid-April), opening testing up to people with mild symptoms in April and to all adults without referrals in May, leading to a relatively low test-positivity rate as more mildly symptomatic/asymptomatic cases were detected; before March 12, tests were offered to all individuals suspected to have COVID-19, based on relevant symptoms together with a risky travel history or close contact with confirmed cases; later, the testing strategy changed to prioritize tests of patients who had suspected disease requiring hospital admission; on March 18, testing was extended to symptomatic health-care workers in critical functions; it widened late March 2020 to include patients with moderate and mild symptoms, as well as broader screening of health-care personnel; during April and May, tests were made available to the whole population, also those with mild symptoms/no symptoms but contact with a confirmed COVID-19 infected; from May 24, all Danes can have been tested even without a requisition from the general practitioner or other health-care professionals. Denmark applied national standardized systems based on electronic health records (EHRs), able to extract high quality routine data for real-time surveillance. The Danish government launched the "*SmitteStop*" App on 18 June 2020, completely on a voluntary basis, to contain the COVID-19 spread during the society slowly reopening.

In Finland, the pandemic curve had been flattening since mid-April; the overall ICUs almost could have been doubled if needed; although the social/healthcare capacity was strengthened, the COVID-19 challenge revealed difficulties in *PPE* purchasing and providing non acute services for the vulnerable groups, due to the fragmented organization of the decentralized local government; on the other hand, the development of digital health services and telemedicine accelerated quickly. Testing, tracing, isolating, and treating have been important elements of the Finnish strategy; in the public sector, symptomatic patients were tested in drive-troughs linked to hospitals; the public sector has bought testing capacity and drive-through testing also from the private sector. The COVID-19 digital self-assessment tool "*Omaolo*" was used nationwide, with some 600,000 questionnaires assessed since March 2020; to support contact tracing, an App ("*Koronavilkku*") was developed (anonymous, free and voluntary, be fully available in September 1, 2020).

In Sweden, with the selected *mitigation strategy*[9,11] (Table 4; see Anderson et al., 2020) choosing fewer and less intense government restrictions, the number of COVID-19 deaths peaked during the first wave on April (the deadliest month since 1993), at a higher level and with slower decline than in the neighboring Nordic countries, reaching a low in early September; 55% of COVID-19 cases were in Stockholm and Västra Götaland municipalities by the end of July; among people aged ⩾80 years, the incidence rate was 6.8 times greater than Norway, Denmark, and Finland; therefore, Sweden experienced disproportionate incidence among the very elderly, and nearly half of all the fatalities occurred in seniors' care homes. The ability to work effectively to minimize the COVID-19 spread has been hampered by a Swedish decentralized and fragmented system of health and social services. Prior to the pandemic, Sweden had the lowest ICUs number per capita among the Nordic countries. The availability of *PPE* and oxygen supplies was low during the COVID-19 early emergency, with insufficient personnel lacking infectious disease training and equipment; virus tests could not have been carried out on primary care patients at health centers. Staff testing became available in some parts of Sweden in late March, not including personnel working in elderly care homes. Testing, contact tracing, source identification, and reporting were inadequate and not expanded until late May, with not sufficient recognition of the importance of presymptomatic/asymptomatic and aerosol transmission. While the regions and county councils accepted their responsibility for testing sick patients and healthcare staff, it was not initially clear who was responsible for testing members of the public with mild symptoms. A COVID-19 testing agreement was put in place in early June, which enabled individuals to book tests through different web-based solutions. The deployment of a contact tracing App was not foreseen. Due to the lack of national and local guidelines for primary care, family doctors tried to solve shortages themselves, by using private contacts from other countries and relying on guidelines from abroad (Brynildsrud and Eldholm, 2020; Christensen and Lægreid, 2020; Claeson and Hanson, 2020; Haase et al., 2021; Helsingen et al., 2020; Juranek and Zoutman, 2020; Juul et al., 2020; Korhonen and Granberg, 2020; Lindström, 2020; Ludvigsson, 2020; Makarychev and Romashko, 2021; Moisio, 2020; Olagnier and Mogensen, 2020; Pottegård et al., 2020; Sheridan et al., 2020; Tiirinki et al., 2020; Ursin et al., 2020; Yarmol-Matusiak et al., 2021).

In Sweden, the light-touch approach in fighting the pandemic has been the result of historical and cultural traditions: its constitution make it difficult to affect individual liberties (such as freedom of movement and assembly); in fact, it is the citizen, not the government, which has the responsibility not to spread the disease. Therefore, quarantine can only be contemplated for people or small areas (such as a school or a hotel) but cannot be legally enforced on larger geographical land extensions. Two main laws regulate COVID-19: the Infectious Diseases Act (2004:168); it states that everyone has a personal responsibility to limit the transmission of infectious diseases; the Code of Conduct (1993:1617); it protects public health. Although the Swedish Infectious Diseases Act can restrict individuals, it does not allow for a general lockdown. The Constitution also stipulates that the Government cannot influence how individual Government agencies carry out their work, especially with regard to individual citizens (Ludvigsson, 2020; Farina and Lavazza, 2020). The very ‘Swedish’ approach of more explicit cooperation between the state's response and people's individual responsibility integrated the sociocultural concept of '*folkvett*', the common sense of the people as a collective (Orlowski and Goldsmith 2020).

About the COVID-19 pandemic, Sweden embarked on a de-facto herd immunity[8] approach (Habib, 2020; Orlowski and Goldsmith 2020), by allowing a proportion of the population to be infected, at the expense of deaths among the vulnerable (Claeson and Hanson, 2020; Korhonen and Granberg, 2020). Anyway, it seemed not a strategic goal itself but a secondary outcome of the selected procedures (Pierre, 2020). However, the Swedish government and PHA denied multiple times that they were following a herd immunity strategy, but the current State epidemiologist Anders Tegnell, as well as the former state epidemiologist Johan Giesecke, believed in herd immunity; Tegnell stated that the main strategy was to have a COVID-19 slow transmission, so that the healthcare system could manage; furthermore, he told that the "great concept" of herd immunity was "not contradictory" with this (Irwin, 2020; Lindström, 2020; Wise, 2020). A nationwide study conducted by PHA on 20 May found that just 7.3% of Stockholm residents had developed COVID-19 antibodies by late April; therefore, it could have been necessary a long time before most of the population has gone through the infection and became likely immune (Habib, 2020). Herd immunity was soon dismissed by the United Kingdom government in the middle of March for the reason of very high expected death rates. In Sweden, a herd immunity acquired by 60% of the population infected (approximately 6 million of a total 10.2 million) would have meant 60,000 deceased. Overconfidence in herd immunity, overconfidence in individual responsibility in a pandemic, neglecting to coordinate with the WHO and other countries, not taking into account empirical observations and practical experience from East Asia, produced additional risks for the Swedish population (Lindström, 2020).

In Sweden there was no relevant coordination with the neighboring countries. Furthermore, rather than anticipating the second wave of the COVID-19 pandemic and change course, the Swedish Government loosened restrictions in early October. However, the upsurge was also evident in Denmark, Finland and Norway since the beginning of Fall.

Finally, the Nordic countries people' trust in parliament, government, health authorities, and in national and local politicians, increased significantly from an already high level during this crisis.

3.6 United Kingdom

The United Kingdom (UK) is a high density country (Table 3), consisting of England, Scotland, Wales and Northern Ireland (the latter three with devolved governments). UK has been one of the most affected countries by the COVID-19 pandemic, which caused a high level of deaths per 100,000 inhabitants until end June 2020 (59.42, see Table 3 and Figure 2d). The Office for National Statistics (ONS) reported at the end of July that England's excess death figures between 21 February and 12 June were the highest in Europe. The scientists upgraded the risk of COVID-19 disease from 'very low' to 'low' on 21 January. The first two cases were declared on January 31, 2020, in the city of York in North England. On 12 March 12, the UK Chief Medical Officers raised the risk from 'moderate 'to 'high'. On March 27, it is announced that the Prime Minister (PM) Boris Johnson and the Health Minister (HM) Nadine Dorries tested positive for the virus. PM was admitted to intensive care on April 6 and discharged from hospital six days later. By March 11, the UK's Scientific Advisory Group for Emergencies (SAGE) rejected lockdown, believing that the population would not have accepted it.

On March 12, Chief Scientific Adviser (Sir Patrick Vallance, chair of SAGE) and Chief Medical Officer (Professor Chris Whitty) announced that the government's strategy was to let the virus to pass through the population, allowing individuals to acquire herd immunity[8] at a delayed speed, founded on an erroneous view that the vast majority of cases would be mild, like influenza (strategy of *mitigation*[9,11] versus strategy of *suppression*[10,11], see Table 4; see Anderson et al., 2020). In fact, the UK Influenza Pandemic Preparedness Strategy 2011 emphasized the need to maintain the continuity of essential services and everyday activities as far as possible. Vallance suggested that 60% of the population must be infected to reach herd immunity, while vulnerable groups would have been protected. As part of this strategy, PM advised the public to avoid unnecessary social contact and travel through partly-voluntary measures, including seven day-self-isolation for people with symptoms. On March 16, PM advises against 'non-essential' travel and contact with others, working from home if possible, and avoiding visiting social venues; pregnant women, people over the age of 70, and those with certain health conditions were urged to consider the advice 'particularly important'. The measures taken at that stage still did not include working from home, physical distancing, facemasks wearing or bans on large meetings. Entry via ports and airports remained unrestricted. However, the brutal consequences of this strategy became clear, including the collapse of the National Health Service (NHS), thanks to the report elaborated by the Imperial College COVID-19 Response Team. If continuing to follow a *mitigation*[9,11] strategy (Table 4; see Anderson et al., 2020), the report estimated a quarter of a million deaths, with a demand for ICUs by a factor of eight to one, overwhelming completely the healthcare system. Therefore, UK should have changed radically to a *suppression*[10,11] approach (Table 4; see Anderson et al., 2020), with strict lockdown measures, with a decrease of the total deaths down to about 20,000. On March 20, growing up casualties and following severe criticism, the government decided to close schools indefinitely (except for the children of key workers), together with restaurants, bars, cafes, cinemas, theatres, gyms, and leisure centers. Major sporting events were already cancelled in the previous days. On March 23, PM announced a lockdown ("stay at home" order) applied to everyone; all businesses, educational institutions, except healthcare and essential food and medicine supplies, were closed. Devolved governments, responsible for public health in Northern Ireland, Scotland, and Wales, introduced very similar measures as part of a coordinated approach. In addition, partial closure of subway lines in London was also implemented; as of March 23, 40 metro stations were closed, and some buses, trains, and tram lines were either cancelled or reduced in number. Citizens were subjected to police fines for failure to comply with these provisions. These measures should have been in place for three weeks and reviewed at the end of this period. However, on April 14, the lockdown was extended until at least 7 May (Alanezi et al., 2020; Cairney, 2020; Davies N.G. et al., 2020; Eubank et al., 2020; Ferguson et al., 2020; Güzel, 2020; Horton, 2020a; Keeling et al., 2021; Kelly, 2020; Sanders, 2020; Scally, 2020; Sibony, 2020; Watkins, 2020).

As the incidence of COVID-19 cases declined, national restrictions were relaxed. England transitioned to more localized interventions, varying in magnitude, to specific areas with rising cases. The first of these local measures was announced on the 29th of June in Leicester, then subsequently in other places, mostly in the North of England. In Autumn, when cases continued to rise, the government created a three-tier system (Jarvis et al., 2020), ranging from Tier 1 (medium risk) to Tier 3 (very high risk). On October 31, 2020, PM announced a second four-week England lockdown. After December 2, the restrictions would have been eased and regions gone back to the tiered system. The same happened on January 4, 2021 when England entered a third national lockdown, with easing measures occurring after February 22.

Problems in providing *PPE* stocks to the frontline medical staff left at work without protection (often contracting and dying from the disease), lacks in delivering new ventilators to meet increasing demand, inconsistencies in setting up an operational test-trace-and-isolate system, and fatal errors in the treatment of elderly patients (discharged from hospitals to care homes without mandatory COVID-19 tests until April 15, therefore mixing infected COVID-19 persons with others), contributed to a systematic failure. By cancelling non-emergency treatment and quickly discharging patients, more than 30,000 beds had been made available, doubling the number of ICUs to nearly 10,000. Furthermore, conflictual relationships at different governance levels and confusing communications during the easing lockdown phases decreased the response capacity. The basic principles of public health and infectious disease control were ignored and NHS resulted wholly unprepared to face an unusual challenge (Cairney, 2020; Davies N.G.. et al., 2020; Gaskell et al, 2020; Güzel, 2020; Horton, 2020b; Scally, 2020). For more than two months, the scientists whose advice guided Downing Street did not clearly signal forcefully their worsening fears to the public or the government (Sanders, 2020). Finally, the UK government's decimation of public health during years of austerity, and its impact on vulnerable groups, is a matter of investigation by public inquiry (Scally, 2020).

3.7 USA

The first confirmed COVID-19 case in the United States was reported on January 20, 2020.The day before, a 35-year-old man presented to an urgent care clinic in Snohomish County, Washington, with a 4-day history of cough and subjective fever. He had returned on January 15 after traveling to visit family in Wuhan, China. Although the patient didn't spend time at the Huanan seafood market, denying any contact with ill persons, the CDC (Centers for Disease Control and Prevention) staff defined him "person under investigation". On January 20, he tested positive and discharged to home isolation with active monitoring. From January 21 through February 23, 14 cases had been diagnosed in the following six states: Arizona (1), California (8), Illinois (2), Massachusetts (1), Washington (1), and Wisconsin (1); 12 were related to travel to China, and 2 occurred through person-to-person transmission to close household contacts. Additional 39 cases were reported among repatriated U.S. citizens, residents, and their families returning from Hubei province, China (3), and from the Diamond

Princess cruise ship (Russell et al., 2020) docked in Yokohama, Japan (36). The first US fatality was assumed to be in the Seattle area (Washington) on February 29, but postmortem testing confirmed that COVID-19 was spreading in the San Francisco Bay area (Santa Clara County) weeks earlier than previously thought (first supposed death: February 6), without travel history, but through community spread. By mid-March, COVID-19 transmission reached every state, including cases with no history of international travel and no contact with infected persons. As of 21 September 2020, more than 28.2 million cases and 199,213 deaths were reported (16.6% in New York alone, also due to high population density). Between February and September, the highest levels of daily deaths at the state level occurred in New York, New Jersey and Texas (998, 311, and 220 deaths per day, respectively). On September 21, the highest level of daily deaths was in Florida (101 deaths per day). In March, factors that contributed to the disease acceleration included: the virus importation by travelers infected elsewhere (for example, 101 persons who had been on nine separate Nile River cruises during February 11-March 5 returned to 18 states and having a positive test result); the attendance at professional/social events and gatherings (among them: Mardi Gras celebrations in Louisiana with more than 1 million attendees; an international professional conference held in Boston, Massachusetts, with approximately 175 attendees; a funeral in Albany, Georgia, with more than 100 attendees; Dougherty County, a small rural county that includes Albany, showed one of the highest COVID-19 cumulative incidences), followed by return to their homes; the infection spread in workplaces (especially in critical infrastructure sectors such as multiple meat packing facilities in rural areas), long-term care facilities, hospitals, and clusters related to religious service attendance; finally, the cryptic transmission from asymptomatic or presymptomatic persons, responsible for more than 50% of the overall COVID-19 attack rate, played a key role in the initiation and acceleration phases of the U.S. outbreak.

As of February 24, 2020, a total of 1,336 CDC staff members have been involved in the response, working with state, local, tribal, and territorial health departments and other public health authorities. Screening and public health risk assessment of travelers in selected U.S. airports, initiated on January 17, were also expanded, implementing quarantine measures. As of April 21, 2020, CDC staff members and U.S. Customs and Border Protection officers had screened approximately 268,000 returning passengers. During February 2020, federal/local jurisdictions did not recommend restrictions on gatherings. However, after the above said large events and subsequent COVID-19 spread, a series of recommendations (from mid-March), were taken to limit mass events (with more than 250 people). Stay-at-home orders, closure of schools and non-essential work-places were issued, including a CDC guidance for face covering in public areas. Demography (with a population density equal to 33.68, see Table 3, varying greatly inside the territory) contributed in a considerable way to the heterogeneous distribution of COVID-19 burden across the United States. The level of deaths per 100,000 inhabitants until end June 2020 was 38.44 (Table 3 and Figure 2d). The disease incidence, hospitalization and ICU admission grew consistently with increasing age >60 years than in younger classes, affecting mostly people with limited life expectancy (Alcendor, 2020; Basu, 2020; Fauci, Lane, Redfield, 2020; Holshue et al., 2020; Jernigan, 2020; Miller et al., 2020; Moghadas et al., 2020a; Peirlinck et al., 2020; Reiner Jr et al., 2020; Schuchat, 2020).

Digital tracing technologies for containing COVID-19, well developed and useful in some East Asian countries, saw a limited use in the U.S., due to its low acceptability caused by cultural and legal reasons focused on data privacy (Jacobson et al., 2020). The ICUs limited resources were overwhelmed by the surge of cases at the peaks of each outbreak, as experienced during the 2009 H1N1 pandemic, as well as the 2003 SARS epidemic in some population settings (Moghadas et al., 2020b). The highest peak demand of hospital ICU beds, far below the need, was observed in New York and New Jersey in April; the ICU capacity levels were exceeded across the United States in the following months (Reiner Jr et al., 2020).

Some researchers consider a real disaster the U.S. government response to the infection. Such a failure, emphasized by the decentralized emergency management, could have been largely avoided or at least its consequences much less devastating if rapid and appropriate measures were put in place at the pandemic early stage; on the contrary, the lack of adequate testing kits/morbidity data, as well as the inhomogeneity of *NPIs* (non pharmaceutical interventions) measures (decided and issued by each state) led to significant delays, incoherence, and inconsistencies across the territory. Furthermore, the CDC institutional capacity and emergency preparedness have been weakened by budget cuts and institutional constraints over the years, in addition to the chronic underinvestment in public health infrastructure (Xu and Basu, 2020). As already stated, mask wearing was a key task, due to the substantial evidence of COVID-19 asymptomatic transmission. In fact, in countries where mask use has been widely adopted (Singapore, South Korea, Hong Kong, Japan and Iceland among others), transmission has declined and, in some cases, halted. In the first months of the SARS-CoV-2 outbreak, restrictive *SDMs* (social distancing mandates) were issued in the U.S., but with conflicting advice about the use of masks. Several studies found that facemask mandating public use is associated with a clear reduction in the COVID-19 daily growth rate. The efficacy of masks (either surgical or N95) in preventing the transmission of *RVIs* (respiratory viral infections) is significant for both *HCWs* (healthcare workers) and non-*HCWs*, effectively filtering the SARS-CoV-2 aerosol and droplets. The risk of influenza, SARS, and COVID-19 infection can be reduced by 45%, 74%, and 96% by wearing masks, respectively (Cheng et al., 2020; Davies A. et al., 2013; Eikenberry et al., 2020; Garcia Godoy et al., 2020; Kantor and Kantor, 2020; Liang et al., 2020; Lyu and Wehby, 2020; Reiner Jr et al., 2020). On the other hand, the facemask effectiveness has been lowered in U.S. and other Western countries because individuals viewed its mandated use as a threat to their civil liberties. Additional social barriers are due to lack of *PPE* access, as well as harassment profiling in some ethnic groups (Jacobson et al., 2020).

The U.S. showed a high disparity in COVID-19 mortality among minority populations, because ethnic and socioeconomic status affects their access to quality healthcare. In fact, COVID-19 disproportionately impacted Afro-Americans (*AAs*) and Hispanics-Latinos (*HLs*) when compared with non-Hispanic Whites (non-*HWs*) from the same communities. Moreover, the death rate for the *AA* counties were found to be six times higher than the rate observed in predominant white counties, probably due to a lack of awareness and best practices, including proper hand hygiene, use of masks in public places, social distancing and physical isolation. In addition, high comorbidity has been noticed among vulnerable populations with low socioeconomic profile, depending on health disparities. Therefore, changes in public policy are essential to combat the long-standing problems associated with inequities in the U.S. health care system, more pronounced during a crisis, such as the current COVID-19 pandemic (Alcendor, 2020). The U.S. fighting strategy against COVID-19 (Table 4; Anderson et al., 2020) is not so easy to define; it can be considered an imperfect result among *mitigation*[9,11] and *suppression*[10,11].

3.8 Canada

In Canada, the first COVID-19 positive case was identified on January 25, 2020, when a 56-year-old man presented to the Emergency Department in Toronto, Ontario, with fever and cough, one day after returning from a 3-month visit to Wuhan, China. The presence of pneumonia was confirmed and COVID-19 detected after PCR swabs. The patient without symptoms was discharged home after an 8-day hospital stay. Public health followed up him and his wife at home, the latter also revealing the infection. Both patients respected home isolation, ended on February 20 after two-negative swabs (Marchand-Senécal et al. 2020; Scarabel et al., 2020; Silverstein et al., 2020). The different Canadian provinces and territories declared the state of emergency between March 12 (Quebec) and 22 (Nova Scotia). As of March 22, this country registered 1563 cases and 21 casualties (March 11: first death); the two most populous provinces, Ontario and Quebec, reported the majority of the infections (36,594; 56,407, respectively), and deaths (2722; 5628, respectively); British Columbia (which initially appeared to be most at risk because of its interconnectivity with Asia and an initial outbreak in a long-term care facility in February) documented only 2990 cases and 187 deaths; Alberta reported 8596 cases; the other provinces and territories saw relatively few cases. The outbreak peaked in early May and have been declining steadily, with fewer than 400 new cases per day from June 20 to July 13. The level of deaths per 100,000 inhabitants until end June 2020 was 22.58 (Table 3 and Figure 2d), much lower if compared with the U.S. rate, but with a population density (3.78, Table 3) 10 times below the U.S. one (Detsky and Bogoch, 2020; Marchand-Senécal et al. 2020; Scarabel et al., 2020).

The jurisdiction in Canada over public healthcare is entrusted to the 10 provinces and 3 territories, which determined containment and mitigation strategies. The federal government was supportive, but its policies were focused on issues like international border closings and managing federal *PPE* stockpiles, testing kits, and ventilators. There has been considerable cooperation between federal and provincial officials, even though responses were somewhat disorganized, with multiple layers of decision-making. In general, politicians didn’t politicalize the pandemic, and the various levels of the government showed relatively little acrimony or conflicting messaging.

The specific steps that Canada used to limit infections included: travel restrictions (with China in late January, then to other nations from March 14; the U.S. land border became effective on March 20, for the first time since Canada was founded); also interprovincial movements were discouraged; physical distancing from March 12, with the closure of schools, universities, public playgrounds, and non-essential businesses; the federal and provincial governments encouraged everyone (except essential workers) to stay at home (but not mandatory); social interactions were actively discouraged beyond people who lived in the same household, with fines issued by police for non-adherence; the size of gatherings outside of households was limited to 5-10 people, depending on the province; a substantial reduction in mobility occurred until 80% for public transit. The Quarantine Act (established by the federal government in 2005) was implemented, requiring everyone who entered the country to self-quarantine for 14 days. Facemasks, initially not encouraged, were recommended in June, becoming mandatory in Quebec, Nova Scotia, and parts of Ontario and Alberta in July.

Although the Canadian healthcare system had limited resources before the COVID-19 pandemic (1.95 acute care hospital beds per 1000 people), it was able to manage patient volumes without being overwhelmed during the first phase of the pandemic, with a rapid redeployment of resources in order to enhance the ICUs capacity. In contrast, the long-term care (LTC) facilities in Ontario and Quebec were not able to protect their residents; in fact, approximately 80% of COVID-19 fatalities involved persons living in LTC facilities. Infection rates were highest for people living and working in close quarters (migrant farm workers, factory workers, and low-income multigenerational families). With the consistent decline of new COVID-19 cases from May 4 to July 13, restrictions started to ease. However, in late June the city of Kingston, Ontario, after weeks without any infected person, experienced an outbreak connected to a single nail salon. Initially, the testing and tracing capacity was limited in many regions, but it gradually expanded across the country by June. A voluntary new COVID-19 exposure notification App became available in some regions in late July (Detsky and Bogoch, 2020). Canada entered the second wave of the COVID-19 pandemic in Autumn. The strategy of *mitigation*[9,11] (Anderson et al., 2020) proved to be insufficient for some analysts, which asked for a new "*No More Waves*" approach, requiring an immediate period of strong strategy of *suppression*[10,11] (Morris and Mintz, 2021, see also Table 4).

3.9 Mexico

The first reported cases appeared in Mexico (population density: 65.64, see Table 3) on February 28, 2020: two (35- and 59-year-old men) in Mexico City, both with a travel history to Italy; the other (a 41-year-old man) put under observation in the northern state of Sinaloa, dead on March 19. On March 7, the cases grew, including: another Mexico City patient (a 46-year-old man) with previous contacts in the U.S.; two positive women students in Torreón and Chiapas, both back from Italy; two cases of patients with respiratory disease on a cruise ship docked in Cozumel Island, Caribbean Sea. Other people resulted infected in the following days: an automotive worker (47-year-old), arriving from Italy (Puebla, March 10); two women (54- and 64-year-old) travelling back from Europe (Jalisco, 11-12 March). The Mexican General Director of Epidemiology José Luis Alomía informed (March 17) about 93 cases and 206 suspected (Abcnoticias, 2020; Caicedo-Ochoa et al., 2020; Diaz-Cayeros, 2020; El Financiero, 2020a; El Financiero, 2020b; Garcia et al., 2020; Indigo, 2020; Informador, 2020a; Informador, 2020b; Lopez-Mejia, 2021; Milenio, 2020a; Milenio, 2020b; Reuters, 2020).

By the end of June, Mexico was third in the death count (20.67 deaths per 100,000 inhabitants, Table 3 and Figure 2d) in the Americas, with the casualties skewed towards older persons (approximately 60%), mostly men. As of October 2020, Mexico saw approximately 860,000 COVID-19 confirmed cases and more than 86,000 reported deaths, although some experts estimated the true values nearly three times higher than figures reported by the Ministry of Health. This underestimation is likely due in part to the lack of COVID-19 testing, with Mexico performing the fewest tests (0.69 per 1,000 people on May 5, 2020) among the Latin American countries with available data. The majority of the confirmed cases and deaths occurred in the 21-million-people greater Mexico City, the financial, economic, and political center of the country; it is one of the largest urban conglomerates in the world, spanning 7,866 square kilometers, with 3,535 registered healthcare units in the public and private sectors (Fowler et al., 2020; Salinas-Escudero et al., 2020).

The Mexican government has implemented a series of policies divided into three stages: *stage 1*, at the beginning of the outbreak; during this period, the government emphasized public communication on the benefits of hygiene and reducing social contact (*Susana Distancia* Campaign); masks efficacy was questioned and not mandated; security personnel at the airports did not perform strict screening; the school system canceled their activities starting from March 20; *stage 2*, from March 24, when the presence of cases without travel history became evident; massive public events were canceled and non-essential activities in all sectors of the economy banned; on March 30, the Health Ministry declared the state of health emergency and launched a sentinel surveillance system to track the pandemic progression; *stage 3*, declared on April 23; the daily number of cases, hospitalizations and patients requiring specialized care rose exponentially; gatherings of more than 50 people were not allowed, while home-office recommended whenever possible; about schools, still closed, the government tried to implement remote learning in a country where only about a half of households have an internet access. In brief, Mexico measures relied principally on public communication and non-compulsory social distance, without strict lockdowns, despite several local governments made masks mandatory for public spaces and limited the supply of public transportation (Rojas, 2020; Straulino-Rodriguez, 2021). Mexico, the 15th largest economy in the world and the second in Latin America, gave an insufficient response to the pandemic, based on the *mitigation* strategy[9,11] (see Table 4; Anderson et al., 2020). This nation delayed many radical actions taken by other countries throughout Latin America. None of the other major pillars of public health, specifically focused on disease control as widespread testing, sick isolation, and tracing were deployed. On the treatment side, the government worked to increase health system capacity (under budgetary stress, particularly due to federal government measures of fiscal austerity) to provide healthcare services, but only about 20% of those with COVID-19 received medical care (Bernal-Serrano et al., 2020; Diaz-Cayeros, 2020).

3.10 Argentina

On February 26, Argentina initiated preventive assessment and self-reporting measures for travelers coming from Italy and other affected countries. On March 3, the first COVID-19 patient (an imported case, a 43-year-old man arrived from Milan, Italy) was confirmed in Buenos Aires. The first death was reported on March 9. On March 12, President Alberto Fernández declared the public health emergency. During this month, the number of people infected progressively grew.

Argentina, a nation with more than 45 million inhabitants (population density: 16.26; deaths per 100,000 inhabitants: 2.75; see Table 3 and Figure 2e) saw more than 1.5 million infections and 41,204 deaths due to COVID-19 as of 15 December 2020. Males aged 70-79 years represented 15.3% of the confirmed deceased cases. Most of them were concentrated in the Capital Federal Buenos Aires and its suburbs. The onset of the SARS-CoV-2 pandemic coincided with the arrival of a new government led by Fernández, who considered this pandemic a severe threat to his country. One of the first steps taken by the new administration was to restore the Ministry of Science and Technology, with a substantial funding increase of research projects (directed at critical goals as new diagnostic kits, therapeutic approaches, and epidemiological platforms) through the specifically created Coronavirus Unit.

By March 13, various local governments started approving lockdown rules: first the province of Jujuy, that ordered the suspension of any educational, sports, social, cultural, and religious activity; the province of Tierra del Fuego followed on March 16. A day before, the President, jointly with the heads of the two most populated districts of the country (Buenos Aires Autonomous City-BAAC, and Buenos Aires Province-BAP), had also announced lockdown measures (suspension of all educational activity throughout the country; full closure of borders for all non-residents and flights restriction; suspension of all activities and work licenses for riskier population over 60-year-old; cancellation of nonessential activities and any related crowd activity; introduction of remote working in all public sector); long-distance and regional bus services suspended, circulation within BAAC restricted; the province of Mendoza ruled quarantine too (March 20). The national government established a scale of phases[12] for the preventive and mandatory social lockdown (PMSL or *Aislamiento Social Preventivo y Obligatorio*) and mandatory and preventive social distancing (MPSD or *Distanciamiento Social Obligatorio y Preventivo*), from stricter to more relaxed ones, extended until late May. These phases foresaw diverse non-pharmaceutical interventions (*NPIs*) such as face covering, social distancing, and avoiding close spaces. Those who did not comply with this self-quarantine could have been denounced and criminal law enacted. Since April 27, the measures were progressively eased in regions and towns where the outbreak seemed to be controlled, with a certain delay in BAMA (Buenos Aires Metropolitan Area), subjected to one of the world's longest blockade (with more than 80% of cases and victims). The infection trend, showing a clear plateau in April, was shaken in May by an outburst in care homes and the disease eruption in one of the BAMA largest poor-neighborhoods, following a problem with water supplies. As August 21, Argentina surpassed Sweden in terms of total deaths, comparing to a country that did not use mobility restriction at all. With the strict shutdown, the government sought to gain time, allowing hospitals to get the equipment and human resources needed to cope with the pandemic. By the end of March, there were 8,500 ICU beds, 2,000 more than before the pandemic’s peak, 8,900 ventilators, with the aim was to have 10,000 by the end of April. In relation to the number of affected people in the course of the pandemic, the lack of validated diagnostic tests, delay in the samples’ processing, and absence of proper health-care facilities in smaller cities may have resulted in an underestimate of the total number of positive cases (Ahumada et al., 2020; Alzúa and Gosis, 2020; Garcia et al., 2020; Gemelli, 2020; González-Bustamante, 2021; Larrosa, 2020; Rabinovich and Geffner, 2021; Valcarcel et al., 2020; Vassallo et al., 2021).

In line with international guidelines, the Ministry of Education of Argentina instituted a series of Ministerial Resolutions regarding the suspension of students' attendance in schools nationwide. Teachers were required to adapt to different learning approaches but they were not always able to access the technology necessary to engage in high-quality remote learning (Coolican et al., 2020). Some researchers found that early interventions, including nationwide school closures, had a substantial impact in reducing the total amount of COVID-19 deaths (84%, 29%, and 91% in Argentina, Italy, and South Korea, respectively, see Neidhöfer and Neidhöfer, 2020). Argentina followed the *suppression* strategy[10,11] (Anderson et al. 2020, see Table 4), however with insufficient testing and contact tracing (González-Bustamante, 2021). The increase in widening critical health infrastructure was appreciable, in particular in BAAC. In any case, none regional health system has collapsed so far (Larrosa, 2020). The economic crisis due to the COVID-19 pandemic found Argentina in an already fragile economic and social situation, in the middle of a sovereign debt renegotiation, and after two years of recession, with inflation above 50% and poverty affecting 35.5% of the population. The early adoption of suppression measures helped Argentina to slow the virus spread, but with heavy economic and social difficulties. The dilemma of "economy vs health", even more challenging for Argentina given its important fiscal imbalances and high public debt burden, could turn into a more disruptive crisis (Alzúa and Gosis, 2020).

3.11 Chile

Chile (population density: 25.25, see Table 3) has a unique geography, being more than 4200 km long, divided into 16 Regions, and separated by the Andes Mountains from the neighboring nations. The Metropolitan Region (MR, located in the Central Region, with 52 administrative subdivisions called communes, and including the capital Santiago) has more than 8 million inhabitants, i.e. approximately 42% of the country's population. Land connectivity is relatively poor, with great distances between cities; therefore, Chile is relatively isolated. This might account for the great differences in the COVID-19 outbreaks among the territory. The pandemic arrived in Chile at a moment of political polarization. Since

October 2019, Chile experienced large protests in opposition to its socio-economic model, with particular regard to the inequities in health and education. Chile has a mix of public and private insurance, with substantial inequalities between high-income participants in the private system and the large majority covered by social insurance and tax-funded public health services.

The first COVID-19 case was identified by health officials on March 3, 2020: a 33-year-old man, living in San Javier and tested in Talca (Maule Region), contracted the virus spending his honeymoon in Southeast Asia. Within March 5, other three persons, also coming back from foreign places, revealed the infection. In the second half of March, dozens of positive cases were detected, mainly people returning to the country with a subsequent local transmission between their closest relatives. Then, an exponential growth started, with 1610 cases in the second half of March (most of them, around 70%, in the capital metropolitan area). Consequently, on March 18, President Sebastián Piñera declared a state of constitutional exception due to the national catastrophe. The disease spread out of the Santiago wealthy areas to low-income neighborhoods, where many residents, living in overcrowded conditions, could not afford to work from home. Later on, outbreaks appeared in other regions. As of 30 June, more than a total of 260,000 cases (distributed similarly among males and females; medium age: 41 years) was reported, with 29.16 COVID-19 deaths per 100,000 inhabitants (see Table 3 and Figure 2e), concentrated in the population over 60 year-old (around 80% of casualties). The number of cases/casualties was particularly high inside the MR and the Central Region. Except the southernmost Magallanes (with a higher rate of infections), the Southern and Northern areas were slightly affected, with the minimum in Atacama and Coquimbo. However, the government was forced to correct the data of new cases/deaths (underestimation nearly 50%), after the publication of studies reporting important gaps between Civil Registry information and COVID-19 official reports.

The Chilean Government and Ministry of Health (MINSAL) discarded the idea of a national lockdown, making public transportation always available. The measures were organized in four phases; *first phase* (between 13 and 15 March): the effort was focused on detection/traceability of imported cases and educating the population to respect hygiene and social distancing measures; on March 16, the government decreed the closure of schools, and universities voluntarily suspended face-to-face activities; *second phase* (between 16 and 26 March): after the declaration of national catastrophe, the government imposed partial lockdowns, reducing human mobility, in two municipalities in Southern Chile and seven municipalities in the MR (intermittent mandatory "*dynamic quarantines*[13]", for small areas and short 2-3 week-periods, depending on total cases growth) and a national overnight curfew (10 pm to 5 am); however, entire cities or territorial regions were not quarantined, with the exception of Easter Island (Clarín.com, 2020); other measures were taken, including light restrictions for public gatherings (only if more than 500 people), quarantine of older adults, 14 days-quarantine for travellers coming from countries with high COVID-19 incidence, quarantine of contacts of COVID-19 cases, restrictions for international and some domestic travelling (air, land or water transport); teleworking was promoted, too; thanks to these measures, an initial break in the epidemic curve was observed on 27 March; an increase of the health funding was announced on March 19 (2% of total public budget); *third phase* (between 26 March to 1 May): it began with the lockdown of the cities of Temuco (Araucanía Region, 28 March), Chillán (Ñuble Region, 28 March), Osorno (Los Lagos Region, 30 March),and Arica y Parinacota Region (16 April); at this stage, the compliance with quarantines was verified, controlling the entry and exit of quarantined areas with sanitary cords and sanitary checkpoints; in general, a relative but fragile stabilization was achieved and a progressive decrease of the infection observed, despite the number of actively infectious individuals remained consistent; the government, talking about "new normality", started to ease the restrictions in late April by reopening the economy under the "Safe Return" plan; *fourth phase* (after May 1): the relaxation of social distancing measures and reopening of society led to a marked exponential increase in the number of cases; the dynamic quarantine worked very partially, without a safe control of the pandemic at the national level, eroding people's trust in the authorities; the strategy imposing/lifting lockdowns in small geographical areas (municipalities), proved unsuccessful, due to high interdependencies present in the Greater Santiago; the delayed response to implement larger-scale lockdowns in the capital poorest neighborhoods, with high rates of household overcrowding and poverty, caused the explosion of a new wave of infections; therefore, the government was obliged to declare again hard massive restrictions in mid-May (interesting at least five million people of the MR and 60% of Chile's population, including Valparaiso and Antofagasta), due to the pressure of the Chilean Medical Association, scientific societies, universities, Chilean Association of Mayors, and civil society organizations. Protests sparked in late May, mainly in Santiago, because of food shortages in certain sectors of the population. The case counts continued to increase in June (concentrated in the MR, Valparaiso in coastal central Chile, and Biobio in the South); only three communes (Vitacura, Las Condes and Providencia) maintained consolidated low levels of the disease. With a low and highly unequal distribution of hospital capacity, critical beds and physicians across the different regions of the country, concentrated mostly in the MR, a worrying increase in the ICUs occupation followed (89% nationally, 95% in the MR), with approximately 2,000 patients undergoing invasive mechanical ventilation and a significant growth in the victims' number. The Chilean Institute of Engineering Complex Systems analyzed the change in movement of some MR counties; Las Condes and Santiago presented a reduction of movement near 60% and 40%, respectively; however, in counties with higher vulnerability, such as Puente Alto, El Bosque and La Pintana, the reduction was only between 20 to 30% during the periods of mandatory lockdown. By mid-July, when the pandemic started to decline, the government implemented the "step by step" ("*paso a paso*") strategy of gradual opening, at the municipality level, based on the periodic monitoring of epidemiological and health system indicators. Chile initially lacked an extensive and systematic testing campaign at the national level in the first stages of the pandemic, due to insufficient laboratory capabilities to meet the demand. Nevertheless, the country expanded quickly the performance (the best in Latin America) until 1 million PCR (polymerase chain reaction) tests performed up to June 30. Anyway, the diagnostic efforts remained insufficient, with many hidden asymptomatic cases undetected by epidemiological surveillance. Testing distribution was concentrated in the most populated urban areas and MR, with important differences across the country (Benítez et al., 2020; Caicedo-Ochoa et al., 2020; Canals et al., 2020; Castillo et al., 2020; Garcia et al, 2020; Grebe et al., 2020; Tariq et al., 2021; Valcarcel et al., 2020; Villalobos Dintrans et al., 2020).

Several shortcomings, especially in the pandemic first phase, affected the action of the Chilean government: delay in reporting of molecular test results; ineffective isolation of infected people; inadequate quarantine of travelers coming from other countries; low levels of *PPE* and medical supplies; lack of information about new cases and mortality; and insufficient contact tracing (Garcia et al, 2020). The fragmented healthcare system was pushed to its limits, with multiple factors that may have influenced this unsatisfactory performance: the presence of enormous social inequalities in large population groups living in overcrowded, precarious conditions; the socio-cultural changes generated by the neoliberal development model, that created high levels of individualism and little capacity to guarantee essential social rights; the loss of credibility and trust in authorities and institutions, aggravated by the social and political revolt started in October 2019 (Artaza, 2020).

The mixed control strategy adopted in Chile, representing a compromise between mitigation[9,11] and suppression[10,11] (see Table 4), resulted generally ineffective: dynamic quarantines failed at the aggregate regional level (municipalities without or with partial quarantine, and municipalities that left quarantine too early relapsing soon after); testing became consistent after months of delay; contact tracing missed an early response (Grebe et al., 2020; González-Bustamante, 2021). Finally, mandatory use of facemasks on public and private transportation was announced only on April 6, 2020 (CNN, 2020).

3.12 Peru

Peru (population density: 25.66; at the end of June 2020, 28.26 deaths per 100,000 inhabitants; see Table 3 and Figure 2e) detected its first COVID-19 case on 6 March 2020. He was a 25-year-old man living in the capital Lima, working for a Latin American airline, with recent travel history to France, Spain and Czech Republic, returned to Peru on February 26. The patient isolation and treatment were at home, but he infected two social and six family contacts. Among them, the first casualty occurred on March 19.

By April 15, 11475 cases (8412 in Lima), and 254 deaths were reported. As on June 21 (with a total of 254,936 infected, 10,566 hospitalized, and 1,137 in ICU patients), Peru showed the worst indicators and therefore was classified among the countries with the highest COVID-19 mortality rate around the world. Lima Metropolitan area, with a high population density and a significant informal economy sector, had the largest death rate per population (110 per 100,000 inhabitants). However, the uncertainty of the data was high, due to the particularly low quantity of tests at the beginning of the outbreak, with only one PCR processing laboratory in the country. The deceases were concentrated among men (60 years-old and over), accounting nearly 70% of deaths.

Peru knew a situation of great political instability before, during, and after the COVID-19 pandemic. President Kuczynski resigned in March 2018, accused of corruption; he was replaced by the vice Vizcarra, subjected to the impeachment for moral incapacity on November 2020; but the substitute Merino stayed in place only for five days; in fact, he was forced to leave after strong protests across the country, with the subsequent succession of the current President Sagasti. Closed the Parliament on

September 2019, the political elections occurred on January 2020. Furthermore, Peru saw seven ministers of health since July 2016: the sixth was fired soon after the declaration of the state of national emergency and lockdown (March 15, 2020).

Peru tried to implement a stringent suppression strategy[10,11] (see Table 4). On 11 March 2020, the government declared a health emergency, delayed the start of the academic year, and ordered travelers from China, France, Italy, and Spain to be quarantined at home or in hotel rooms for 14 days; the measures adopted at the international airport, not so rigid as necessary, were essentially the temperature control of arriving passengers and an health form affidavit, added after some days. On March 13, universities were closed, public events with more than 300 people banned, and social distancing/remote working promoted. On March 15, Vizcarra declared the state of national emergency with a strict lockdown, allowing the circulation only for critical activities. National borders were closed the day after. On March 18 a nightly curfew from 8 PM to 5 AM was nationally imposed, with the police and military force support. Additional measures were implemented in the following weeks, such as mandatory outside facemask wearing and restricting movements by gender, just to purchase food and medicines.

The distribution of infected people spread from the initial places to the densely populated and low-income districts; markets became the focal points of outbreak, being controlled by public forces only at the end of April. Another mechanism producing contagion was due to the crowds without any personal distance produced in the bank offices when the government announced that the economic support bonuses for vulnerable families began available. Safety provisions were not followed by all citizens: by March 30, the number of people detained at police stations for breaking the curfew reached 33,000. The closure of public transport and markets generated a massive outflow of workers from Lima to the periphery of the country, with hundreds of families walking together for days to their residence regions, probably spreading the virus in the rest of the territory.

As already said, testing and contact tracing presented the problem of late response and reliability. Peru started with 3,000 tests per day, reaching the maximum of almost 50,000 in a single day, and conducting approximately one million and half evaluations until the end of 2020. Both molecular and serological tests were performed; of the nearly 124,000 confirmed cases reported as of May 25, only 27% had been detected by PCR; the rest were positive results from antibody tests. In Peru the electronic tracking through cell phones was absent. Therefore, tracking was essentially administrative;

the free telephone numbers of the Ministry of Health were quickly overwhelmed.

Healthcare workers, subjected to detrimental effects in the mental status, protested many times for the lack of *PPEs*, driving to 1713 infected, 41 ICU-hospitalized, and 60 dead doctors. There was also a serious problem with oxygen supplies, as well as not enough beds, insufficient ICUs and ventilators. A new hospital in the capital, dedicated exclusively to COVID-19 patients, was set up, adapting the 2019 Pan-American Games buildings as a place for quarantine and less complex cases. Prisoners in overcrowded jails were particularly affected by the pandemic: this 0.3% of the population represented 6% of COVID-19 casualties.

The first COVID-19 case in the Peruvian Amazon was detected on March 17. Rural indigenous peoples have historically encountered the steepest barriers to health services and endured profound discrimination based on ethnicity, poverty and language. Malnutrition, infectious diseases and chronic illnesses characterize their epidemiological profile. The health services collapsed in some remote regions with a prevalence of indigenous population, predominantly living in the rural Andes or the jungle, mostly characterized by poorer health outcomes, food insecurity, household overcrowding, and often without access to running water. The indigenous federations banned the entry of foreigners, but most communities tolerated residents to travel to larger towns to purchase supplies, sell produce or claim social support; in addition, strict home quarantine on return was seldom observed, especially after visiting crowded urban markets identified as infection hotspots; use of facemasks was not systematical and shortage common. In Iquitos (capital of Loreto region, with no connection by road and flights interrupted), patients overflew into the corridors of the regional hospital, oxygen tanks and test kits missed, the number of victims was closer to 800 (as of May 13), 17 local doctors died in March. The COVID-19 virus also spread in the neighboring Ucayali region, where there were 3200 cases and 114 confirmed deaths, as of May 25. Centrally planned lockdown measures were hardly feasible in the Amazon context, due to lack of external provision of supplies and local availability of social support.

The pandemic trend increased in Peru during all April. Later, when the epidemic curve showed a stabilization, the economic activities started to reopen; some industries and services (mining, construction, tourism and retail) resumed their activity from May onwards. However, the incidence of confirmed cases gradually grew again in the following weeks, peaked in early June and subsequently found a higher level plateau (Alvarez-Risco et al., 2020; Benítez et al., 2020; Bill of Health, 2020; Caicedo-Ochoa et al., 2020; Fraser, 2020; García, Veneros, and Tineo, 2020; Garcia et al., 2020; Gonzales-Tamayo et al., 2020; González-Bustamante, 2021; Grebe et al., 2020; Machicao, 2020; Mejia et al., 2021; Mendoza-Saldaña and Viton-Rubio, 2020; Meneses-Navarro et al., 2020; Munayco et al., 2020; Reinders et al., 2020; Salinas-Escudero et al., 2020; Solari, 2020; Valcarcel et al., 2020; Yáñez et al., 2020; Zegarra-Valdivia et al., 2020).

Due to the Peruvian fragmented and underfunded healthcare system, self-medication (with acetaminophen, ibuprofen, azithromycin, penicillin, antiretrovirals, and hydroxychloroquine) became evident during the COVID-19 pandemic, without sufficient scientific evidence and no confirmed clinical efficacy against SARS-CoV-2 (Quispe-Cañari et al., 2020).

The mandatory social distancing and mobility restrictions implemented by the Peruvian government were gender-based, with different days for men (Monday, Wednesday and Friday) and women (Tuesday, Thursday and Saturday) to circulate in public spaces. On Sunday no Peruvian citizens were allowed to leave their homes. Forbidding any access to essential services, these measures deprived transgender persons (outside of the conservative binary classification) of their identities, exposing them to direct brutal violence (documented by videos, photos, and comments circulating on social media) from law enforcement officials, in charge of implementing this regulation, with a well-known historical role as agents of institutionalized transphobia. Moreover, health inequalities of these marginalized communities were strongly exacerbated. The LGBTQ Human Rights Observatory at the Universidad Peruana Cayetano Heredia documented eleven cases of violence and related suffering experienced by gender non-binary people. The rise of transgender activism, contesting these policies and collecting donations through mobilization efforts, underscored the critical role of civil society in promoting solidarity and justice during the COVID-19 pandemic (Garcia-Rabines and Bencich, 2020; Perez-Brumer and Silva-Santisteban, 2020).

3.13 Brazil

On 20 January 2020, the Brazilian Ministry of Health created an Emergency Operations Center, in preparation for the COVID-19 pandemic; a Public Health Emergency was declared on February 3; three days after, the Ministry of Health approved the Quarantine Law, regulating restrictive measures, with significant innovations to the Brazilian legislation, followed by the Decree No. 356 of March 11 (De Freitas Lima Ventura et al., 2020).

The first COVID-19 case was detected on February 25. He was a 61 years-old man, traveling back from Milano (Lombardia, Northern Italy), arrived in São Paulo, the most populous city (23 million people) in the Southern hemisphere (Brazil overall population density: 24.96, see Table 3), on February 21. At home, he infected at least two local contacts. After entering the Hospital Albert Einstein with fever, dry cough, sore throat, and coryza, he resulted positive at the PCR test. There, he received standard care, and then passed the quarantine at home. Other four patients, declaring journeys from abroad, caused SARS-CoV-2 multiple independent introductions, followed by virus local transmission. In fact, São Paulo usually is the final destination of nearly half of the passengers arriving to Brazil, followed by Rio de Janeiro (with the main seaport of the country too) and Belo Horizonte. Approximately 50% of all imported cases probably were associated with infected travellers coming from Italy, while much less from China and France (9% and 8%, respectively). Within mid-March, COVID-19 reached all the Brazilian federal states, with a certain heterogeneity among them. The carnival celebrations (9-25 February 2020) in the cities of Salvador, São Paulo, and Rio de Janeiro registered an average of 16.5, 15.0, and 6.4 million of people, respectively, with many tourism arrivals; these mass gatherings could have contributed to the rapid spread of the outbreak. The pandemic grew quickly: 27.11 deaths per 100,000 inhabitants at the end of June 2020 (see Table 3 and Figure 2e); furthermore, as of 12 July 2020, Brazil reported approximately 1,800,000 cases (34% concentrated in the São Paulo Southeast region, with 45% of victims), and more than 70,000 deaths, the largest figures in Latin America. Overcrowded urban spaces with poor systems for water supply, sanitation, and waste collection were the main factors that would have facilitated the virus spreading; infection attacked harder neighborhoods with lower income levels, where social distancing was almost impossible in small, overcrowded and poorly ventilated single-room houses. Moreover, poor people, suffering catastrophic declines in well-being and quality of life, seemed more reluctant to social isolation due to various difficulties (attainment of food and wage; lack of formal jobs or less flexible work; fear of losing their employment; and need of resources/services). COVID-19 infections revealed a high proportion in middle/older-age individuals (cases: median age 59 years, 57.5% male; deaths: 59% men, 70% people over 60 years). The most prevalent comorbidities were cardiovascular disease and diabetes.

In addition to the provisions described above, the Brazilian federal government didn’t foresee the implementation of key policies to fight the virus, except some recommendations for social distancing (March 13). There was no federal coordination with indispensable guidelines of the public health response. President Jair Bolsonaro persistently rejected social distancing recommendations made by international and Brazilian organisms, declaring on several occasions that the pandemic was just a light flu. Two health ministers resigned in one month (May 2020), and the third was fired in March 2021. Three weeks were lost; national borders were checked with delay, with ineffective health screening at the international airports. Instead, the actions took place at the state and municipality levels, even asynchronous in time and inhomogeneous in entity. The State of São Paulo was the first since March 16: issuing guidance to “stay at home” and remote work; closing schools, museums, public buildings, parks, beaches, and all establishments providing non-essential services (bars, restaurants, and bakeries, except for delivery and “drive thru” services; nightclubs, shopping centers, gyms and fitness centers); essential services were considered only those related to food, healthcare, essential good supply, and security. With substantial variation of measures between territories in the extent and timing, other states followed shortly after: Federal District of Brasília, Acre, Amapá, Amazonas, Alagoas, Bahia, Ceará, Espírito Santo, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, Paraíba, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Norte, Rio Grande do Sul, Rondônia, Santa Catarina, Sergipe, Tocantins. More than three thousand municipalities adopted *NPIs*, closing non-essential services, prohibiting large gatherings, reducing public transportation, and implementing sanitary cordons. However, population felt lack of transparency, authoritarianism and censorship, with continuous changes in the methodologies used to calculate cases, deaths and other relevant indicators; No public data for daily tests and ICU patients were available; medical professional associations and research institutes were questioned; political tensions and conflicting messages impacted the country’s capacity to contain the virus spread. Although state governors, mayors, and Ministry of Health officials were urging people to stay home and maintain social distancing, the president was dismissing the COVID-19 danger, encouraging people to continue working, in order to avoid the economic collapse. Given these contradictory views, the Supreme Court declared that decisions about quarantine and other COVID-19-related restrictions should have been made by local authorities. The Court also restored the publication of epidemiology reports, previously cancelled by the government. *NPIs* measures were eased too early (end of March), and Brazil opened its borders to international air travel tourists in July 2020.

In the first phase of the pandemics, the effective reproduction number R_t[11] values were found higher than 3 in São Paulo and Rio de Janeiro; this indicates that community-driven transmission was already established in Brazil by early March, suggesting that international travel restrictions initiated after this period would have had limited impact. After the state-mandated *NPIs*, R_t dropped substantially, but remaining above 1 for several months, missing consistent mobility reductions, because a general lockdown was not implemented to prevent people mass movement. The continued increase of COVID-19 cases and deaths highlighted the urgent need to implement diagnostic screening, contact tracing, and strict quarantine of new cases. On the contrary, due to the initial weak testing/tracing policies, a considerable underestimation of confirmed cases would have been possible. In the period February-March, 2020, most of the diagnostic tests were performed only on persons with moderate to severe symptoms in private medical laboratories; they were enough expensive (300-690 Brazilian Reais, BRL) for a current minimum monthly salary of 1,045 BRL. Later, the testing capacity expanded, thanks to rapid tests, cheaper but less reliable. Several factors, including non-equitable and heterogeneous access to testing/diagnostic across the population, delays in reporting, and changes in notification, obfuscate the prompt assessment of the virus transmission.

Although Brazil is a country with a national healthcare system with universal coverage, it has been affected by important vulnerabilities: insufficient resources and staff; fragmentation/fragility in the most affected areas; regional disparities; difficult access by lower income strata; modest communication capability; and lack of coordination. Brazil allocated less than 1 dollar per capita in the middle of March for actions related to stopping the COVID-19 spread, although the country increased substantially the health package in the following period. Brazil had the highest rate of ICU beds per population, but the regional distribution was uneven; therefore, the most affected areas reached quickly 100% occupancy, overwhelming the capacity of the hospital facilities. By 31 May 2020, 91% of COVID-19 patients were hospitalized; of these, 30% were admitted to ICUs, with a median length of ICU stay of five days. These structures were reinforced later on by increasing ICU beds and ventilators, personnel, *PPE* and other supplies. On March 27, Ministry of Health made official the use of chloroquine and hydroxychloroquine for patients with severe COVID-19 forms.

In Brazil, only mitigation[9,11], and not suppression[10,11], of the pandemic has been achieved (see Table 4), being herd immunity far from to be reached (Benitez et al., 2020; Caicedo-Ochoa et al., 2020; Cimerman et al., 2020; Croda and Posenato Garcia L., 2020; Croda et al., 2020; Da Silva Candido et al., 2020a; Da Silva Candido et al., 2020b; De Souza et al., 2020; De Souza Santos et al., 2021; Freitas Reis et al., 2020; Garcia et al., 2020; Goes de Jesus et al., 2020; González-Bustamante, 2021; Grebe et al., 2020; Hajar et al., 2020; Mayer Brown, 2020; Mellan et al., 2020; Rodriguez-Morales et al., 2020; Salinas-Escudero et al., 2020; Silveira et al., 2020; Teixeira, 2020; Valcarcel et al., 2020).

In Manaus (the largest metropolis in the State of Amazonas, with more than 2 million inhabitants and a population density of 158 inhabitants/km^2), the first COVID-19 case was confirmed on 13 March 2020; it was followed by an explosive epidemic, peaking in early May, followed by a consistent drop in new cases despite *NPIs* relaxation. A study made on blood donors indicated that 76% of the population had been infected with SARS-CoV-2 by October, 2020. This attack rate would be above the theoretical herd immunity threshold (67%), given a basic case reproduction number R_0 of 3. The abrupt increase of COVID-19 hospital admissions in Manaus (1-19 January 2020: 3431; 1-19 December 2020: 552) was unexpected and of concern. In fact, after a large peak in late April 2020, COVID-19 hospitalizations in Manaus remained stable and fairly low for seven months, from May to November. There are at least four non-mutually exclusive possible explanations for this resurgence: i) the attack rate could have been overestimated during the first wave, and the population remained below the herd immunity threshold until the beginning of December, 2020, when a greater mixing of infected and susceptible individuals occurred; ii) herd immunity might have already begun to wane by December, 2020 because of a general decrease of the protection after a first exposure; however, waning immunity alone is unlikely to fully explain the above said resurgence, also in a period of decreasing mobility; iii) the SARS-CoV-2 lineages (two circulating in Brazil and one detected in Manaus on 12 January 2021) might evade immunity generated in response to the previous infection; iv) SARS-CoV-2 lineages circulating in the second wave might have higher inherent transmissibility than pre-existing lineages detected in Manaus. Therefore, Manaus represents a “sentinel” population, giving indication of what may happen if SARS-CoV-2 variants are allowed to spread largely unmitigated (Sabino et al., 2021; Buss et al., 2021).

3.14 Spain

The COVID-19 pandemic started in Spain (population density 92.40, see Table 3) on 31 January 2020, when a German tourist tested positive in La Gomera, Canary Islands; however, it was just an isolated imported case (Oliver et al., 2020). On February 13, the first death in Valencia (diagnosed post-mortem) was recorded, involving a 69-year-old man who visited Nepal. The city of Vitoria (capital of Alava Province, Basque Country), experienced a massive contagion during a funeral (February 24, see Barrasa et al., 2020). On February 25-26, at least eight new cases, related to the Italian cluster, were detected: a medical doctor (from Piacenza), his wife, and two friends, spending their holidays in Tenerife, Canary Islands; a 36-year-old Italian woman and a 22-year-old man living in Barcelona, who visited Italy before; a 24-year-old man from Madrid, recently returned from Northern Italy; a man from Villarreal, in the Valencian Community, after travelling to Milano. As already said, an important outbreak was linked to the Champions League soccer match with Atalanta, the team of Bergamo: first leg in Milano, February 19; return match in Valencia, March 10 (Corriere dello Sport, 2020; Bergamonews.it, 2020a). In the following days, the infection spread quickly in all Spain: Andalusia, Aragon, Asturias, Balearic Islands, Basque Country, Cantabria, Castile and León, Castilla-La Mancha, Catalonia, Extremadura, Galicia, Guadalajara, La Rioja, Madrid and Valencian Community, Murcia, Navarre, Tarragona; by March 13, cases had been confirmed in all 50 provinces and the autonomous city of Melilla; the Autonomous City of Ceuta (first positive two days after), El Hierro (first positive on March 20) and Formentera (first positive on March 29) islands were the only territories without cases reported (Wikipedia, 2020d). As of end-June, 2020, 63.57 deaths per 100,000 inhabitants were registered (see Table 3 and Figure 2f).

After the provisions issued by the Spanish Episcopal Conference on March 6 (removing the holy water from the pillars, avoiding to shake hands as a way of giving peace, forbidding to kiss religious images), the first restrictions were taken in an uncoordinated way, depending on the Spanish local authorities: confinement of single municipalities (Haro in La Rioja, March 7; Igualada, due to the contagion focus in the local hospital, Vilanova del Camí, Òdena and Santa Margarida de Montbui in Catalonia, March 12; Arroyo de la Luz, Estremadura, March 13; coastal municipalities in the Murcia Region, March 13); cancellation of educational activities (a kindergarten in Barcelona, March 7; all the schools in the municipalities of Vitoria and Labastida, March 7, and Álava, March 11, in the Basque

Country; classes at all educational levels in the Madrid Autonomous Community, March 7; all the public universities in Madrid, March 10; classes in la Rioja Region, March 10); ban of social events (suspension of events with more than one thousand attendants in Madrid, La Rioja and Vitoria, declared by the Spanish Government, March 10; this decision was followed by the Catalonia Region on March 11; postponement of the Falles of Valencia, for the fifth time in its history, and the Magdalena Festival, in Castellón, issued by the Valencian Government, March 10; cancellation in Madrid of the main tribute in honor of the 11-M terrorist attacks in Atocha, March 11); mobility limitations (suspension of direct flights between Spain and Italy, March 10; request of closure of all Catalonia's ports, airports and railways, March 10; request of traffic interruption between the mainland and the Balearic islands, March 10); interruption of commercial activities and tele-work encouraged (closure of bars and terraces in the capital until its total confinement, March 13; closure of all shops except those selling food and basic necessities in Asturias, Catalonia, Cantabria, Galicia and Madrid, March 13; the same decision followed the day after in Murcia Region and Basque Country); closure of parks and public gardens in Madrid (March 14). Under the pressure of the pandemic growth, some wide-range decisions were issued: suspension of the activities at the Assembly of Madrid and Andalusia Parliament, March 11; cancellation of classes at all educational levels in Aragon, Asturias, Balearic Islands, Basque Country, Canary Islands, Cantabria Castile-La Mancha, Catalonia, Estremadura, Galicia, Murcia, Navarre, and the city of Melilla, with a total of 14 out of 17 communities and one autonomous city, March 12; more than 10 million students started to stay at home, after the nationwide closure declared the same day; declaration of sanitary emergency in the Basque Country, allowing the population confinement, March 13 (Wikipedia, 2020d). When the national lockdown (home confinement with few justified exceptions) was declared on March 14, 2020 (and enforced the day after), Spain presented 5753 confirmed cases and 136 deaths. The state of emergency was declared until March 29, and then extended twice, the first time until April 11, and the second until April 26 (Dos Santos Siqueira et al., 2020; Rodríguez-Rey et al., 2020). The postponement of elections in Galicia and Basque Country, scheduled for 5 April, was issued on March 16. Spanish frontiers were closed the same day.

Despite the lockdown efforts, there was a two-week exponential increase of confirmed cases, hospital/ICU admissions, mortality trends, that no expert had predicted. Therefore, on March 30, new mobility restriction and social distancing measures were implemented. As of April 6, with 135,032 confirmed cases and 13,055 deaths (respectively 9.45% and 18.75% of the world's total), Spain became one of the countries with the highest number of fatalities (after Italy) and cases (after United States). The economic and social impact was without precedent. In the period March-June 2020, the monitoring system of the Carlos III Health Institute recorded 43,000 excess deaths, which the National Statistics Institute raised to 48,000. After a reduction of the pandemic trend, the state of alarm ended on June 21. The government started to ease the lockdown with a gradual lifting of restrictions. However, the number of COVID-19 cases increased again: at the beginning of July, Spain ranked seventh in the world in terms of absolute number of victims; as of October 12, the country suffered 861,112 confirmed cases and 32,929 deaths. The most affected areas were the Madrid Community, Basque Country, Catalonia, La Rioja, and Castile-La Mancha Regions, probably due to: higher demographic density in the most populated zones; people interconnection and mobility before the lockdown and not negligible after it; disease transmission by asymptomatic patients in allowed environments, such as working firms, healthcare facilities, supermarkets, and pharmacies. Ceuta and Melilla, located in the North region of the African continent where the first infected persons were identified later than the Iberian Peninsula, practically did not suffer great consequences, emphasizing the benefits of early closures. Studies have suggested that the number of reported cases/deaths may had been underestimated due to lack of testing. Many people with only mild or no symptoms were not detected; on 6 July 2020, a nationwide seroprevalence investigation showed that about two million people (5.2% of the entire population) could had been infected during the pandemic. In addition, the disease of healthcare professionals must be mentioned. The first death of a worker, a nurse from the Basque Country, was reported on March 19. As of July 23, the medical personnel experienced high infection rates (more than 50,000), and nursing homes saw nearly 20,000 deaths in elder people, a particularly fragile social group with multiple comorbidities. In fact, the Spanish age distribution was another decisive factor in the COVID-19 incidence; being one of the most aged countries in the world, this nation is characterized by close daily intergenerational contacts, even if the elderly relatives live in small and old houses (Aleta and Moreno, 2020; Dos Santos Siqueira et al., 2020; García-Basteiro et al., 2020; Lancet, 2020; Legido-Quigley et al., 2020; Molina et al., 2020; Oliver et al., 2020; Perez-Bermejo and Murillo-Llorente, 2020; Rodríguez-Rey et al., 2020; Saez et al., 2020; Wikipedia, 2020d).

Nevertheless negative psychological effects, social resilience and support to the *NPIs* were clear in the Spanish population; up to 97.3% viewed the measures as necessary. The medical staff, sometimes stretched to the point of exhaustion and exacerbated by the quarantining of a growing number of them, showed clear professionalism, carrying out the work with a certain degree of creative improvisation. The healthcare system proved insufficient after years of austerity, revealing unquestionable social inequalities. Reinforced in the emergency with band-aiding measures (cancelling holidays, bringing retired nurses and doctors back into the health service, hiring graduates without specialization and final year medical/nursing students), it did not break down. However, a lack of pandemic preparedness and governance was evident: weak surveillance systems; initial low capacity in PCR testing; inadequate critical care equipment with an insufficient number of ICUs/ventilators; scarcity in *PPE*, especially facemasks due to early panic buying. The most affected areas, Catalonia and Madrid in particular, cancelled non-emergency surgery and cleared beds where possible, due to their overwhelmed facilities; telephone help lines underwent long delays or simply collapsed in some regions. In addition, slow decision-making processes, delayed reaction, and poor coordination by central and regional authorities were evident. The Health Alert and Emergency Coordination Centre (*Centro de Coordinación de Alertas y Emergencias Sanitarias*), created in 2004, didn't provide the necessary effectiveness (García-Basteiro et al., 2020; Lancet, 2020; Legido-Quigley et al., 2013; Legido-Quigley et al., 2020; Molina et al., 2020; Rodríguez-Rey et al., 2020). Until the declaration of the State of Alarm, mobility remained unchanged; the entry of citizens from countries severely affected by the pandemic (especially Italy) was allowed without any restrictions; numerous mass demonstrations was authorized on March 8, on the occasion of Women's Day, mainly in the city of Madrid, as well as celebrations in the Fallas of Valencia and other sports events (Perez-Bermejo and Murillo-Llorente, 2020).

An improved test-trace-isolate strategy was implemented only in May; by late June, more than 80% of COVID-19 suspected cases were PCR-tested within 48 hours, and 90% of patients had their contacts traced. Although strategies and protocols were implemented, weaknesses persisted in the system, i.e. chronic underinvestment in public healthcare, digitalization, research, and innovation; bureaucratic procedures, and little availability of trained professionals (Sierra Moros et al., 2021). In Spain there were some political controversy about the effectiveness of the *NPIs*, i.e. whether an effective and consolidated flattening of the infection curve were achieved, among mitigation[9,11] and suppression[10,11] strategies (Table 4). The strict lockdown measures were effective during the first half of 2020, and the COVID-19 contagion curve flattened enough to significantly reduce the number of new cases. Therefore, several restrictions were relaxed between May 11 and July, 2020. Unfortunately, reopening too quickly led to a strong outbreak resurgence, because background of virus remained somewhere. The dramatic increase in the number of new positive cases required the adoption of new restrictive measures at the beginning of October, particularly in highly dense urban areas with high levels of contagions (Casares and Khan, 2020; Saez et al., 2020).

3.15 France

SARS-CoV-2 seemed to be already spreading in France (population density 101.39, see Table 3) since late December, 2019 (Desson et al., 2020b; Wikipedia, 2020e), but the first three certified COVID-19 cases were confirmed in the second half of January, 2020 in Bordeaux and Paris. Case 1 was a 48-year-old male patient living in France, travelling for professional reasons in China in various cities including Wuhan; he did not report any visit to markets, exposure to live animals or contact with sick persons during his stay; however, a visit to family members and friends was confirmed; after experiencing symptoms (fever, headaches and cough) on January 16, he flew back to Bordeaux and then admitted to the local hospital on day 23, isolated and tested positive. Cases 2 and 3 were a Chinese tourist couple (a 31-year-old male; a 30-year-old female); leaving Wuhan on January 18, they developed symptoms arriving in Paris the day after; the infection was confirmed on January 24 for both of them; neither of the two persons reported any visit to markets, exposure to live animals or contact with sick persons; the male patient was admitted to ICU on January 29 and discharged from hospital on February 12. All the contacts were identified and followed; secondary transmission events were considered negligible (Stoecklin et al., 2020). Then, other three cases occurred: an 80-year-old male Chinese tourist from Hubei and his daughter (admitted to hospital in Paris on January 28-29); the man died on February 15, the first COVID-19 victim in France; a doctor (January 30), always in Paris, after a contact with a Chinese tourist (Wikipedia, 2020e). In February, four clusters were reported in Haute-Savoie, Oise, Morbihan, and Haut-Rhin, mainly due to contacts with people travelling back from Singapore, China, Italy, or Egypt. On February 8, a group of people spending a holiday in Les Contamines-Montjoie (Haute-

Savoie), contracted the infection from a British man who had attended a conference in Singapore a few days before. On February 25, a 60-year-old French teacher from Crépy-en-Valois (Oise Department) was first admitted to Creil Hospital, then transferred to Paris, where he died a few hours later. The same day: an Oise 55-year-old man was admitted to ICU at Amiens; a 64-year-old man from La Balme-de-Sillingy (Haute-Savoie Department), returned from a trip to Lombardia on February 15, tested positive and was treated in the Centre Hospitalier Annecy-Genevois, at Épagny-Metz-Tessy; his wife also tested positive and was admitted to the same hospital. On 26 February 2020, a 36-year-old man, after multiple trips to Lombardia, tested positive and was treated in a Strasbourg hospital. The Haut-Rhin outbreak occurred in Mulhouse city, where one religious event (Christian Open Door Church, from 17 to 21 February, 2020) brought together 2000-2500 participants from all over France and several other countries (Belgium, Switzerland, Germany, and Burkina Faso); many attendees became infected and then the virus spread onwards when they returned home. The Oise cluster, near Paris, appeared in late February around a military airbase employing around 2500 people; several staff members had been involved in the repatriation of a French citizen from China (occurred on January 31). The COVID-19 pandemic extended rapidly and exponentially from Northeastern France (Grand-Est) towards the North-central regions of Île-de-France and Haut-de-France. On February 28, a 23-year-old fashion student from Nice, recently returned from Milan, and a woman of Mont-de-Marsan (Landes Department) confirmed the first COVID-19 cases also in Southern France (Desson et al., 2020b; Gaudart et al., 2021; Wikipedia, 2020e). A cluster of COVID-19 involved a high school in the Oise Department, thanks to a study by antibody detection (Fontanet et al., 2020).

After the flights limitations with China (started since January 23), ban of gathering (more than 5000 people: March 5; then 1000: March 14; and 100: March 16), the closure of all the schools and universities was announced by Emmanuel Macron on 12 March 2020, followed the day after by pubs, restaurants, cinemas, and nightclubs. A study conducted from March 5 to April 7 detected SARS-Cov-2 viral particles in Paris wastewaters (Wurtzer et al., 2020). In spite of the pandemic growth, the first round of the municipal elections took place on March 15, with minimal changes to voting procedures, aside from priority lines for vulnerable people and recommendations to maintain safe distances from others. In fact, most measures initially came just in the form of light recommendations for safe practices to slow the spread of the virus, but in many cases these were largely ignored. Also the policy approach regarding border control was enough contradictory: France initially issued a loose recommendation to arriving travellers to self-isolate for 14 days upon arrival, followed by a complete closure of their borders to non-essential travellers alongside the lockdown measures, resulting in confusion amongst citizens about the severity of the disease. In fact, on March 17, as France had already recorded a total of 7730 cases, saturation of ICU beds, and 175 deaths, with an incidence doubling every 3 days, a national lockdown (extended until May 11) was ordered by the government, imposing also the closure of the Schengen area borders as well as the postponement of the second round of municipal elections. Tens of thousands of police officers patrolled streets, issuing fines up to 135 euros to people without a written declaration to justify their reasons for being out of their homes. After these *NPIs*, including the mandatory use of mask for indoor public spaces, the infection reached the rest of the country more slowly. In the Southeastern region, the most densely populated department (Bouche-du-Rhône including Marseille, the second largest French city) was hit more severely than the surrounding ones, in terms of cases and mortality numbers. Île-de-France, Grand-Est, Auvergne- Rhône-Alpes, and Hauts-de-France accounted for more than 74% of all ICU patients nationwide; many of the hospitals in these regions were overwhelmed, in some instances forcing hospital workers to make rationing decisions regarding the distribution of necessary care; the government was required to mobilize the military to evacuate some patients to less affected regions within the country or even to send some by air to Germany and Switzerland. By June 10, France was one of the most affected countries, with 150,000 cumulative cases and nearly 30,000 associated deaths (Desson et al., 2020b; Faranda and Alberti, 2020; Fontanet et al., 2020; Gaudart et al., 2021). As of end-June, 2020, 45.55 deaths per 100,000 inhabitants were registered (see Table 3 and Figure 2f).

Since early March, Santé Publique France (SPF), the centralized national agency for public health, published regularly an official dashboard with detailed epidemiological statistics about region, age, gender, and daily reports on key data such as case numbers, hospitalizations, and deaths. The COVID-19 impact in France was distributed disproportionately amongst men and older populations, with over 90% of total deaths due to the virus occurring in over 65-year aged male people; furthermore, serious risk factors for mortality depended on one or more pre-existing comorbidities, principally hypertension and other cardiovascular diseases, diabetes, and obesity. Poverty and ethnic minority status were also correlated with COVID-19 worse health outcomes: the poorest department in mainland

France, Seine St. Denis, reported higher mortality than any other French site (Desson et al., 2020b).

Public health reports showed that lockdown had a marked impact on the dynamics of the pandemic; the benefits revealed effective in May, when a gradual easing begun, dividing the country into zones (green, orange, and red), based on health indicators; Paris and Ile de France, with about 12 million inhabitants, was flagged as an orange area. When the disease resurgence arrived later, France didn't experience the same levels of concern seen during March and April; the resulting impact on the healthcare system appeared to be less dramatic, possibly due to the increase of ICU capacity (Carrat et al., 2021; Desson et al., 2020b; Faranda and Alberti, 2020; Fontanet et al., 2020; Gaudart et al., 2021). Mobility restrictions influenced very much the France connectivity, with a reduction of almost 79% (Galeazzi et al., 2020).

The SPF surveillance system didn't detect a significant quote of the infectious cases, symptomatic or not, during the first epidemic wave due to a shortage of devices, having reserved RT-PCR tests for hospital (Gaudart et al., 2021). Indeed, testing strategy was limited only to suspected cases, being conducted by hospitals, laboratories and even veterinary clinics across both the public and private sectors. In order to aggregate the information from all of these sources, the government launched the secure SI-DEP platform (May 13), which allowed all test providers to directly upload their results to a unified database. The French centralized decision-making system may have allowed for effective coordination of healthcare resources across the country, and a more transparent and integrated data policy. The most emblematic example of this reactive capacity has been the SPF new plan to invest 12 billion euros in the public hospital facilities, including a reevaluation of healthcare personnel salaries. However, the great centralization was not enough to catalyze the implementation of an effective testing strategy. Compared to more federalist nations, France's testing policies were delayed and soft-handed and may have hindered its overall ability to manage the pandemic (Desson et al., 2020b).

The quarantine acceptance was very high in early April: 87% of respondents (COCONEL study), especially female, older and wealthier people, considered it as the only effective strategy to fight COVID-19. On the other hand, data privacy was the major barrier about the use of contact-tracing applications: the number of French people willing to use these tools decreased from 80% (investigation of March 26-27, 2020) to 44% (investigation of April 4-5, 2020), with higher acceptability found among men, older people, and those not able to telework during the quarantine. In early April, media coverage and associated controversies around the contact-tracing development by the French government greatly increased. Technical features of the forthcoming StopCovid App were only released by the Minister of Health on April 8 (Guillon and Kergall, 2020). During the early stage of the pandemic, everything in the French Emergency Department (ED) was slowed down by the complexity of the necessary procedures and by the staff's lack of experience with them; the key word was creativity, to set up new departments, new roles, and new workflows (Haug, 2020). In the first months, some treatments (mainly chloroquine and hydroxychloroquine) were suggested to have antiviral properties, with a low level of evidence; these drugs have been shown not to be effective (Gaudart et al., 2021).

Of course, the progressive plan to reopen schools was a key part of the exit strategy. Pre-schools and primary schools were allowed to reopen on May 11, with classes limited to groups of 15 and based on voluntary attendance. Middle schools followed one week later only in weakly affected departments, with students asked to wear masks, differently from younger children. High schools reopening was decided in late May case by case, depending on the pandemic evolution in each department. Universities remained closed till September. A study found that the full attendance in middle/high schools was not recommended after lifting lockdown, because it could have led to an increase of COVID-19 cases and put in difficulty the ICU system. No substantial difference in the epidemic risk was predicted between progressive and prompt reopening of pre-schools and primary schools. In fact, adolescents would have been considered with a different role in driving the COVID-19 spread compared to younger children (Di Domenico et al., 2021).

France followed mainly a suppression[10,11] strategy against the COVID-19 pandemic (see Table 4).

3.16 Portugal

The first two COVID-19 cases appeared in Portugal (population density 110.58, see Table 3) on 2 March, 2020: a 60-year-old male doctor (who travelled to North Italy for vacation), felt the first symptoms on February 29, was hospitalized at the Santo António University Center of Porto; a 33-year-old man working in Valencia, Spain, sick since February 26, entered the São João hospital in Lisbon. The Health Minister, Marta Temido, affirmed that the contacts of these patients were under control at that time.

The first death was registered 14 days after (March 16) at the Santa Maria Hospital in Lisbon; he was an 80-year-old man with other medical conditions, a former physical therapist for the Portuguese football team Estrela da Amadora (Fragata et al., 2020; Milhinhos and Costa, 2020; Nogueira et al., 2020; Shaaban et al., 2020; Silva et al., 2021; Valente de Almeida et al., 2020; Vieira et al., 2020; Wikipedia, 2020f). The disease grew exponentially with an average rate greater than 30% new cases per day; as of March 27, 4268 infected persons and 76 deaths; the highest outbreaks were in Porto and Lisbon. Then, the disease run throughout the entire country. On April 30, the cases reached the total of 24,987, with 1,007 victims. By June 28, 41,189 individuals and 1,561 mortalities resulted in Portugal, with this geographic distribution: the most affected North 42.4% (infected) and 52.2% (casualties); Center: 9.9% and 15.8; Lisbon Metropolitan Area (mainly the suburbs, not the city center): 44.6% and 29.7%; Alentejo: 1.1% and 0.3%; Algarve: 1.4% and 1.0%; Autonomous Region of Azores: 0.4% and 1.0%; Autonomous Region of Madeira: 0.2 and 0.0% (Cardoso et al., 2020; Fragata et al., 2020; Nogueira et al., 2020; Pais and Taveira, 2020; Ribeiro Correia et al., 2020; Shaaban et al., 2020; Vieira et al., 2020). As of end-June, 2020, 15.38 deaths per 100,000 inhabitants were registered (see Table 3 and Figure 2f).

Due to the pandemic rush in the country and the progression of the disease in other nations, especially in neighboring Spain, the Portuguese government quickly issued the highest level of alert (March 12), followed by the State of Emergency declaration (March 18, Decree 14-A/2020, the first since the Carnation Revolution in 1974) by the President of the Republic Marcelo Rebelo de Sousa (together with the government and the *Direção-Geral da Saúde* DGS [National Health Directorate]), renewed two times until April 17, with special restrictions during Easter celebrations. Educational activities had been already suspended since March 16. The lockdown temporary measures, restricting constitutional rights and liberties except basic services such as medical and food supplies, were: mandatory confinement at home or at health facilities; prohibition of movements and unjustified stays at public roads; shutting down of many public services and limitations of economic activities; imposition to public or private employees to work at home or in a different location (teleworking); suspension of the right to strike; ban of events, reunions, manifestations, religious celebrations or other cult events with 100 or more people; prohibition of drinking alcoholic beverages in public open-air spaces and resisting the public authorities' orders; suspension of any activity of stomatology and dentistry, with the exception of proven urgent situations; closure of airports to civil transportation and increased control of the national borders. Protective antiseptic policies such as the usage of masks were also adopted (Fragata et al., 2020; Milhinhos and Costa, 2020; Pais and Taveira, 2020; Ribeiro Correia, 2020; Shaaban et al., 2020; Silva et al., 2021; Valente de Almeida et al., 2020; Wikipedia, 2020f).

After the State of Emergency declaration, the Portuguese Government (March 27, Order n. 3863-B/2020) decided to grant temporary regular status to all migrants with precarious situations who had previously started their regularization procedure, and asylum seekers with pending applications, in order to fully have access to social benefits, including healthcare, in the same conditions as all other citizens. In fact, health inequalities played an important role in shaping the COVID-19 distribution. In addition to the heavy affected elderly sector, migrants and ethnic minorities showed a marked infection and fatality rate, concentrated in the Lisbon Metropolitan Area neighborhoods, as the densely populated Bairro da Cova da Moura, municipality of Amadora; there, the health authorities were obligated to take drastic measures (closing restaurants, cafés, and bars) in one of the poorest areas of the country, named "Vale de Chícharos" also known as "Bairro da Jamaica", characterized by many degraded and illegal houses, to contain the outbreak spread among residents (Shaaban et al., 2020).

Infection occurred mostly in individuals' with ≥40 years of age (71.9% males; 69.3% females); death mostly in males (64.5%) mainly with ≥50 years of age (Pais and Taveira, 2020). Between March 16 and April 14, there was an excess of 2000-4000 deaths over the expected, almost among people aged 75 years or more, in comparison with the average daily mortality data of the previous 10 years. This circumstance was particularly evident in the densely populated districts (Aveiro, Porto and Lisbon). However, Portugal registered less excess mortality than many other countries during the pandemic first wave, probably due to the early stringent confinement measures taken and high compliance of the population (Nogueira et al., 2020; Vieira et al., 2020). In fact, only two days passed from the first death (March 16) and the *NPIs'* issue (March 18). As of April 30, in 6 Lisbon hospitals, 95 (4.8% of a total of 1,988 cases) COVID-19 patients were admitted to ICU, 39 (41.1%) aged ≥70 years. Among them, 16 (16.8%) patients did not survive the ICU stay (Cardoso et al., 2020). However, Portugal did not enter an overload situation: the levels of ICU occupancy, by June 14, were of 61% at national level and 65% in the Lisbon and Vale do Tejo region (Silva et al., 2021).

During the lockdown, Portuguese people developed more positive attitudes toward food waste, sustainable food and heathy products. In addition, they cancelled flights and almost 60% didn´t plan vacations away from home. The biggest change was revealed in the use of digital videoconferencing platforms. After the lockdown, organizations, schools, and universities were forced to adapt their work habits, and companies to extend greatly home office, accelerating the adoption of new technologies, such as communication platforms. The closure of schools and universities had consequences managed with difficulty: lacking opportunity for children to grow and develop, due to the interruption of in-presence teaching; increasing problems for parents, also forced to stay at home, with family stress due to reconciling work and family life. Therefore, digital portals helped to face the problem, but they were not available in all schools, especially in the Portuguese interior villages, characterized by few accesses to technology and satisfactory internet connections (Fragata et al., 2020).

With respect to the COVID-19 number of infected people, fatalities, and ICU internments, the pandemic reached the peak by April 21 (Pais and Taveira, 2020), and a plateau near the end of the lockdown. Hence, Portugal’s strategy seemed a potential case of success as, by mid-April, fatalities were kept below 1,000 and the healthcare system did not attain saturation (Milhinhos and Costa, 2020). Therefore, the Portuguese Ministers' Council approved a plan to ease the restrictions (April 30), and the State of Emergency was canceled a few days after (May 2). On May 18, nurseries and the last two years of the secondary schools reopened, with restaurants, cafés, street stores and museums, all with mandatory usage of mask and distance rules (Silva et al., 2021; Valente de Almeida et al., 2020; Wikipedia, 2020f).

More than two hundred testing laboratories were set up across Portugal, depending on the SNS (*Serviço Nacional de Saúde* [National Health Service]) and the private sector (respectively 45.2% and 39.3%), but including also military and academic laboratories (15.7%). The average number was 11,500 tests per day (April 2020), increased until 13,550 (May 2020). As of June 3, 2020, more than 860,000 tests have been carried out. Areas dedicated to treat COVID-19 patients were created through several selected Emergency Service Units (ADC-SU, *Área Dedicada COVID-19 de um Serviço de Urgência*) and COVID-19 Community Dedicated Areas (ADC-COMMUNITY) (Shaaban et al., 2020).

The *NPIs* implemented by the Portuguese authorities (national and local) faced in a positive way the COVID-19 pandemic first wave, flattening the initial exponential trend of infected people and casualties. This effective action, due to the importance given to planning, probably came from the experience of the still remembered tragic Pedrógão Grande fire (Leiria, 22

June 2017), with the death of 64 Portuguese citizens (Ribeiro Correia et al., 2020).

After the initial successful fight against the pandemic first wave, the infection numbers began to grow again (September 2020), and the Government progressively abandoned its deconfinement strategy. In October, the use of masks or visors in public spaces was made compulsory by law. Mandatory contact tracking smartphone application (Stayaway Covid) failed, because it didn't reach parliamentary consensus due to constitutional concerns over privacy issues. After the declaration of a new state of emergency (November 6, 2020), curfews were imposed (December 2020) from 11 PM to 5 AM (working days) and from 1 PM to 5 AM (weekends), as an attempt to save Christmas. These provisions were unsuccessful, because the disease exploded at the beginning of 2021, with alarming rates of deaths and SNS near breakdown. In this period, Portugal became the country with the highest number of infections per million inhabitants. A second lockdown was imposed (January 14, 2021, tightened a week later). Some exceptions for political activities were foreseen, first the presidential elections scheduled on January 24. The COVID-19 disease continued to rise (16,432 daily cases and 303 daily deaths on 28 January), characterizing Portugal as a country with one of the worst pandemic surges in the world (Violante and Lanceiro, 2021).

Portugal followed strictly a suppression[10,11] strategy against the COVID-19 pandemic (see Table 4).

3.17 Greece

The first COVID-19 case was diagnosed in Greece (population density 78.99, see Table 3) on February 26, 2020: a 38-year-old woman from Thessaloniki (the second largest city in Greece after Athens), who had recently visited Milan, Northern Italy, tested positive; she was admitted to AHEPA University Hospital of the same city. Her family, as well as other contacts, voluntarily isolated themselves (Damaskos et al., 2020; Delinasios et al., 2021; Giannopoulou and Tsobanoglou, 2020; Kousi et al., 2021; Parlapani et al., 2020; Sypsa et al. 2020; Vatavali et al., 2020; Wikipedia, 2020g). On February 27, the daughter of the first case (a nine-year-old little girl) entered the healthcare facility as her mother; therefore, the 105th Primary School of Thessaloniki was closed for two weeks; fortunately, she was released, with her mother, completely healed on March 11. Always on February 27, a 40-year-old woman, coming back from Italy too, tested positive and was admitted to Attikon University General Hospital, Athens, followed by the fourth case a day after (another 36-year-old woman back from Italy); thus, eight state schools were precautionary closed in Attica and all educational trips abroad cancelled, to prevent the COVID-19 spread. The Minister of Health, Vasilis Kikilias, announced (February 27) the cancellation throughout Greece of all carnival events. On February 29, a friend of the first Greek case had the same course, and two more patients were admitted to the Athens Sotiria General Hospital (Wikipedia, 2020g).

The first death from COVID-19 in Greece was announced on March 12: a 66-year-old man, hospitalized in the city of Patras, returned from a religious pilgrimage to Israel and Egypt at the end of February (Delinasios et al., 2021; Wikipedia, 2020g). As of 11 April at 15:00 the total number of confirmed cases reached 2081, from which 56.8% are men; 535 (25.7%) are connected to international trips, 796 (38.3%) linked to previously infected people, and the rest without known connections (Kousi et al., 2021). As of June 30, the first pandemic wave in Greece caused 3,409 confirmed cases and 192 victims; 1.83 deaths per 100,000 inhabitants were registered (see Table 3 and Figure 2f).

Immediately after the first three COVID-19 cases appeared, the Greek government, prioritizing science over politics, announced the cancellation of all carnival events (February 27), although the measure was perceived as hyperbolic by the public. Starting on 28 February, the precautionary local closure of schools was decided, suspending educational trips and disinfecting buildings, if contacts were suspected with infected persons; this very early provision was extended nationwide to all educational activities on March 10, with 89 confirmed cases and no deaths in the country. On April 10, the Minister of Education Niki Kerameos announced the extension of the measure until May 10 (Damaskos et al., 2020; Delinasios et al., 2021; Farsalinos et al., 2021; Giannopoulou and Tsobanoglou, 2020; Kousi et al., 20201; Parlapani et al., 2020; Wikipedia, 2020g). Hospitals restricted the number of visitors; mass gatherings with more than 1000 attendants were promptly banned: the Europa League football match between Olympiakos Piraeus-Wolverhampton (March 12) took place with no fans attending, due to the government's decision of March 9 (Kousi et al., 2021; Wikipedia, 2020g), contrary to Atalanta-Valencia at Bergamo, Italy (as already seen in Section 4).

Theatres, courthouses, cinemas, gyms, playgrounds, and clubs were closed (March 14); the same restriction was applied the following day to malls, department stores, cafes (excluding supermarkets, gas stations, banks, and pharmacies), libraries, museums, archaeological sites, amusement parks, and beauty salons of all kinds. On March 16, two villages in Western Macedonia (Damaskinia and Dragasia) were quarantined; gatherings in Greece were furtherly limited to less than of 10 people (March 18), with the imposition of a 1,000 euros fine to violators. After March 20, only permanent residents and supply trucks were allowed to travel to the Greek islands.

On Sunday March 22, Prime Minister Kyriakos Mitsotakis, in less than a month after the first COVID-19 case, declared the national lockdown and curfew until April 6 (then renewed two times until April 27 and May 4); citizens were allowed to leave their house only for specific purposes (working movements; for close relatives, attending a major ritual as funeral, marriage, baptism; visits, for divorced parents, to their children; going to bank for services not possible online; health reasons; buying essential goods; assisting other people in need; exercising and taking one’s pet out for a walk) and after filling a special permit; teleworking was imposed in public and private sectors; strict traffic restrictions (only driver plus one passenger in the vehicle) were in force with few exceptions.

Hotels across the country remained closed until the end of April, with the exclusion of three hotels in Athens and Thessaloniki, and one hotel per regional capital. The Hellenic Police corps were required to enforce the restrictions and issue fines for each offense. Since the beginning of the curfew, more than 20,000 violations were recorded, with 348 arrests; in fact, many people decided to practice forbidden outdoor activities, crowding public places like parks and beaches. Anyway, according to the Google Mobility Report, the mobility trends decreased substantially (to retail and recreation places: -85%; to parks: -70%; to transit stations: -80%; to grocery and pharmacy places: -45%; to workplaces: -55%). On March 31, the municipalities of Kastoria, Orestida, Nestorio (Kastoria Regional Unit), Xanthi and Myki (Xanthi Regional Unit) were subjected to restrictive measures. Due to the danger of local COVID-19 outbreaks, all construction activities on the Mykonos and Santorini islands were suspended on April 2. From April 8, the Hellenic Police installed permanent roadblocks and intensified checks of vehicles in all national roads and highways across the country, as well of travellers at the airports, ports, railway, and bus stations, with 300 euros fine for violators without a valid reason except reaching the permanent residence (Damaskos et al., 2020; Giannopoulou and Tsobanoglou, 2020; Golemis et al., 20201; Farsalinos et al., 2021; Kousi et al., 2021; Parlapani et al., 2020; Sypsa et al. 2020; Vatavali et al., 2020; Wikipedia, 2020g). After the opposition of some Greek Orthodox Church members with the support of the Holy Synod (favoring the continued practice of Holy Communion and other functions), a general agreement was reached (March 16) in order to suspend all religious services, with the exceptions of personal prayer and funerals. Approaching the Orthodox Easter Date, the government instructed on 7 April 2020 the citizens to remain home and avoid celebrations. Although the government, as well as the stores, assured that the supplies are efficient and there is no need for trepidation, people queued in the first days outside supermarkets to purchase everyday essentials in large quantities. Also a shortage of masks and antiseptics occurred after the first COVID-19 case confirmation. Moreover, there was a rush of citizens abandoning the cities for more remote regions in an attempt to avoid contamination (Kousi et al., 2021).

With regard to travel and entry restrictions, since March 9 the Hellenic Civil Aviation Authority suspended all flights to and from Northern Italy and Spain, ferry services to and from Italy, as well as the prohibition of all cruise ships and sailboats docking in Greek ports. On March 16, Greece closed its borders (road, sea and air links) with Albania and North Macedonia, permitting only the transport of goods and the entry of Greek nationals and residents. The same day, a 14-day home quarantine was mandatory for those entering the country. Two days later, the borders were closed to non-EU nationals, banning also all private boats from abroad; from March 23 to 28, the closure of all air, sea, rail and road connections with Turkey followed; flights with UK, Germany, the Netherlands, and other nations with high COVID-19 transmission rates were banned until April 15, then extended until May 15, and June 1, except a few exemptions: emergency, sanitary, humanitarian, state, military, ferry and Frontex flights, those supporting the Hellenic National Healthcare System and for repatriation of Greek citizens, permitted through the Athens Eleftherios Venizelos Airport (Damaskos et al., 2020; Delinasios et al., 2021; Parlapani et al., 2020; Wikipedia, 2020g). Restrictions on entry for international travellers were lifted in mid-June, except for British tourists, expired on July 15. Passengers arriving from countries with high infection rates were required to take a test and agree to a two-week quarantine; passengers from lower risk countries were tested randomly, avoiding a mandatory isolation period (Wikipedia, 2020g).

COVID-19 pandemic occurred in Greece when the country was facing the refugee/migrant crisis, started in 2015, with thousand people living in overcrowded hotspots lacking proper health services. The tension exploded on February 28, after the Turkey President notice about the opening of the Greek border; as a result, thousands of refugees arrived, trying to enter the European Union. In response, Greece declared a state of emergency (March

3), just six days after the confirmation of the first COVID-19 case in its territory. Illegal entry of migrants in Greece was considered by Prime Minister Mitsotakis as a threat to public health; therefore, the government decided to suspend temporarily the procedures for asylum seekers (measure lifted on April 1).

The government (March 17) announced a list of protective actions and restrictions in order to limit contamination inside and outside the camps: entrance allowed only to employees; all other visits (individuals or organizations); other visitors banned for two weeks; mandatory temperature control for all the new arrivals; movements for grave causes allowed only to small groups (one person per family) between 7 am and 7 pm, controlled by police. All informal educational structures suspended their operation and all other indoor activities were also restricted. Two refugee structures on the mainland were placed in quarantine. On March 24, many international human rights organizations (including Amnesty International, the Human Rights Watch, Médecins Sans Frontières, and ActionAid) considered the conditions of these centers deplorable and dangerous, and asked the Greek government to take immediate measures against the COVID-19 spread. Specialized medical teams were sent to the camps for the creation of virus isolation areas in every Reception and Identification center. The Region of North Aegean islands, hosting a big number of refugees (approximately 40,000), decided to create health facilities outside every camp. With the aim to control further COVID-19 spreading, the International Organization for Migration advised Greek authorities to ensure all refugees the access to the health care system; therefore, on April 13, approximately 2000 high-risk people were transferred to the mainland, hosted by hotels and other accommodations specifically organized to receive them. The situation de-escalated when the Turkey decided to close the borders as a measure against the COVID-19 outbreak (Giannopoulou and Tsobanoglou, 2020; Kousi et al., 2021; Wikipedia, 2020g).

During the COVID-19 first wave, the most affected area was the prefecture of Attica, including the capital Athens, where almost half of the Greek population resides; the second was Central Macedonia, with Thessaloniki, the second largest city. Few clusters of infected individuals scattered across Central Greece and the prefecture of Thessaly, in the North-Eastern part of the Peloponnese and the region of Evros including the Greek-Turkish border. No cases were recorded in the prefecture of Sterea Ellada, the entire region of Khalkidhiki, as well as the island of Chios (Delinasios et al., 2021).

After a 42-day early lockdown, from May 4, the pandemic curve flattened; gradually, restrictions were lifted and economic activity restarted. From June 1, hotels and campsites reopened and allowed to welcome visitors from abroad from June 15, when flights restarted at the Athens airport, followed by the others in the country from July 1. The government provided a detailed plan regarding hygiene and protection in tourist accommodation, buses, car rental companies, maritime and air transport. A collaborating doctor was foreseen for each accommodation, as first evaluation point, followed by sharp rules to move a patient from an island to the next health facility as quick as possible. The COVID-19 impact on Greek tourism receipts was very huge, from 9 to 14 percent of GDP. Until the confinement end, 2632 confirmed cases and 146 deaths were recorded, one of the lowest number of deaths in Europe during the COVID-19 first wave. Greece, acting swiftly and adopting containment policies at an earlier stage of the disease before any casualties, has been referred as an example of a country with successful response against COVID-19, despite the severe financial crisis experienced in the recent years and its aged population. The political system of the country, including Syriza the main opposition party, responded with control and unity (Damaskos et al., 2020; Delinasios et al., 2021; Farsalinos et al., 2021; Fouda et al., 2020; Kousi et al., 2021; Papanikos, 2020; Parlapani et al., 2020; Sypsa et al., 2020; Vatavali et al., 2020). Greece recollected the 1918 "Spanish flu" experience, when up to one third of the infected population were killed in some areas; also during that period, restriction measures had been imposed: closure of schools, prohibition of pedestrian traffic and of any assembly, with the immediate arrest of violators (Golemis et al., 2021; Parlapani et al., 2020).

Altogether, the psychological impact of long-lasting strict lockdown measures and the risks linked to isolation disrupted daily routine, studying, professional life, finances, and imposed physical distance; lockdown destabilized people's lives and affected their social activities, emotional state, everyday activities, working conditions, and mobility. Stress, fear, sense of inactivity, boredom, and frustration were the feelings that increased for a large part of the people, leading to psychosomatic or psychological problems, including alcohol drinking. Staying at home has placed some children and adults (mainly women) at increased risk of domestic violence; however, resilience and functional coping strategies were also developed to manage home confinement. Activities within the family grew and those with friends reduced. Working changes presented multiple features: still working, less or more productive; the opposite: job lost or suspension status; shifting to teleworking or not. Mobility practices saw major changes. In many cases, gender was a crucial factor, with women more vulnerable in the new conditions. Family status seemed to differentiate experiences during the COVID-19 crisis: becoming closer to relatives, but often more nervous, stressed, and scared than unmarried persons, within an uncertain and more fluid socioeconomic context. Singles felt lonelier, a fact that highlighted the importance of the family in social life in Greece (Giannopoulou and Tsobanoglou, 2020; Golemis et al., 2021; Vatavali et al., 2020). In-depth limitations of fundamental rights (mainly to freedom of: movement and assembly; economic activity; religion exercise) found their legal basis on the "necessity law" provision (Article 44 of the Greek Constitution), enforced by several Acts of legislative content; however, the executive, establishing a "state of emergency" to cope with the extreme situation, put civil rights under intense pressure; a significant example was the ban of the annual protest march (47th anniversary of the Athens Polytechnic Uprising in the 70s against the military dictatorship, November 17, 2020), contested by someone as a violation of Article 11 of the Constitution (Karavokyris, 2021).

Greece suffered the COVID-19 pandemic when the 2008 economic and political crisis was not yet resolved. In fact, the Greek healthcare system was severely affected by austerity measures as: budgets decrease and inadequate primary services in terms of access, integration, and continuity; healthcare workforce, salaries, and pensions reductions; drop in purchase of medical goods; merging of healthcare units; rise of access; health coverage of unemployed people. Currently, the country offers a predominant social health system with a supplementary voluntary insurance, although the healthcare services accessibility remains problematic for vulnerable population groups.

Another weakness point is that most healthcare services are strongly concentrated in large cities, while the rural areas miss both adequate facilities and specialist staff. The geomorphological structure of Greece itself with several little islands was an additional disadvantage, making necessary patients' transportation to the mainland in order to be treated effectively. Thirteen hospitals were designated as reference structures to deal with COVID-19 cases. Specific Health Centers in six major urban areas (Athens, Thessaloniki, Patras, Larissa, and Heraklion) were exclusively designated for the screening of patients with respiratory infection, conducting early detection, monitoring, and management of mild symptoms cases not requiring hospitalization. Clinics were closed and wards evacuated. Some of these were designated for the care of infected patients, while others have been converted into ICU beds (only 560 at the beginning of the outbreak with lack of ventilators, then increased to reach 12 ICUs per 100,000 inhabitants). No effort was made to reinforce the role of family physicians; community care were largely neglected, scheduled surgical operations and specialist appointments cancelled, and only emergencies remained operative. The healthcare personnel worked daily under 'emergency' conditions, without an efficient control of the patient flows. The initial response to the pandemic was mainly focused on enhancing hospital resources in terms of *PPE*, specialized care equipment such as ventilators, expansion of ICU beds and hiring healthcare personnel. Private donations also supported the increased needs; these were necessary steps considering the budget cuts during the recent economic crisis. An additional problem was that several hospitals were used as isolation facilities for COVID-19 symptomatic patients who could not follow quarantine, social distancing and personal hygiene measures, such as migrants and refugees. Some specialized infectious disease hospitals which were shut down in previous years were not re-opened during the pandemic. Despite this negative background, the government acted early against the COVID-19 first wave, within a few weeks after the first confirmation of positive cases, without embracing a herd immunity but a strictly a suppression[10,11] strategy (see Table 4). A key change was the creation of EOPYY (The National Organization for the Provision of Health Services) as the sole public insurer in the country, which replaced the previous fragmented system. The responsibility for the pandemic containment was assigned to the National Public Health Organization (EODY). In an effort to modernize the Greek bureaucracy, most of the transactions with the banks or public services started to be done electronically; even medical prescriptions were sent via phone messages; Greece obtained millions of masks both for health professionals and patients. As of May 3, Greece with population of 10.7 million has 2620 confirmed cases, 144 deaths, 1473 recovered cases, and 37 hospitalized in ICU. The number of hospitalized cases did not overwhelm the system during the COVID-19 first wave, although a number of healthcare workers were affected by COVID-19. Most of deaths were concentrated in the 65 + age groups, due to the large amount of elderly population, presence of comorbidity factors, and high percentage (27%) of daily smokers (Damaskos et al., 2020; Farsalinos et al., 2021; Fouda et al., 2020; Giannopoulou and Tsobanoglou, 2020; Kousi et al., 2021).

Testing was restricted to patients with acute respiratory symptoms. Asymptomatic close contacts were not included, leading to an underestimation of the reported cases; additionally, the testing capacity of primary healthcare centers was inadequate to handle the increased demand;

people had no other alternative but to visit hospitals, already on duty for emergencies, in order to perform a diagnostic test, also facilitating the virus transmission. Patients attending private laboratories needed to personally cover the whole test cost. Therefore, the rapid identification and diagnosis of suspected COVID-19 cases and their closed contacts was compromised. On this basis, COVID-19 pandemic would have been devastating in Greece, if effective *NPIs* were not implemented early enough. Also the tracing App Covid Checker was quickly approved and made available (March 29). Ending the first lockdown, Greece applied a four-level exit strategy implemented on a daily basis since April 28. The first level started on day 69; the second on day 76; the third on day 83; and the final on day 97 (Delinasios et al., 2021; Farsalinos et al., 2021; Fouda et al., 2020; Kousi et al., 2021).

The beginning of a pandemic second wave occurred in August, also due to the number of tourists (5 millions) that visited Greece. Daily fatalities started to rise in mid-September and further increased; therefore, a second strict lockdown and curfew were announced (November-January 2021), with schools retail, restaurants and nightlife closure, and with permission to leave home only for specific reasons. During this period, hospitals were subjected to immense pressure: Greece saw one of the highest COVID-19 death rates in Europe, and all the healthcare system weaknesses resulted evident. A precautious easing was attempted after the Winter holidays; the government's planned the reopening of all schools (since the first decade of January), decision criticized by many epidemiologists in the country. COVID-19 outbreaks triggered again in February; Attica was again placed in lockdown, as more and more local districts, with approximately half of the prefectures in the deep red level. By 13 March the total number of confirmed cases had risen to 217,018 and the death toll to 6,986 (Delinasios et al., 2021; Farsalinos et al., 2021; Karavokyris, 2021; Wikipedia, 2020g).

4. The Italy case: overview of the first phase (January - June 2020)

The first Italian official document about COVID-19 disease dates on 22 January 2020 (Italian Ministry of Health, 2020b). It speaks about: some Far East affected areas (China, South Korea, Thailand, and Japan); the ongoing WHO monitoring; the moderate estimate about the risk of introduction of that infection in Europe by ECDC (European Centre for Disease Prevention and Control, an agency of the European Union, ECDC, 2020a-n). This report followed a healthcare procedure started the day before (January 21;

Italian Ministry of Health, 2020a) in the Roma-Fiumicino airport (with direct/indirect flight connections to/from Wuhan) to detect suspect symptomatic persons through thermometric scanner, including a possible bio-containment of potentially affected people at INMI (*Istituto Nazionale Malattie Infettive*, Italian National Institute for Infective Diseases) Lazzaro Spallanzani in Rome. Among 68 individuals tested, 3 positive cases (an Italian researcher coming from Wuhan; a tourist Chinese couple) were detected and hospitalized (INMI, 2020a). For the Italian researcher, the prognosis dissolved soon without complications, while for the Chinese couple it was quite serious, requiring a period of intensive care unit-ICU until February 26 (INMI, 2020b). At the beginning of February, an INMI research team succeeded at isolating SARS-CoV-2 from the Chinese hospitalized patient (Colavita et al., 2020). At the beginning of March, the positive cases in quarantine at INMI increased, including a police officer with a link to the Lombardia contagion area (INMI, 2020c), as discussed forward.

The novel coronavirus from Wuhan had been going smoldering. Since the virus identification in December 2019, the number of cases from China that have been imported into other countries was on the rise. The search for the “patient 0” had begun, without any reasonable result. The first cases in Europe were detected in France on January 23-26, 2020. On January 26, an infection appeared to have occurred to a 33-year-old healthy German Webasto businessperson; after feeling better, he went back to work (January 27). On January 28, 3 additional employees at the company revealed the contagion (VVAA, 2020). This case is significant because the diagnosis was done in Germany, while the virus, at that time, was supposed to be contained in China. No connections with French/German cases were evident with Italy. By the way, on January 27, the Italian Ministry of Health (2020c) prohibited any Chinese flight arrival to the airports of Roma-Ciampino, Roma-Urbe, Perugia, Ancona, and Pescara. The planes were all redirected to Roma-Fiumicino, and the passengers taken under health control. On January 30, the Italian Ministry of Health (2020d-e) ordered to suspend all direct flights to/from China, Hong Kong, Macao, and Taiwan, in order to guarantee an adequate level of protection. Unfortunately, such restrictions were rather ineffective, due to people arriving from COVID-19 risky areas via indirect routes, and because the virus was probably already present in North Italy since Fall 2019, as argued months later (Amendola et al., 2021: virus evidence in an oropharyngeal swab specimen; Apolone et al., 2020: unexpected detection of antibodies in the prepandemic period; Gianotti et al., 2021: COVID-19-related dermatosis in a patient; La Rosa et al., 2021:

virus traces detected in Northern Italy sewage). In fact, the silent growing up of the inside infection could have been originated by previous and unknown people movements. A day after (January 31), the Italian Council of Ministers (2020) declared a six-month state of emergency due to COVID-19 health risk, entrusting the Department of Civil Protection for emergency response (Italian Council of Ministers, 2020a-c; Decree-Law, 2020a-c; Law, 2020a-c; DPC, 2020a), allocating first financial resources, and activating a permanent coordination table with the Italian Regions and Autonomous Provinces. A14-days quarantine should have been applied to all the individuals coming from China or having close contacts with COVID-19 confirmed cases (Italian Ministry of Health, 2020f). This decision was taken after the WHO declaration of International healthcare emergency. In that phase, the current idea in Italy was to shut down the country against a "foreign virus". On January 23-24, the schools were closed in Piemonte, Lombardia, Veneto, Friuli-Venezia Giulia, Emilia-Romagna, Liguria (Italian Ministry of Health, 2020g-h; Decree-Law, 2020d). In the meantime, life in Italy had not changed much for the public, despite the initial reported cases (WHO, 2020h).

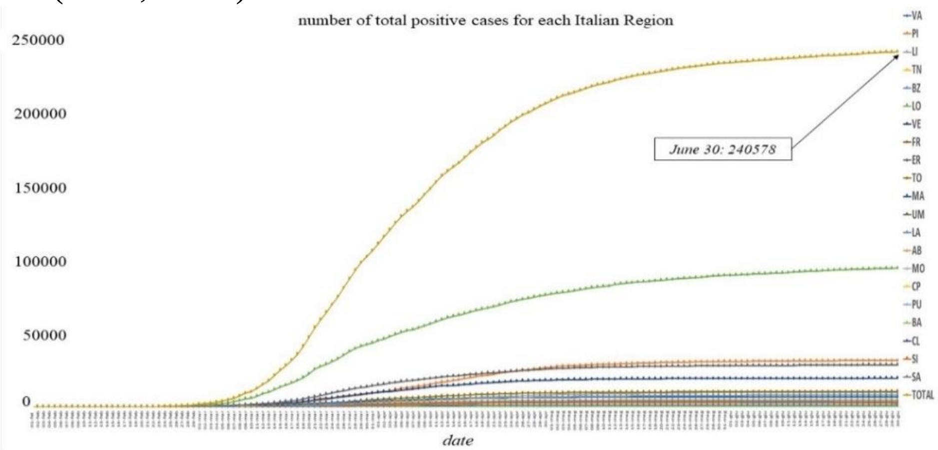


Figure 3: COVID-19 trend in all the Italian Regions from February 1 to June 30, 2020 (VA: Valle d'Aosta; PI: Piemonte; LI: Liguria; TN: Trentino; BZ; Alto Adige; LO: Lombardia; VE: Veneto;
FG: Friuli-Venezia Giulia; ER: Emilia-Romagna; TO: Toscana; MA: Marche; UM: Umbria; LA: Lazio; AB: Abruzzo; MO: Molise; CM: Campania; PU: Puglia; BA: Basilicata; CL: Calabria; SI: Sicilia; SA: Sardegna).

However, the crucial period between the beginning of February and early March outlined the underground work of the incoming pandemic, pushing like an eruption magma. Stefano Merler, a researcher of the Bruno Kessler Foundation (FBK, Trento, Italy), presented (on February 12, 2020) to the

Italian Scientific Committee (held at the Italian Ministry of Health, meeting behind closed doors) a very worrying scenario based on mathematics applied to epidemics ("*Scenari di diffusione di 2019-NCOV in Italia e impatto sul Sistema Sanitario Nazionale*" ["Scenarios regarding the spreading of 2019-NCOV in Italy and impact on the Italian Healthcare System"], predicting the quick increase of the contagion until millions of infected people and thousands of deaths within a few months (Guzzetta et al., 2020a,b), therefore being very scarce the current ICUs in the hospitals and a next lockdown unavoidable. The study was considered too alarmist and dramatic, anyway underrated and classified *top secret* by the Italian Government, in order to avoid panic in the country.

Figure 3 shows the COVID-19 trend in all the Italian Regions since the first official monitoring of the pandemic until the end of June (data from: DPC, 2020b): Italy became quickly the European epicenter of the pandemic.

It should be noticed that the COVID-19 data, in the first pandemic phase, should be managed with caution, due to: *i)* the high underestimate of the individuals found positive (in Lombardia, the ratio between certified illness cases - by symptoms evaluation or by molecular analysis after oropharyngeal swab - and probably infected people were about 1/10, i.e. the tip of the iceberg; Del Re and Meridiani, 2020); *ii)* the undervalued fatalities (comparing the worst months of the disease, the mortality rate of 2019 were about ¼ of 2020 in Lombardia; Ciminelli and Garcia-Mandicó, 2020; Del Re and Meridiani, 2020); *iii)* moreover, there was a discussion if people died *because of* SARS-CoV-2 or *with* it (Il Sole 24 Ore, 2020a), since a number of patients were already affected by other severe syndromes.

Probably, since first January 2020 (or even Fall 2019!; see: Amendola et al., 2021; Apolone et al., 2020; Gianotti et al., 2021; La Rosa et al., 2021), a COVID-19 silent spreading initiated in a small core of the Southern Province of Lodi, attested by an exceptional explosion of heavy pneumonia and flu cases (later, this coronavirus was revealed by traces of antibodies in healed patients' blood: see Percivalle et al., 2020). Maybe a few asymptomatic individuals triggered the pandemic in that area, until early affected sick patients were recognized.

The first official case (Cereda et al., 2020) was diagnosed at the Codogno hospital (February 20) in a 38-year-old healthy and sporty man (serious symptoms and ineffective response to therapy against pneumonia), thanks to the audacious and long-sighted intuition of the doctors Annalisa Malara and Laura Ricevuti: they forced the standard medical protocol and took every possible precaution during the test (L'Espresso, 2020a; Malara, 2020). As a consequence, the day after, the Italian Ministry of Health and Lombardia

Region Authority (2020) in agreement appropriately decided to close most of the public activities (mass events of any kind including religious ceremonies, all jobs except home/smart working, all commerce except essential services, all sport/recreational events, school/education of every order and grade, bus stops) in 10 municipalities sited in the Province of Lodi (Codogno, Castiglione d'Adda, Casalpusterlengo, Fombio, Maleo, Somaglia, Bertonico, Terranova dei Passerini, Castelgerundo, and San Fiorano, Figure 4). Noteworthy the coincidence: those same places around Codogno were heavily hit by the 1630 pestilence, brought by the Lansquenets coming from North Europe, causing thousands of deaths and disruption (Manzoni, 1995; Ripamonti, 2009; Tadino, 1648).

Unfortunately, a contextual lockdown decision was not applied to other disease clusters (again with an unusual number of pneumonia cases since December 2020; TPI, 2020a; Valseriana news, 2020) located in the provinces of Bergamo (municipalities of Alzano Lombardo, Nembro, Albino, Seriana Valley) and Brescia (Orzinuovi), although ISS (*Istituto Superiore di Sanità*, the Italian National Institute of Health) recommended it in a confidential communication (March 2; see TPI, 2020b). The first COVID-19 probable positive cases could be found at the hospital "Pesenti-Fenaroli" of Alzano Lombardo (Seriana Valley, 6 kilometers far from Bergamo) since February 13 in a couple of old patients with acute respiratory distress/pneumonia. A primary doctor (February 23) was infected, too (Eco di Bergamo, 2020b). The facility was closed in the afternoon and inexplicably reopened a few hours later without effective sanitization. Therefore, the contagion found a favorable environment: starting from the department of Internal Medicine and Emergency Room, part of the medical personnel was infected; people took out the virus into families, work sites, stores, and open spaces.

It is impossible to identify exactly date and place of the outbreak real origin: maybe Villa al Serio between Alzano (less than 14,000 inhabitants) and Nembro (about 11,500). In any case, it expanded thanks to delayed fighting actions (TPI, 2020c). Nembro was perceived by the local community as a sort of "ghost town", where the elder group was almost totally cancelled and entire family nuclei disappeared (90 fatalities in about three weeks), often dying in complete solitude, only speaking with eyes to nurses, under the mask desperately connected to the oxygen bottle. The town of Albino (18,000 inhabitants) reached 145 deaths between February 23 and March 27. In general, in these towns, about ¾ of the victims "flooded out" from the official COVID-19 fatality list, compared with the mortality rates of previous years. At Alzano Lombardo and Nembro, the overall death increase in February-March 2020, with respect to the same period of 2019, was more than 1,000%. A similar peak of fatalities happened in Bergamo, with a delay of 14 days. Because of the high number of victims, in the most acute phase of the crisis, the regular course of funerals and cremations was impossible. Military trucks moved away to other plants hundreds of coffins without the comfort of the loved ones.

On the contrary, the death rate was +480% at Codogno and +128% at Casalpusterlengo. Therefore, the Seriana Valley can be considered the effective COVID-19 epicenter for the Province of Bergamo (TPI, 2020d), with a strong influence on the whole Lombardia Region. Moreover, the Champions League soccer match between Atalanta (the team of Bergamo) and Valencia, played with public at the San Siro Stadium of Milano on February 19, was certainly an early context of contagion transmission (Corriere dello Sport, 2020; Bergamonews.it, 2020a).

The virus hit Orzinuovi on February 25 (first official case) and increased quickly in amount (March 6: 36 infected with 7 fatalities), again without any action (Radio Onda D’Urto, 2020; TPI, 2020f).

A summary of the daily number of deaths from all causes in 2019-2020 respectively in Northern and Central-Southern Italy is given in Figure 9a-b. The number exceeded expectations as COVID-19 took hold from March onwards, particularly in Northern Italy (ISTAT, 2020a; Davoli et al., 2020; in WHO, 2020h).

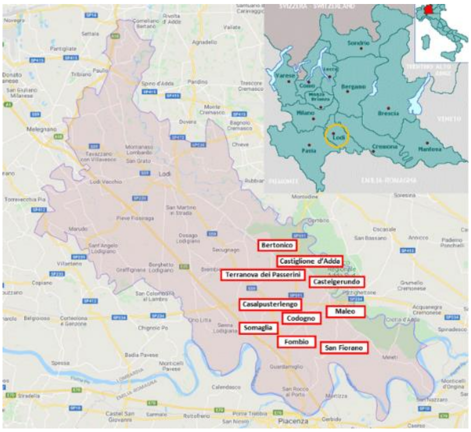


Figure 4: 10 municipalities (Lombardia Region) locked down due to COVID-19 as decided on 21 February 2020.

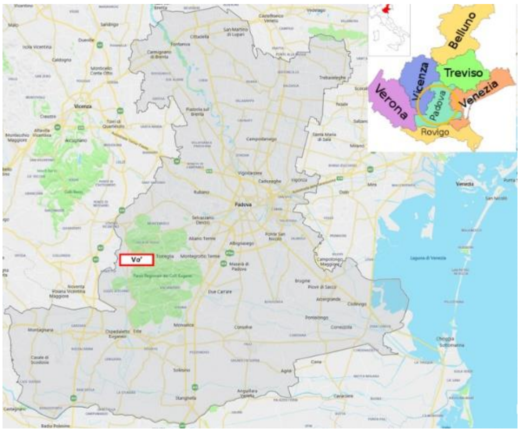


Figure 5: Vo’ municipality (Veneto Region) locked down due to COVID-19 as decided on 22 February 2020.

Thus, the disease run “without a ticket” on the transportation routes through Lombardia, the richest and most crowded and industrialized area of

Italy, which "*could never stop*" (TPI, 2020e), as said the President of Lombard Confindustria (the Italian Industrial Federation).

Figure 6a shows the trend of positive cases in the Region Lombardia (data source: DPC, Italian Department of Civil Protection, DPC, 2020b) from February 1 to June 30, 2020. It is clear that the lockdown helped to reduce the infection in the Lodi province, while the contagion boomed in the areas of Bergamo and Brescia, and rose quickly also in Milano (Figure 6b). In fact, 15 days of hesitation (half February, beginning of March) led to a tragic surge of the pandemic, due to unproductive disputes among the powers of the State (with different political tendencies) about the creation of a "red", or "orange" zone, or nothing: the central government/Civil Protection didn't impose a decision (after the above said ISS note); Region Lombardia minimized the potential danger ("*COVID-19 disease like a little stronger flue*", the Governor Attilio Fontana stated; see Il Giornale, 2020); the involved municipalities watched helplessly the drama; the entrepreneurs pushed for continuing the industrial productions. On February 27, for example, the Union of the Italian Restoration Brands promoted a video entitled "*Milano non si ferma*" [Milano doesn't stop] (Il Fatto Quotidiano, 2020a). The objective was to avoid excessive alarm, asking for keeping open public activities, avoiding a switched off city. The Mayor of Milano, Beppe Sala, who supported the initiative first, later recognized the mistake (on March 23, see Ilpost, 2020). The same happened at Bergamo ("*Bergamo non si ferma*" [Bergamo doesn't stop]) with the Mayor Giorgio Gori (Bergamonews.it, 2020b).

In particular, the virus attacked the retirement homes, mowing down more and more the most fragile and exposed generation (Italian Ministry of Health, 2020i). After a resolution of Region Lombardia (Deliberazione, 2020), a silent massacre initiated in several healthcare residences for older people (in Italian: *RSA*, *Residenza Sanitaria Assistenziale*). Due to the urgent necessity to make available hospital beds for many incoming patients needing intensive care, the territorial healthcare facilities (ATS, *Aziende Territoriali della Sanità* [Territory Health Agencies]) of Lombardia were asked for identifying in the senior citizens homes spaces where to move COVID-19 low intensity infirms. The absence of any containment caused a rapid contagion with hundreds of fatalities. A similar event, with minor occurrence, happened somewhere else (Emilia-Romagna, Veneto, Piemonte, Trentino, Toscana, and other regions; ISS, 2020a).

The virus still had moved from Lombardia to Emilia-Romagna through the close border belt. In fact, a possible disease outbreak, carried by people moving from the above said Lodi's Province towns, started in a private clinic of Piacenza (Sant'Antonino) in middle February, when the coronavirus contagion appeared in an old man (general symptoms and high fever). The infection passed quickly to another patient, then to a cooperating doctor of the same health facility (hospitalized at Tenerife, Canary Islands, on February 25 during his holidays and checked positive), until the shocking event of March 16, when a housekeeper woman of that clinic was found lifeless at home. In those crucial days, the silence of the responsible staff of the medical facility was complete; therefore, the infection spread like an undercurrent wildfire to infirms, healthcare personnel and outside (Guglielmetti et al., 2020; TPI, 2020g; Il Fatto Quotidiano, 2020b). Figure 7a shows the trend of positive cases in the Region Emilia-Romagna (data source: DPC, Italian Department of Civil Protection, DPC, 2020b) from February 1 to June 30, 2020. Figure 7b shows the trend of positive cases in all the provinces.

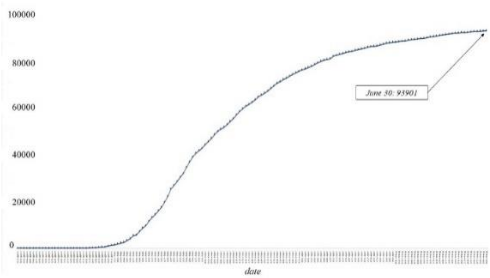


Figure 6a: COVID-19 total positive cases in Region Lombardia.

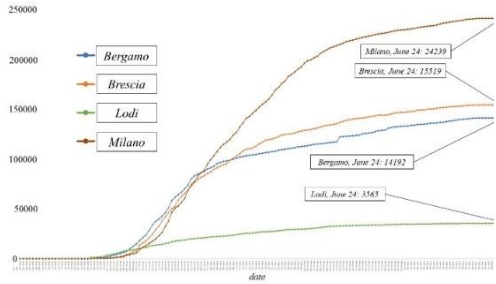


Figure 6b: COVID-19 total positive cases in the Provinces of Milano, Brescia, Bergamo, Lodi.

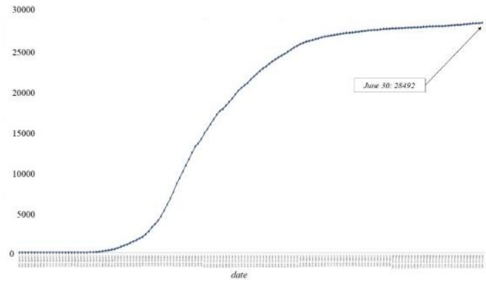


Figure 7a: COVID-19 total positive cases in Region Emilia-Romagna.

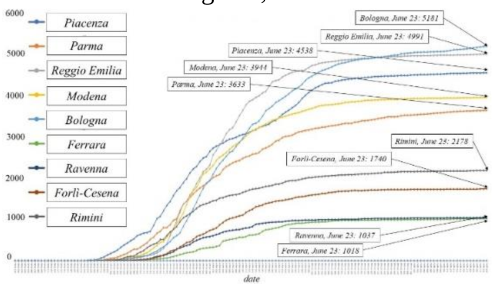


Figure 7b: COVID-19 total positive cases in all the Provinces of Emilia-Romagna.

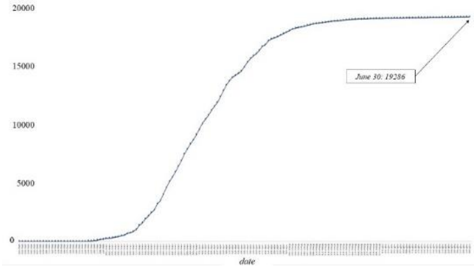


Figure 8a: COVID-19 total positive cases in Region Veneto.

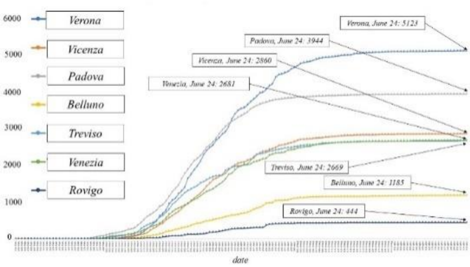
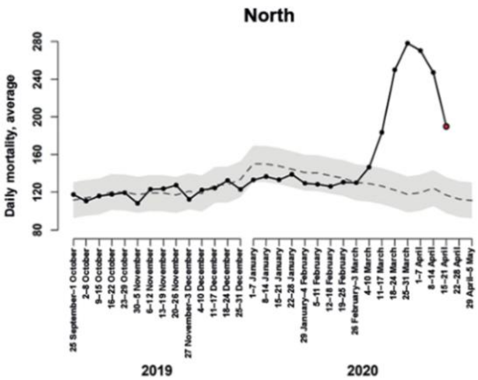
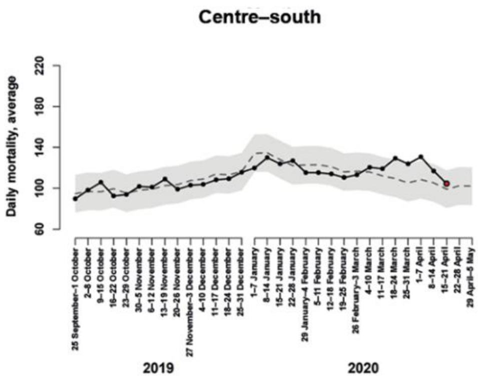


Figure 8b: COVID-19 total positive cases in all the Provinces of Veneto.





Daily number of deaths from all causes in 2019–2020, plotted against the median (dotted line) and range expected on basis of previous years
(Source: Davoli et al., 2020; in WHO, 2020h).

Figure 9a: Northern Italy. Figure 9b: Central-Southern Italy.

On February 22, the Italian Ministry of Health and Veneto Region Authority (2020) deliberated to apply the same measures, as reported above for the Lodi Province, for the municipality of Vo’ Euganeo, Province of Padua (Figure 5), a secondary outbreak probably linked to Lombardia: 2 men infected (67 and 77-year-old, February 21 assessment, both later killed by the disease). The elder of them was the first Italian victim (February 22), already put under ICU 10 days before, but recognized positive (with swab) only on February 20, thanks to Prof. Andrea Crisanti (full professor of Molecular Medicine at the University of Padova), who forced the standard medical protocol as Drs. Annalisa Malara/Laura Ricevuti at Codogno (L’Espresso, 2020a; Malara, 2020). Immediately, the authorities prescribed the accurate sanitization of the two hospitals (Schiavonia, South Padova; Mira, East Venice) which saw the presence of the infection. Figure 8a shows the trend of positive cases in the Region Veneto (data source: DPC, Italian

Department of Civil Protection, DPC, 2020b) from February 1 to June 30, 2020. Figure 8b shows the trend of positive cases in all the provinces. In the cluster of Vo' Euganeo, the beneficial lockdown was immediately effective.

Although the COVID-19 first cases were officially registered on the same day (February 20) at Codogno (Lodi, Lombardia) and Vo' Euganeo (Padova, Veneto), the pandemic developed in a quite different way, with different short-term outcomes. As of April 1, Lombardia experienced 44,733 cases and 7,539 deaths; for Veneto, the corresponding values were 9,625 and 499; the cumulative case rate was 445/100,000 for Lombardia and 196/100,000 for Veneto, a 2.3-fold difference; mortality rates were 7.5 times higher in Lombardia than in Veneto: 75/100,000 and 10/100,000, respectively (Binkin et al., 2020).

This different trend may be attributed to several reasons. First, the social-morphological factor: Vo' Euganeo is a small rural village on the hills (3,416 inhabitants), while Codogno lies in a high urbanized territory where people live in apartment dwellings; in addition, the population density in Veneto is lower than Lombardia (270 versus 420 inhabitants per square kilometers). Second, in Veneto the public healthcare relied much more on territorial garrisons and household services, filtering the request of hospitalization, avoiding the overcrowding of medical structures, and confining at home the asymptomatic patients; in Lombardia, 51.5% of patients were admitted to hospitals, including 5.2% to ICUs; for Veneto, the corresponding figures were 25.1% and 4.3%, respectively (Binkin et al., 2020). Two different epidemic control strategies were implemented: Veneto opted for the strict containment of the outbreak and piloted case-finding through extensive testing; Lombardia reported high transmission and disease rates and strengthened hospital services to meet a massively increased demand for hospitalization and ICU beds (Odone et al., 2020), limiting testing to symptomatic cases, following national policy (WHO, 2020h). Furthermore, the COVID-19 infected persons were moved from the Codogno outbreak to other hospital facilities, with lack of sanitization and use of protective tools, spreading the contagion in a wide area. Andrea Crisanti was encharged by the Veneto Region to set up effective strategies to face COVID-19 spread. He insisted that it was crucial to strictly conjugate people lockdown and active surveillance (family, workplace, contacts, and so on), that must be identified by increasing as much as possible the number of swab tests, enforcing the territorial traceability and confining at home all non-serious positive cases, also asymptomatic ones.

Figure 10 (data source: DPC, Italian Department of Civil Protection, DPC, 2020b) shows the comparison between the swab percentage [‰] on populations of Veneto (4,905,854) and Lombardia (10,088,484), respectively, in the period February 1 - June 30; cumulative rates of testing were nearly twice as high in Veneto and were 2.7 times higher in the first week of the epidemic (Binkin et al., 2020). All the Vo' Euganeo residents were continuously monitored by swab tests and submitted to genetic studies, permitting to investigate the unknown virus (Lavezzo et al., 2020).

The Italian Government promulgated on March 5 a decree (DPCM, 2020a), compelling the closure of all the Italian schools until March 15, 2020 (then postponed to April 3 and later to September). The same act also declared the suspension of all the sport/culture events, and moratorium of workshops/social meetings of medical personnel, smart working features, and other minor duties.

An emblematic example of hesitancy, enacting regulations against this coronavirus, is given by the Autonomous Province of Trento (Provincia Autonoma di Trento, PAT). On February 22, PAT (2020a,b) had already declared the closure of kindergartens, university/research activities, libraries and some indoor sporting events for the following 3 days, but open-air activities (like the incoming carnival) were still allowed. Two days after, a second injunction prolonged this interruption (until February 29) to all the schools, and prohibited all the public events (indoor and outdoor). However, museums could stay open. MUSE, the Science museum of Trento, for instance, saw a mass of visitors, most of them coming from Lombardia and Veneto, on Sunday March 1, and interrupted its activities only 7 days after. The snowing at the beginning of March let the ski tourism hope to profitably conclude the winter season. In fact, during the March 7-8 weekend, the Trentino ski runs were crowded with people in long queues, whilst the National government was elaborating the lockdown rules. Considering the economic aspect, the president of ANEF (Associazione Nazionale Esercenti Funiviari [Italian Association of Ski Cableway Operators]) Valeria Ghezzi declared that "*snow is more powerful than coronavirus*". Those words were defined as "*staggering*" by the Italian CGIL-CISL-UIL Trade Unions, which called such detriment of the public health as a "*dance on the Titanic*" (Il Dolomiti, 2020a); in fact, the ski facility closure in Trentino and Alto Adige has been applied only on March 11. With regard to skiing as a robust vehicle of infection, the case of Ischgl (a village of Austrian Tirol) is paradigmatic. Although in February 2020 more than a thousand tourists from North Europe were infected there, only on March 22 the place was declared red zone: this long delay avoided the impairment of the skiing season (Corriere della Sera, 2020a) but exported the virus to a wide area.

A similar COVID-19 spreading into holiday seaside resorts happened in Liguria, where the infection grew very similarly to Trentino (Figure 11, adapted from Il Dolomiti, 2020b).

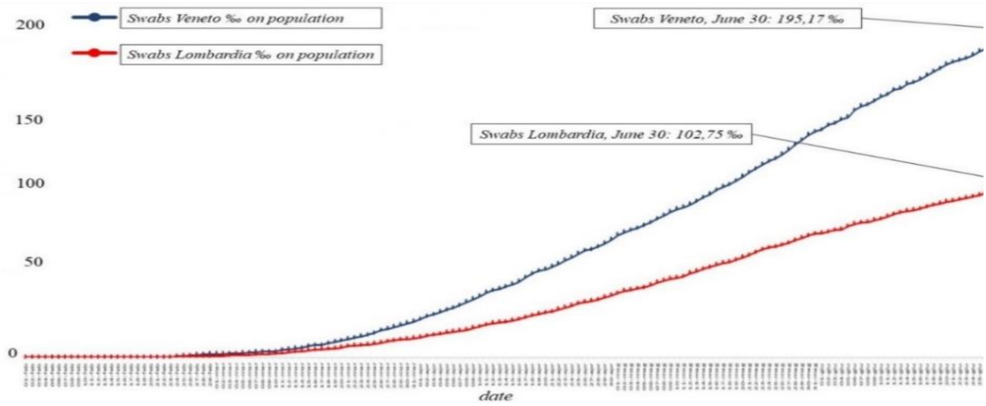


Figure 10: Comparison between the swab percentage [‰] on populations of Veneto (4,905,854) and Lombardia (10,088,484) in the period February 1- June 30, 2020.

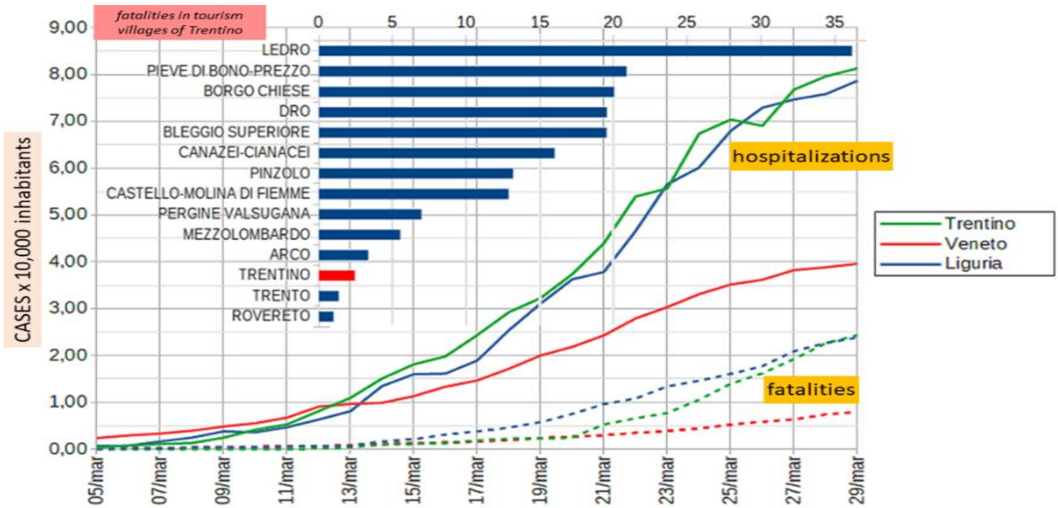


Figure 11: COVID-19 infection increase (fatalities/hospitalizations) in Trentino, Liguria, and Veneto, March 5 - March 29 (adapted from Il Dolomiti, 2020b).

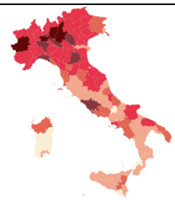
Finally (March 8), the Italian Government (DPCM, 2020b) imposed a quarantine (restriction of the population movements except for necessity, work, and health circumstances, temporary closure of non-essential shops and businesses) to the entirety of Lombardia, in addition to other fourteen provinces of Piemonte, Veneto, Emilia-Romagna, and Marche, involving roughly a quarter of the Italians, and an area of approximately 56,000 square kilometers (Table 5, adapted from Wikipedia, 2020a). A day after (March 9), the lockdown (Table 6, adapted from Wikipedia, 2020b) was extended to the whole Italy (DPCM, 2020c) and became total. During March 8 afternoon, before this new measure becoming effective, a leak of information caused an overwhelming exodus of people to their residential homes, mostly from North to South, with assaults to trains, buses, and sea ferries; worried appeals of Southern Italy Regional Governors called on to stop that messy migration and make barriers against the contagion, setting up police patrolling and checkpoints. Fortunately, the "back-migrants" largely respected the quarantine (often self-imposed), as proved by the low development of the infection in Southern Italy in the following days.

Table 5: Provinces under quarantine, March 8, 2020 (adapted from Wikipedia, 2020a).

Province	**Population**	**Province**	**Population**
Region Lombardia		*Region Piemonte*	
Bergamo	1,115,536	Alessandria	420,017
Brescia	1,265,954	Asti	214,342
Como	599,204	Novara	368,607
Cremona	358,955	Verbano-Cusio-Ossola	157,844
Lecco	337,380	Vercelli	170,298
Lodi	230,198	*Region Veneto*	
Mantova	411,958	Padova	938,957
Milano	3,263,206	Treviso	888,293
Monza and Brianza	875,769	Venezia	857,841
Pavia	545,888	Padova	938,957
Sondrio	180,811	*Region Emilia-Romagna*	
Varese	890,768	Modena	705,422
Region Marche		Parma	452,022
Pesaro and Urbino	358,886	Piacenza	287,152
		Reggio Emilia	531,891
		Rimini	339,437
Quarantine total		**16,466,636**	

Table 6: Italy under quarantine (after March 9, 2020) and SARS-CoV-2 infection on June 19, 2020 (adapted from Wikipedia, 2020b).

	50 ≤ 99 cases
	100 ≤ 499 cases
	500 ≤ 999 cases
	1000 ≤ 4999 cases
	5000 ≤ 9999 cases
	≥ 10000 cases



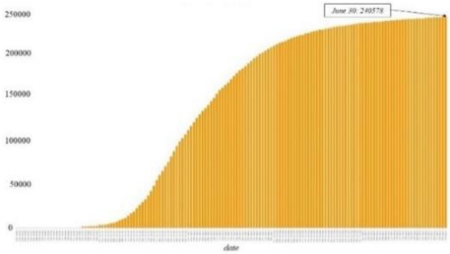
On April 26, 2020, the President of the Italian Council of Ministers declared the end of the lock down after 56 days and the official restart for the incoming May 4 (opening of Phase 2), following the milestones reported in Table 7. Displacements and activities should have followed strictly the recommendations of physical distance, mask wearing, hygiene and protocols, according to the government measures (Decree-Law, 2020e; DPCM, 2020d; DPCM, 2020e).

Taking into account 5 months (February 01-June 30, 2020), the COVID-19 pandemic trend in Italy (data source: DPC, Italian Department of civil Protection, DPC, 2020b) is shown in Figure 12:

- a) total number of positive cases;
- b) daily variation of total positive cases;
- c) daily number of currently positive cases;
- d) daily number of symptomatic people treated in hospital;
- e) daily number of patients in hospital with ICU;
- f) daily number of infected people in domestic quarantine;
- g) total number of victims;
- h) total number of released/healed.

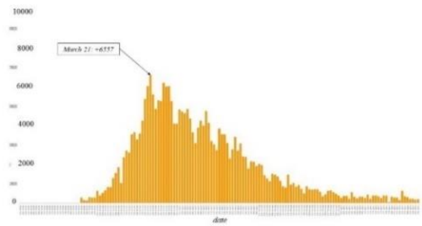
a) total number of positive cases

June 30: maximum 240578



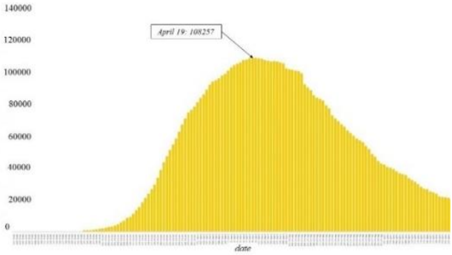
b) daily variation of total positive cases

March 21: maximum +6557



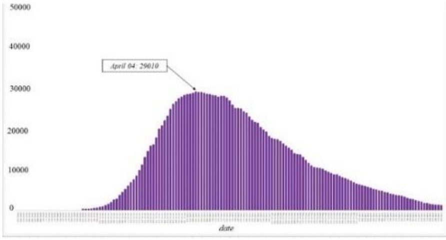
c) daily number of currently positive cases

April 19: maximum 108257



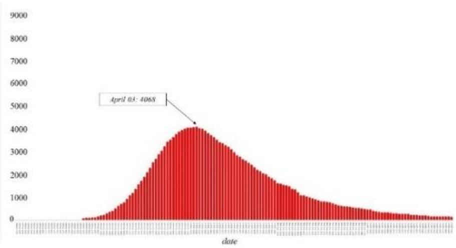
d) daily number of symptomatic people treated in hospital

April 04: maximum 29010



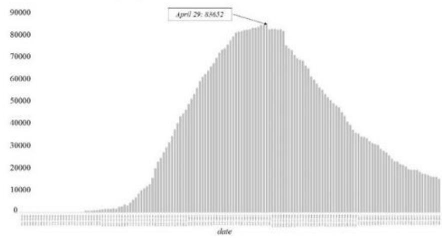
e) daily number of patients in hospital with ICU

April 03: maximum 4068



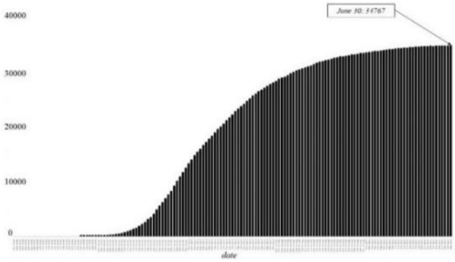
f) daily number of infected people in domestic quarantine

April 29: maximum 83652



g) total number of victims

June 30: maximum 34767



h) total number of released/healed

June 30: maximum 190248

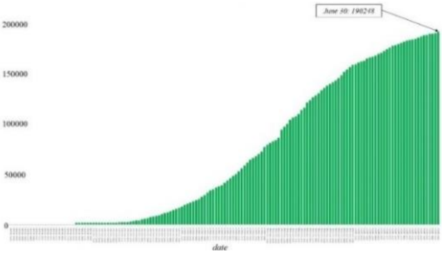


Figure 12: COVID-19 pandemic trend in Italy from February 1 to June 30, 2020.

Figure 13 (a: total positive cases; b: total casualties, until June 30) depicts the situation on 10,000 inhabitants for each Italian Region and the Autonomous Provinces of Trento and Bolzano (data source: DPC, Italian Department of civil Protection, DPC, 2020b). It is clear that the trend varies very much from North to South Italy. Further in-depth studies are presented in the next Section 5.

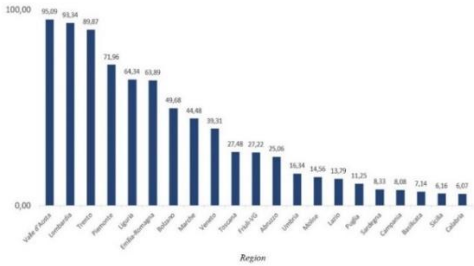


Figure 13a:
COVID-19 total positive cases
on 10,000 inhabitants in the
Italian Regions.

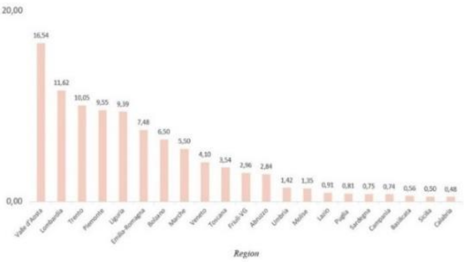


Figure 13b:
COVID-19 total casualties
on 10,000 inhabitants in the
Italian Regions.

Table 7: Milestones of the official restart (Phase 2) after the lockdown in Italy.

Date	Activity
April 27	strategic activities already allowed during lockdown (ATECO codes list, see Annex 3, DPCM, 2020d)
	industrial machinery, industries with safety protocols already active, preparation of opening
	yards for prisons, schools, health facilities, public housing
	works against hydrogeological instability
May 4	strategic activities already allowed during lockdown (ATECO codes list, see Annex 3, DPCM, 2020d)
	reopening of various manufacturing sectors (textile, fashion, automotive, glass, building), wholesale trade
	displacements within the region only for justified reasons (work, health, necessity, visits to relatives)
	displacements outside the region only for justified reasons (work, health, urgency, reentering home)
	displacements towards second homes only for indispensable maintenance
	displacements of off-site workers and students reentering home
	limitation of passengers on buses, metros, trains, airplanes
	reopening of parks and gardens with limitation of presence, but not kindergartens; permission of physical activities (with reciprocal distance) beyond the previous limit of 200 m from home
	reopening of laboratories and research activities, university examinations and theses
	funerals (15 people maximum, immediate family) and cemetery visits permitted, not Masses celebration
	bars and restaurants only for take-away
	closed doors training for individual sports
May 18	reopening of commercial retail activities
	reopening of bars, restaurants, pizzerias, ice-cream parlors, pastry shops, pubs
	reopening of accommodation facilities (hotels, etc.)
	reopening of hair salons, beauty centers, massage services
	reopening of beach activities
	reopening of museums, libraries, exhibitions
	displacements within the region without limitations
	displacements outside the region only for justified reasons (work, health, urgency, reentering home)
	Masses celebration permitted
	closed doors training for team sports
	permission of public demonstrations only in static way (no protest marches, processions, parades, etc.)
May 25	reopening of gyms, swimming pools, sporting centers
June 3	displacements outside the region (no limitations and self-certification) except specific areas under control
	displacements to/from abroad with limitations, following Italian and EU recommendations
June 12	restart of Italy Soccer Cup
June 15	permission for kids to enter amusement parks, summer centers, fun activity places
	reopening of cinemas and theaters
	reopening of wellness and thermal centers
	reopening of games rooms, bingo rooms, betting parlors
June 20	restart Italian Serie A Soccer Championship

5. The Italy case: lethality studies

5.1 Method

This Section has been originally developed by the authors in order to provide more in-depth results, based on matemathical and statistical models, with regard to the COVID-19 pandemic in Italy, in comparison to the data showed above and usually carried out by several other studies.

The preliminary analysis of the SARS-CoV-2 epidemic data in Italy in the first months of the pandemic (Figures 12-13) has shown an high level of *Lethality L*, as compared with the numbers of other countries (percent on the population amount) which previously faced the epidemic assault (for example China and Korea). Several hypotheses have been proposed, and a rather heated debate took place on the media. Above all, it would be expected that L has a Gaussian distribution with a mean value (μ) and a standard deviation (σ) in each country, depending only on the virus feature (virulence), although it may vary among the nations due to inland factors, as demography (people age) and level of life. For example, if a country with younger population has a mean L = 5±2%, in another state with a double ratio of older people we can expect L = 10±4%. If L doesn't oscillate around a mean value, virulence should not be regarded as the unique responsible of the fatality amount in combination with the people age. Therefore, our study tries to demonstrate that L in Italy can be strongly influenced by other factors as, for instance: the number of infected people with respect to the availability of facilities, bed places, equipment, health care effectiveness, co-morbidity with other illnesses, physicians ability, and so on. In addition, although in presence of a similar demography, we suppose that great variations in different areas of the country could be detected, due to the different regional healthcare governance and organization. In Italy, the healthcare system is under the control of the regional institution, while the national government has a minor power, mostly in controlling and supervising the management and the economic costs of the single regional healthcare system.

In order to analyze in an exhaustive way the L trend in Italy, taking into account the number of the infected people and the sensitivity of the healthcare systems, we introduce four definitions L_1, L_2, L_3, and L_4, according to the expressions (2), (3), (4), and (5), respectively.

Lethality L_1, given by equation (2), is calculated in the simplest way using the cumulative values of fatalities and infected people at a certain time t.

$$L_1(t) = \frac{D_c(t)}{N_c(t)} \times 100 \quad (2)$$

$L_1(t)$	*Lethality* L_1 (%) at time t (in days) for cumulative number of infected people or total positive cases N_c;
$D_c(t)$	cumulative number of fatalities at time t (in days);
$N_c(t)$	total cases of infected people (cumulative) registered from the beginning of the data records.

Lethality L_2, given by equation (3), considers the numbers of fatalities and infected people not in a cumulative way, but taking into account, although in an indirect way, the daily stress on the healthcare system.

$$L_2(t) = \frac{D_d(t)}{N_d(t)} \times 100 \quad (3)$$

$L_2(t)$	*Lethality* L_2 (%) at time t (in days) for number of people infected at a given day N_d;
$D_d(t)$	number of fatalities at time t (in days);
$N_d(t)$	number of infected people at a given day $[N_d(t) = N_c(t) - D_c(t) - healed]$.

Lethality L_3, given by equation (4), introduces a variable that gives a direct measure of the hospitalized people.

$$L_3(t) = \frac{D_d(t)}{N_h(t)} \times 100 \quad (4)$$

$L_3(t)$	*Lethality* L_3 (%) at time t (in days) for the number of hospitalized people N_h;
$D_d(t)$	number of fatalities at time t (in days);
$N_h(t)$	number of hospitalized people at time t (in days).

Finally, *Lethality* L_4, given by equation (5), introduces a variable that gives a direct measure of people recovered in the Intensive Care Units (ICUs).

$$L_4(t) = \frac{D_d(t)}{N_i(t)} \times 100 \quad (5)$$

$L_4(t)$	*Lethality* L_4 (%) at time t (in days) for the number of hospitalized people N_i;
$D_d(t)$	number of fatalities at time t (in days);
$N_i(t)$	number people recovered in Intensive Care Units (*ICUs*) at time t (in days).

Defining for each L_x (x=1, 4) the correspondent *Impact Velocity Factor* $I_x(t)$, considered the first derivative of $N_x(t)$ [$N_x = N_c, N_d, N_h, N_i$] with respect to time, which is the velocity of growth of N_x; this crucial factor defined in equation (6) takes into account the growth velocity of the infection and the push on the health care system.

$$I_1(t) = \frac{dN_c}{dt} \qquad I_2(t) = \frac{dN_d}{dt} \qquad I_3(t) = \frac{dN_h}{dt} \qquad I_4(t) = \frac{dN_i}{dt} \tag{6}$$

In order to quantify the vulnerability of the system, for each L_x (x=1, 3) a dimensionless parameter named *Weakness Index* W_i is introduced, as written in equation (7).

$$W_1(t) = \sqrt{\frac{D_c^2(t)}{I_1(t) \times N_d(t)}} \qquad W_2(t) = \sqrt{\frac{D_d^2(t)}{I_2(t) \times N_d(t)}} \qquad W_3(t) = \sqrt{\frac{D_d^2(t)}{I_3(t) \times N_h(t)}} \tag{7}$$

A dimensionless *Resistivity Factor* R_i can be defined as the inverse of the weakness W_i, as written in equation (8).

$$R_1 = \frac{1}{W_1} \qquad R_2 = \frac{1}{W_2} \qquad R_3 = \frac{1}{W_3} \tag{8}$$

5.2 Results for whole Italy

Figure 14 gives the cumulative trend (period from February 24 to June 3) of infected people N_c [black line] compared with L_1 [red line]. N_c and L_1, being cumulative, do not have a peak value, but the maximum is reached asymptotically at the infinite. It is clear that L_1 is not constant, as it should have been if depending only on the SARS-CoV-2 virulence; this variable is not normally distributed ($p<0.001$; confidence 95%). Figure 15a-c summarizes the trend of the following functions: Lethality Factors L_1, L_2, L_3 [red line]; N_c (cumulative number of infected people), N_d (number of infected people detected every day), N_h (number of hospitalized people every day), [black line]; Impact Velocities I_1, I_2, I_3 [blue line]; Resistivity Factors R_1, R_2, R_3 [green line]. L_1 shows an abrupt change of the slope (April 3), while the increase of N_c (approximated by a sigmoid, S-shaped) is almost linear. The inner small panel shows the L_1 distribution and the relative Gaussian function (with mean and standard deviation).

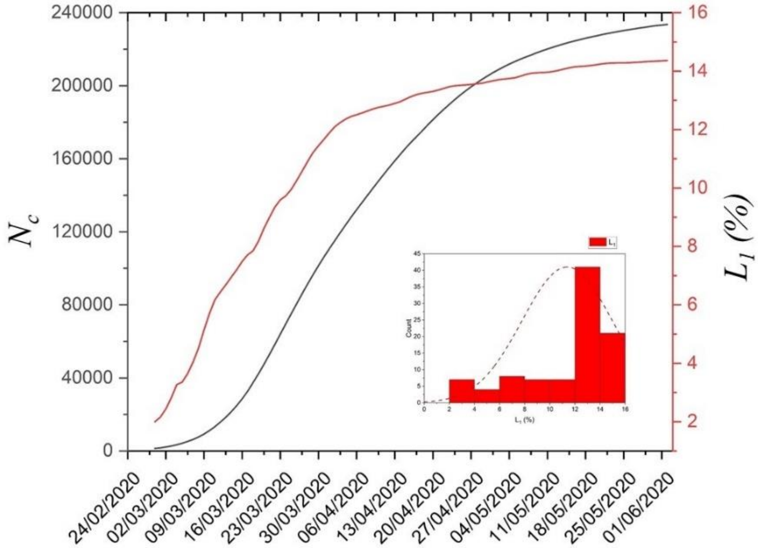


Figure 14: Cumulative number of infected people N_c [black line] compared with L_1 [red line]. The small panel shows the L_1 distribution and the relative Gaussian function.

Figure 16a-c shows the variables L_1, L_2, L_3 [red line] and N_c, N_d, N_h [black line], with the fitting models [dashed lines respectively green and purple], as reported in Table 8a-f. L_1 and N_c are both fitted in the best way by a Boltzmann function [$r(N_c)=0.999$; $r(L_1)=0.998$], but with different parameters. L_2 and N_d are well fitted by a Gaussian function [$r(N_d)=0.978$; $r(L_1)=0.982$]. L_3 and N_h are well fitted by a sum of two Gaussians. Figure 16d shows the variable L_4, which can be fitted by a logistic function (dashed blue line), whose parameters are given in Table 8g; the mathematical trend shows a rapid growth in the first two weeks, followed by a Gaussian behavior distributed around a mean value; time dependence is unclear and the interpretation of the results doesn't lead to an evident link with N_i. Therefore, in the further discussion, we focus our analysis mainly on L_1, L_2, and L_3. Figure 17 compares R_1, R_2, R_3.

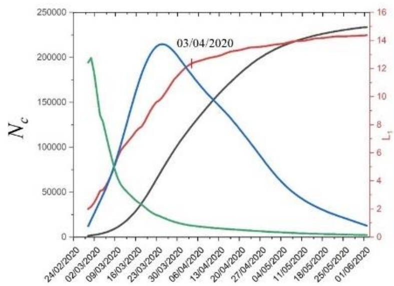


Figure 15a: N_c (black line) compared with L_1 (red line), I_1 (blue line), and R_1 (green line).

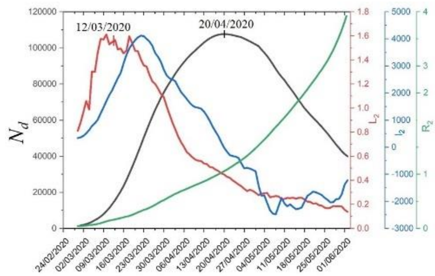


Figure 15b: N_d (black line) compared with L_2 (red line), I_2 (blue line), and R_2 (green line).

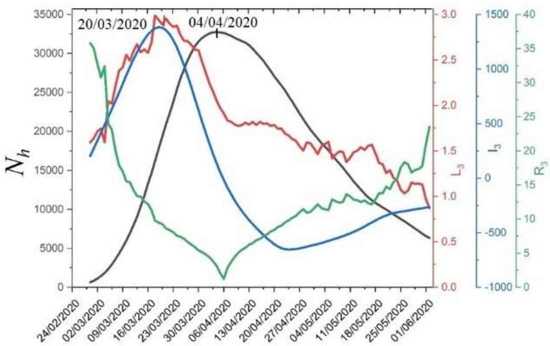


Figure 15c: N_h (black line) compared with L_3 (red line), I_3 (blue line), and R_3 (green line).

The L_1, L_2, L_3 peaks, although not coincident, are enough closer one each other. After an increase of both the variables L_1 and I_1, (L_1 sweetly than I_1), L_1 changes its slope about a week after the decrease of I_1, showing a great influence of the second factor on the first; then, both the curves become asymptotic. L_2 and L_3 don't have a Gaussian distribution. The peaks of L_2 (March 12) and L_3 (March 20) precede (respectively 40 and 15 days) the maximum values of N_d (April 20) and N_h (April 4). It is enough surprising, because we would have expected a coincidence or, at list, a late occurrence in a shorter range (i.e. one-two weeks), after reaching the acme of infected/hospitalized people; it means that I_2 (much) and I_3 (less) are more significant than N_d and N_h for the L_2 and L_3 decrease; it occurs when the pressure on the healthcare system starts to reduce. All these results suggest that I_2 and I_3 influence very much the performance of the healthcare facilities during the heaviest phases of the pandemic, inducing vulnerability in the system.

Analyzing N_x, L_x, and I_x (x=1, 3) through further statistical studies, we find interesting results confirming what already said; the abnormally high L_x, registered in Italy if compared with other countries, was probably due to the vulnerability of the system itself than the COVID-19 virulence. The Pearson test shows a high direct correlation between L_1 and N_c (r=0.94, $p<0.05$); on the contrary, it is very weak (even negative) between L_1 and I_1 (r=-0.14, $p>0.05$); a similar output is given by Sperman (but more negative: r=-0.57, $p<0.01$). This analysis suggests that L_1 is more related to the increasing number of infected people N_c than the Impact Velocity I_1. The opposite can be found for L_2, highly correlate to I_2, according both to Pearson (r=0.86, $p<0.001$) and Spearman (r=0.87, $p<0.001$); on the other hand, the L_2 correlation with N_d is weakly negative, although significant, in the Pearson (r=-0.26, $p<0.05$) and Spearman (r=-0.22, $p<0.05$) tests. Similar results are clear for L_3: positive with I_3 (Pearson: r=0.87, $p<0.001$; Spearman: r=0.67, $p<0.001$); negative, non-significant, with N_h (Pearson: r=-0.11, $p>0.05$; Spearman =-0.15, $p>0.05$).

R_1 decreases rapidly, following a negative exponential until I_1 reaches the maximum; after this point, R_1 changes its slope. R_2 grows exponentially, changing the slope just after the I_2 peak. The most interesting results regard R_3; I_3 and L_3 increase until their almost coincident peaks, while R_3 reduces exponentially; however, R_3 starts growing after the N_h maximum; it indicates that the Resistivity Factor depends strongly on the amount of people crowding or not the hospital facilities. However, the behavior of R_1, R_2, R_3 is quite different and cannot provide a clear interpretation. Therefore, a more in-depth study has been necessary.

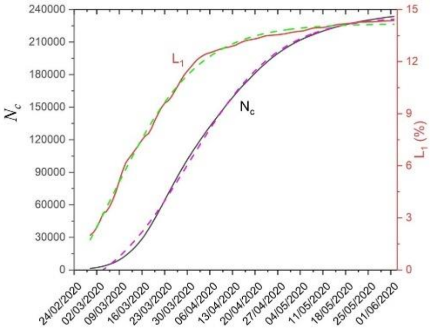


Figure 16a: N_c (black line) compared with L_1 (red line). The dashed lines (respectively purple and green) are the fitting models of Table 6a-b.

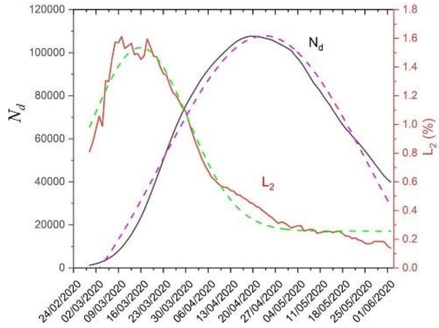


Figure 16b: N_d (black line) compared with L_2 (red line). The dashed lines (respectively purple and green) are the fitting models of Table 6c-d.

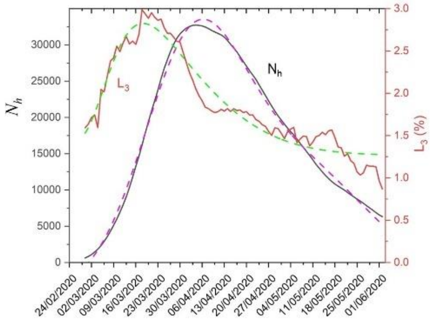


Figure 16c: N_h (black line) compared with L_3 (red line). The dashed lines (respectively purple and green) are the fitting models of Table 6e-f.

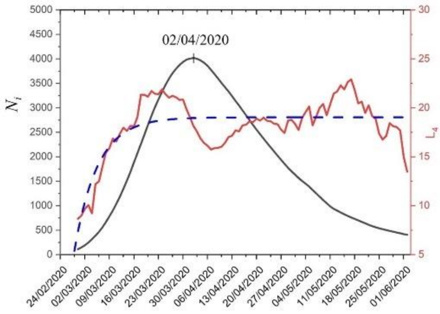


Figure 16d: N_i (black line) compared with L_4 (red line). The dashed blue line is the fitting model of Table 6g.

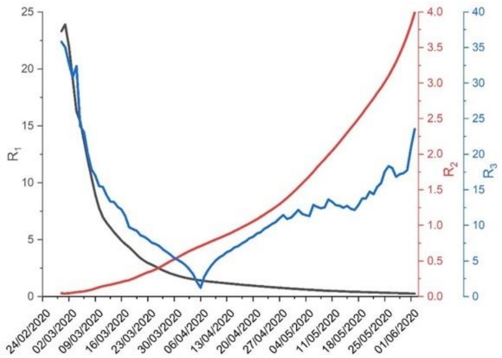


Figure 17: R_1 (black line) compared with R_2 (red line), and R_3 (blue line).

Table 8: Parameters of the fitting functions.

a) N_c parameters		*b) L_1 parameters*	
Model	Boltzmann	Model	Boltzmann
Equation	$y = A2+(A1-A2)/[1 + exp(x/x_0)/dx)]$	Equation	$y = A2+(A1-A2)/[1 + exp(x/x_0)/dx)]$
Plot	$N_{(c)}$	Plot	$L_{(1)}$
A1	-33768.488 ± 2798.693	A1	-6.045 ± 0.992
A2	233768.605 ± 916.095	A2	14.183 ± 0.038
X_0	2458938.727 ± 0.342	X_0	2458914.316 ± 1.312
dx	13.849 ± 0.283	p	13.481 ±0.418
Reduced Chi-Sqr	9445572.844	Reduced Chi-Sqr	0.033
R-Square (COD)	0.999	R-Square (COD)	0.998
Adj. R-Square	0.999	Adj. R-Square	0.997
c) N_d parameters		*d) L_2 parameters*	
Model	GaussAmp	Model	GaussAmp
Equation	$y = y_0+A\exp[-0.5((x-x_c)/w)^2]$	Equation	$y = y_0+A\exp[-0.5((x-x_c)/w)^2]$
Plot	$N_{(d)}$	Plot	$L_{(2)}$
y_0	-41694.821 ± 7753.305	y_0	0.256 ± 0.012
x_c	2458962.55 ± 0.233	x_c	2458923.914 ± 0.316
w	32.161 ± 1.353	w	14.962 ± 0.394
A	149515.559 ± 7385.67	A	1.279 ± 0.021
Reduced Chi-Sqr	2.183E7	Reduced Chi-Sqr	0.006
R-Square (COD)	0.982	R-Square (COD)	0.978
Adj. R-Square	0.982	Adj. R-Square	0.977
e) N_h parameters		*f) L_3 parameters*	
Model	GaussAmp	Model	GaussAmp
Equation	$y = y_0+A\exp[-0.5((x-x_c)/w)^2]$	Equation	$y = y_0+A\exp[-0.5((x-x_c)/w)^2]$
Plot	Peak 1 [$N_{(h)}$]; Peak 2 [$N_{(h)}$]	Plot	Peak 1 [$L_{(3)}$]; Peak 2 [$L_{(3)}$]
y_0	-4543.258 ± 4709.533; -4543.258 ± 4709.533	y_0	1.266 ± 0.055; 1.266 ± 0.055
x_c	2458941.408 ± 0.244; 2458969.324 ± 16.53	x_c	2458904.788 ± 6.317; 2458904.788 ± 36.874
w	15.218 ± 2.189; 27.778 ± 14.072	w	-2.143 ± 2.193; 2.31 ± 2.119
A	25480.776 ± 14109.878; 19494.914 ± 9620.471	A	1.279 ± 0.021
Reduced Chi-Sqr	481154.865	Reduced Chi-Sqr	0.022
R-Square (COD)	0.996	R-Square (COD)	0.933
Adj. R-Square	0.995	Adj. R-Square	0.929

g) L_4 parameters	
Model	Logistic
Equation	$y = A2+(A1-A2)/[1 + (x/x_0)^p]$
Plot	$L_{(4)}$
A1	-5.403E7 ± 1.459E14
A2	19.043 ± 0.241
X_0	2458806.927 ± 1.78E7
p	373245.31 ±140243.124
Reduced Chi-Sqr	3.809
R-Square (COD)	0.637
Adj. R-Square	0.625

5.3 Results for geographical areas

With regard to the Italian Regions (20) and Autonomous Provinces (2), we selected three geographical groups, depending on the start/growth of the pandemic, specificity of the local healthcare system, efficiency of the medical facilities, demography and difference in the level of life: North (Lombardia, Piemonte, Emilia-Romagna, Veneto, Provincia Autonoma di Trento); Center (Toscana, Lazio, Marche); South (Campania, Puglia, Sicilia). In fact, the Sars-Cov-2 outbreak, started in Lombardia and Veneto, spread through the bordering Emilia-Romagna, and only later progressively irradiated to West, East, Center, and South, with different degrees (timing and amount) of the infection trends. In addition, Sicily, being an island, can take into account specific effects. All the data have been collected from the official daily reports produced by the Ministry of Health/Civil Protection Department-DPC. As for Italy, the period of observation is from February 24 up to June 3, 2020, including the imposed national lockdown and the easing phases, occurred 100 days later. The variables L_1, L_2, L_3 (Figures 18a-c) and R_1, R_2, R_3 (Figures 19a-c) have been studied for the above said three macro areas through the one-way-ANOVA (analysis of variance) test, in order to find significant statistical differences. The colored boxes limit the quartiles; the horizontal lines represent the medians; the small black squares inside the colored boxes are the mean values; the external dots are outliers. The graphs have been computed using the same scale to facilitate the comparison.

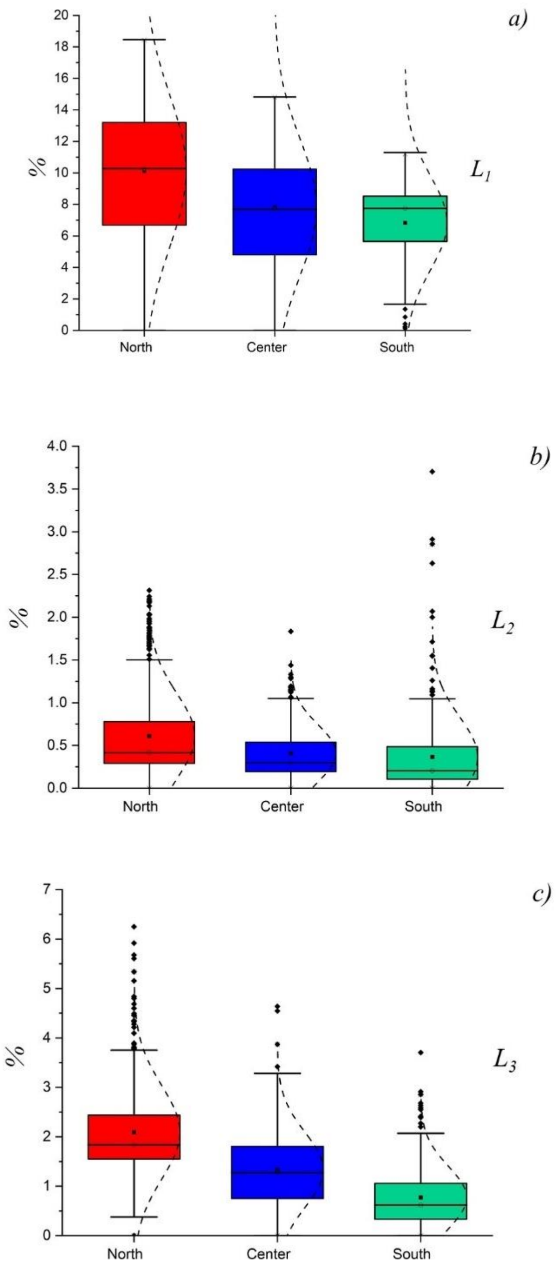


Figure 18a-c: Distribution in quartiles of L_1, L_2, L_3 comparing North, Center and South macro areas.

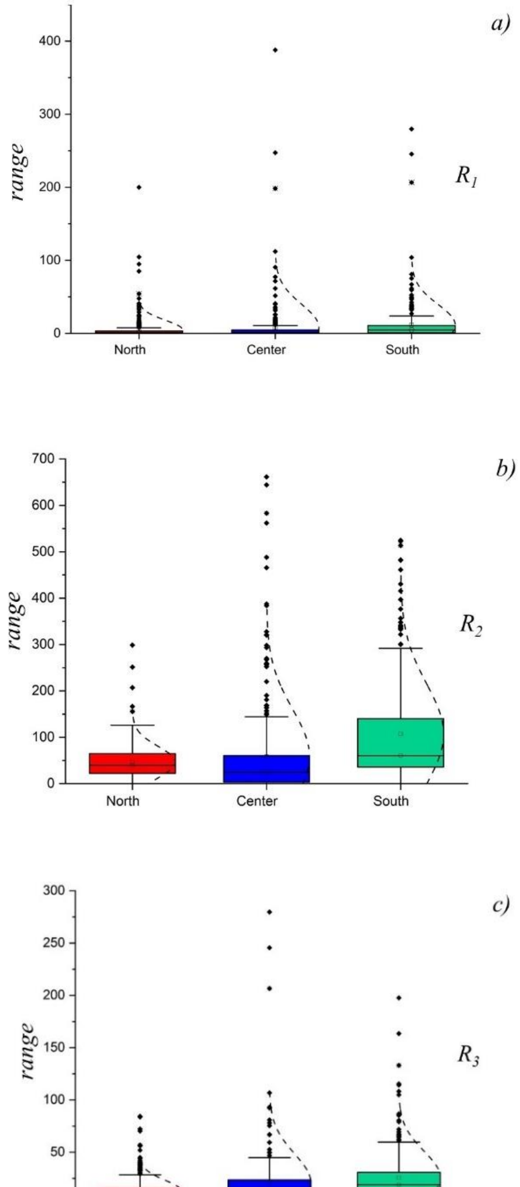


Figure 19a-c: Distribution in quartiles of R_1, R_2, R_3 comparing North, Center and South macro areas.

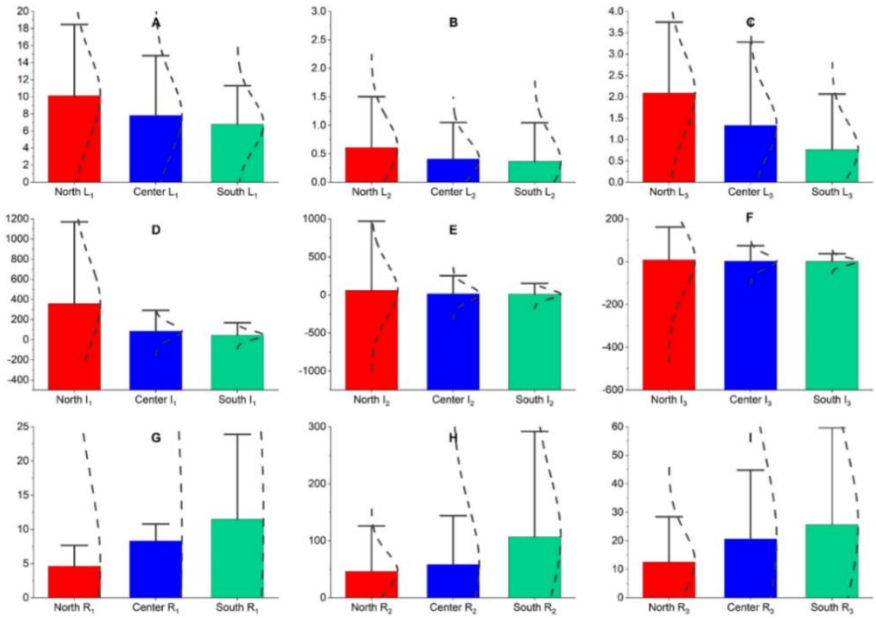


Figure 20: Synthetic representation of all the considered parameters in terms of mean and standard deviation;
graphs A-B-C: L_1, L_2, L_3 for North, Center and South macro areas;
graphs D-E-F: I_1, I_2, I_3 for North, Center and South macro areas;
graphs G-H-I: R_1, R_2, R_3 for North, Center and South macro areas.

With regard to L_1, the difference among the three areas is quite important ($F=59.01$, $p<0.001$); the Tukey's post-hoc test (comparison among the mean values) confirms this result among each pairwise combination. Similar outputs are evident for L_2 ($F=32.29$, $p<0.001$); however, the Tukey's post-hoc test highlights that the gap is higher between North and the other two areas, because Center and South have comparable values. About L_3, the computation gives again great differences for all the comparisons ($F=243.5$, $p<0.001$).

For R_1, one-way-ANOVA shows a statistical difference ($F=7.51$, $p<0.05$) among the three areas, but Tukey's post-hoc test speaks about a certain difference only between North and South groups. For R_2, one-way-ANOVA gives a significant difference among all the areas ($F=49.83$, $p<0.01$), while Tukey's post-hoc test doesn't confirm this behavior between North and Center. For R_3, both the tests show statistical differences ($F=36.85$, $p<0.001$) for all the pairwise combinations.

Figure 20 gives a summary of the results. Considering the mean values for each L_x (x=1, 3), the North macro area, where the outbreak started, shows always the highest numbers, while the lowest ones are reported for

South, the farthest from the origin of the pandemic. This behavior is still evident by the analysis of I_x (x=1, 3). R_x (x=1, 3) is the opposite, with South being the most resistive, because the infection hit with a lower intensity in the first months of the disease, and not depending from the effectiveness of the healthcare system.

In order to get more details, the study continues in the next Section 5.4 with an analysis of the single regions which are part of the selected macro areas.

5.4 Results for single Italian regions

Also analyzing the single regions, the graphs have been computed using the same scale, with the aim to facilitate their comparison. One-way-ANOVA (analysis of variance) and Tukey's post-hoc tests have been performed.

5.4.1 North Italy macro area

Figure 21 shows the ANOVA results for L_1. Statistical differences are evident (F=91.83, $p<0.001$), confirmed by Tukey (Table 9a) for all the comparisons ($p<0.01$), with the only exception of P.A. Trento versus Veneto ($p>0.05$). Figure 22 shows the ANOVA results for I_1. Statistical differences are evident (F=117.79, $p<0.01$). Tukey (Table 10a) confirmed these divergences ($p<0.01$) in eight out of ten comparisons, except for Emilia-Romagna versus Piemonte and Veneto ($p>0.05$). Figure 23 shows the ANOVA results for R_1. A weak statistical difference (F=3.68, $p>0.05$) has been found, confirmed by Tukey (Table 11a) for all the comparisons, except in P.A Trento versus Lombardia and Emilia-Romagna. Figure 24a-e reports N_c (black line), L_1 (red line), I_1 (blue line), and R_1 (green line) respectively for Lombardia, Emilia-Romagna, Veneto, Piemonte, And P.A. Trento. Figure 25a-c summarizes the L_1, I_1, R_1 behaviors for all the sites under examination.

Table 9: Tukey's post-hoc test results for L_x.

	(a)	*(b)*	*(c)*
	L_1	L_2	L_3
comparison	*significant difference (p<0.01)*	*significant difference (p<0.01)*	*significant difference (p<0.01)*
Emilia-Romagna vs Lombardia	yes	yes	yes
Veneto vs Lombardia	yes	yes	yes
Veneto vs Emilia-Romagna	yes	yes	yes
Piemonte vs Lombardia	yes	yes	yes
Piemonte vs Emilia-Romagna	yes	yes	yes
Piemonte vs Veneto	yes	yes	yes
P.A. Trento vs Lombardia	yes	yes	yes
P.A. Trento vs Emilia-Romagna	yes	yes	yes
P.A. Trento vs Veneto	no	yes	yes
P.A. Trento vs Piemonte	yes	yes	yes

Table 10: Tukey's post-hoc test results for I_x.

	(a)	*(b)*	*(c)*
	I_1	I_2	I_3
comparison	*significant difference (p<0.05)*	*significant difference (p<0.05)*	*significant difference (p<0.05)*
Emilia-Romagna vs Lombardia	yes	yes	no
Veneto vs Lombardia	yes	yes	no
Veneto vs Emilia-Romagna	no	no	no
Piemonte vs Lombardia	yes	yes	no
Piemonte vs Emilia-Romagna	no	no	no
Piemonte vs Veneto	yes	no	no
P.A. Trento vs Lombardia	yes	yes	no
P.A. Trento vs Emilia-Romagna	yes	no	no
P.A. Trento vs Veneto	yes	no	no
P.A. Trento vs Piemonte	yes	no	no

Table 11: Tukey's post-hoc test results for R_x.

	(a)	*(b)*	*(c)*
	R_1	R_2	R_3
comparison	*significant difference (p<0.05)*	*significant difference (p<0.05)*	*significant difference (p<0.05)*
Emilia-Romagna vs Lombardia	no	no	no
Veneto vs Lombardia	no	yes	no
Veneto vs Emilia-Romagna	no	yes	no
Piemonte vs Lombardia	no	no	no
Piemonte vs Emilia-Romagna	no	no	no
Piemonte vs Veneto	no	no	no
P.A. Trento vs Lombardia	yes	yes	no
P.A. Trento vs Emilia-Romagna	yes	yes	no
P.A. Trento vs Veneto	no	yes	no
P.A. Trento vs Piemonte	no	yes	no

The highest L_1 value is in Lombardia, region where the pandemic started, the second in Emilia-Romagna, with the Piacenza Province lying on the border with the Lodi municipalities confined in March 2020 by the first local lockdown. Veneto has the lowest L_1 values, probably because the local initial outbreaks were immediately isolated. While N_c can be always approximated by a sigmoid (S-shaped) function, no one of the North Italy regions shows L_1 as a constant: the respective curves vary from an almost linear model (Veneto) to time-dependent logistic functions (other zones). It is interesting to note that P.A. Trento shows high L_1 values, being those of N_c and I_1 very low; it is countertrending, because, in general, high I_1 drives to high L_1. The R_1 behavior is a time-dependent exponential decay, although with a different slope. This trend, firstly related to the increase of N_c, is mainly influenced by I_1 than L_1, as demonstrated by the combination of high I_1 and low R_1 in Lombardia and Emilia-Romagna, where the initial outbreak occurred; P.A. Trento shows apparently the fastest R_1 decrease until the asymptotic decay (from a very high initial value).

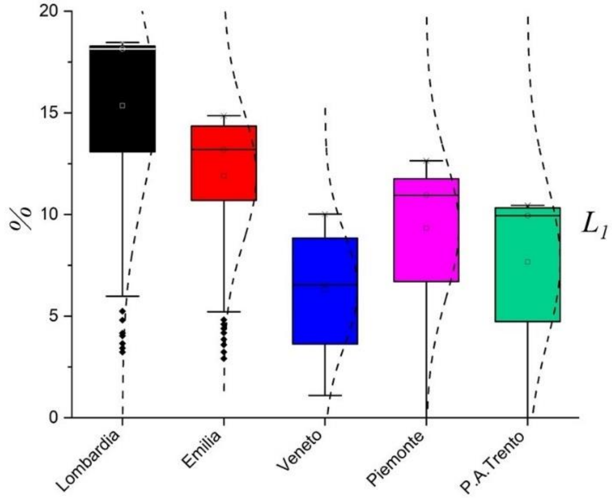


Figure 21: Distribution in quartiles of L_1 for the regions belonging to the North macro area.

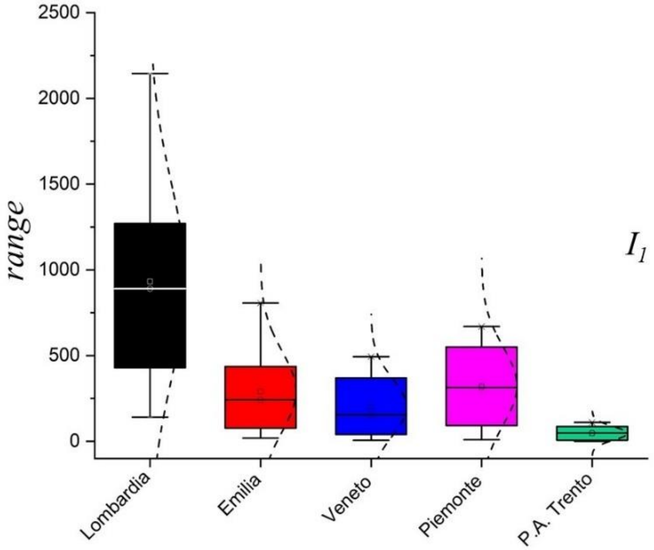


Figure 22: Distribution in quartiles of I_1 for the regions belonging to the North macro area.

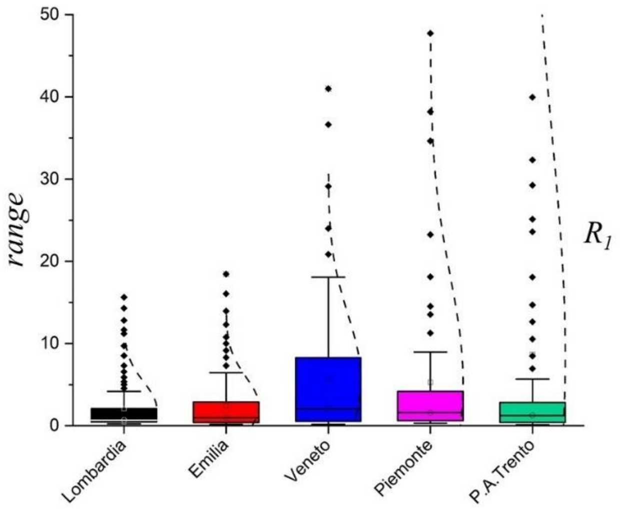


Figure 23: Distribution in quartiles of R_1 for the regions belonging to the North macro area.

Figure 26 shows the ANOVA results for L_2. Statistical differences are evident among the regions, confirmed by Tukey ($p<0.01$) for all the comparisons (Table 9b). Figure 27 shows the ANOVA results for I_2. Statistical differences are evident among the regions ($F=5.41$, $p<0.01$). Tukey (Table 10b) confirmed the divergences ($p<0.05$) only for 4 out of 10 comparisons, always with Lombardia on the top end. Figure 28 shows the ANOVA results for R_2. Consistent statistical differences among the regions (F=18.96, p<0.01) are evident. Tukey results (differences on six out of ten comparisons) are reported in (Table 11b). Figure 29a-e reports N_d (black line), L_2 (red line), I_2 (blue line), and R_2 (green line) respectively for Lombardia, Emilia-Romagna, Veneto, Piemonte, And P.A. Trento. Figure 30a-c summarizes the L_2, I_2, R_2 behaviors for all the sites under examination. Again, the highest L_2 value is in Lombardia, followed by the bordering Emilia-Romagna, both regions with a great I_2. The L_2 peak coincides with the N_d rising phase, indicating the dominant influence of I_2 on L_2. As already seen for whole Italy, all the regions have their L_2 and I_2 maximum values much closer one each other than the N_d peak, which is located enough forward; I_2 can be also negative, when L_2 takes a descending slope: it confirms the reciprocal interaction among these two parameters. P.A. Trento has apparently the best R_2, while Lombardia the worst, being the region with the highest I_2 and N_d.

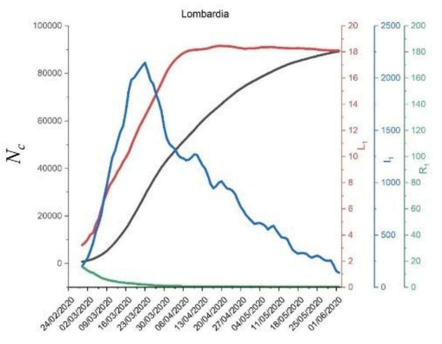


Figure 24a: N_c (black line) compared with L_1 (red line), I_1 (blue line), and R_1 (green line) for Lombardia.

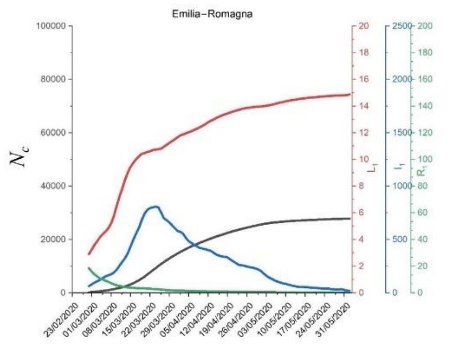


Figure 24b: N_c (black line) compared with L_1 (red line), I_1 (blue line), and R_1 (green line) for Emilia-Romagna.

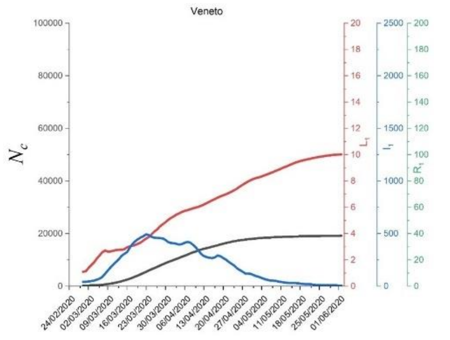


Figure 24c: N_c (black line) compared with L_1 (red line), I_1 (blue line), and R_1 (green line) for Veneto.

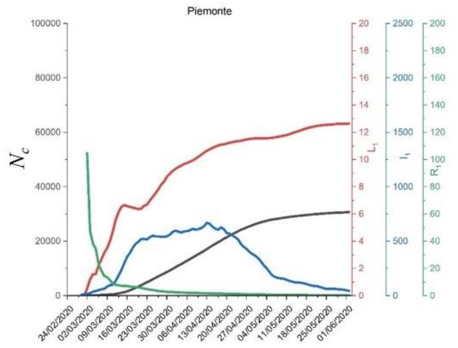


Figure 24d: N_c (black line) compared with L_1 (red line), I_1 (blue line), and R_1 (green line) for Piemonte.

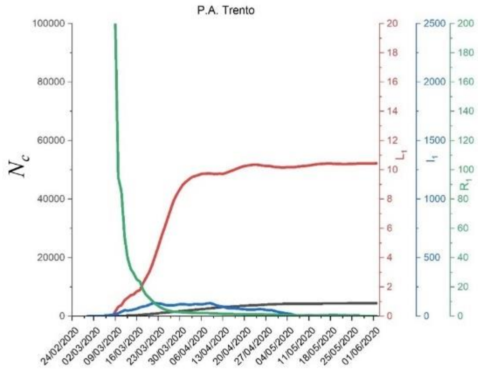


Figure 24e: N_c (black line) compared with L_1 (red line), I_1 (blue line), and R_1 (green line) for P.A. Trento.

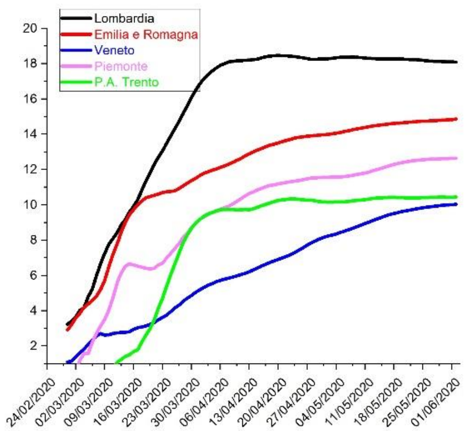


Figure 25a: L_1 for the regions studied.

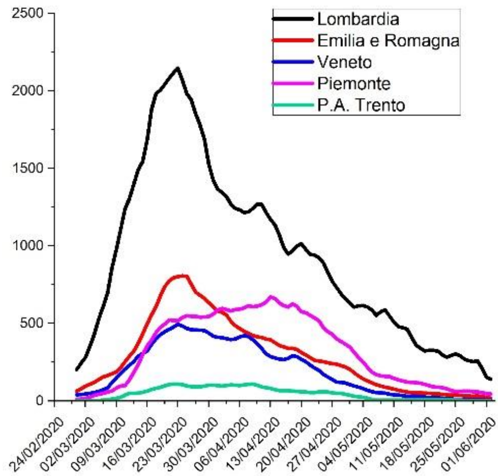


Figure 25b: I_1 for the regions studied.

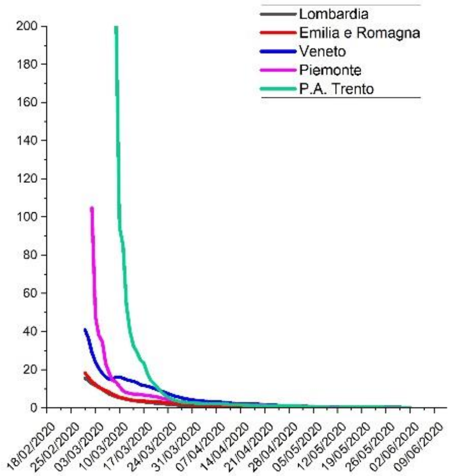


Figure 25c: R_1 for the regions studied.

Figure 31 shows the ANOVA results for L_3. Statistical differences are evident, confirmed by Tukey (Table 9c) for all the comparisons ($p<0.01$). Figure 32 shows the ANOVA results for I_3. No significant statistical differences are evident among the regions ($F=0.66$, $p>0.05$), confirmed by Tukey (Table 10c). Figure 33 shows the ANOVA results for R_3. Statistical differences among the regions ($F=2.49$, $p=0.04$) are not confirmed by Tukey (Table 11c). Figure 34a-e reports N_h (black line), L_3 (red line), I_3 (blue line), and R_3 (green line) respectively for Lombardia, Emilia-Romagna, Veneto, Piemonte, And P.A. Trento. Figure 35a-c summarizes the L_3, I_3, and R_3 behavior for all the sites under examination. Again, all the regions have their L_2 and I_2 maximum values much closer one each other than the N_h peak.

Figure 36 presents the synthesis of all the parameters for Lombardia, Emilia-Romagna, Veneto, Piemonte, P.A. Trento respectively for L_1, L_2, L_3 (graphs A-B-C), I_1, I_2, I_3 (graphs D-E-F), and R_1, R_2, R_3 (graphs G-H-I). Although some differences can be noticed among the regions of the North Italy macro area, as demonstrated by the functions' shapes and statistical data, it is confirmed that the variables L_x (x=1, 3) don't depend only on the Sars-Cov-2 virulence, being not constant and time-dependent. Moreover, for most of the regions, L_2 and L_3 peaks anticipate the respective N_d and N_h maximum values, as seen for whole Italy (this behavior is partially true for Veneto). About I_2 (related to N_d, number of infected people detected every day), this variable can be considered a good estimator of the stress subjected by the healthcare system, while I_1, related to N_c (cumulative number of infected people), it is too generic to achieve this purpose. Furthermore, I_2 is exceptionally high in Lombardia (of course, subjected since the beginning to the heaviest pandemic attack), and much lower and comparable in the other regions; however, being appreciable some statistical variations among the latter, changes of the healthcare system effectiveness could have influenced in a certain measure the Lethality data. With regard to R_x (x=1, 3), R_1 statistically differs in a significant way only for P.A. Trento; it shows a fast decrease from a very high initial value until the asymptotic decay, in correspondence with the greatest L_1 and I_1; a possible explanation is the immediate growth of the amount of infected people starting from negligible numbers at the beginning of the period considered. In general, the most significant variations can be detected for R_2, because it takes into account the various degree of response of the regional healthcare systems. Finally, the almost uniformity of R_3 indicates the comparable efficiency of the hospital facilities among the regions.

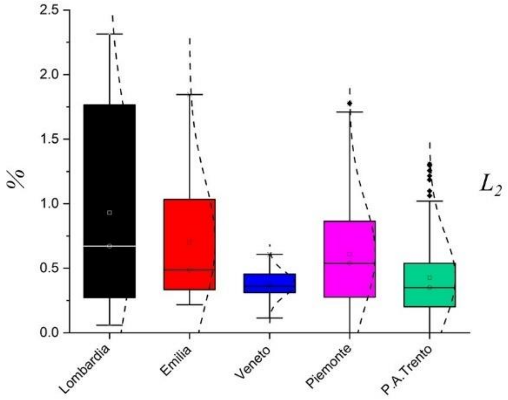


Figure 26: Distribution in quartiles of L_2 for the regions belonging to the North macro area.

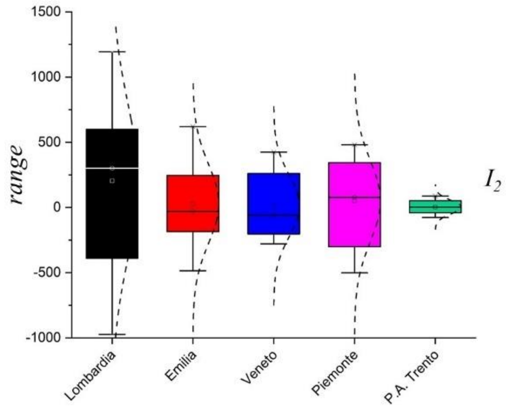


Figure 27: Distribution in quartiles of I_2 for the regions belonging to the North macro area.

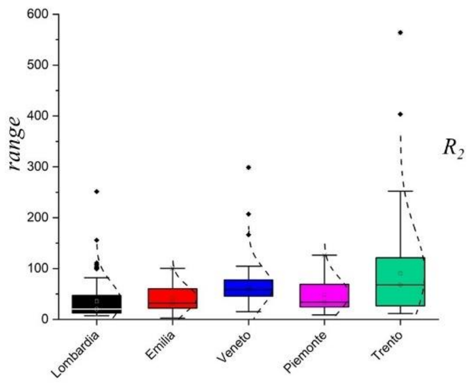


Figure 28: Distribution in quartiles of R_2 for the regions belonging to the North macro area.

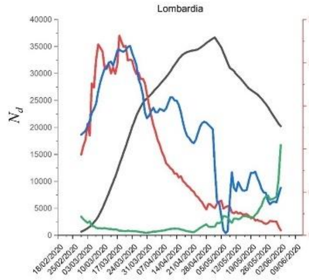


Figure 29a: N_d (black line) compared with L_2 (red line), I_2 (blue line), and R_2 (green line) for Lombardia.

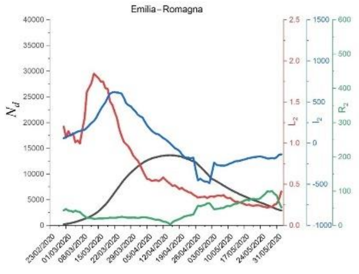


Figure 29b: N_d (black line) compared with L_2 (red line), I_2 (blue line), and R_2 (green line) for Emilia-Romagna.

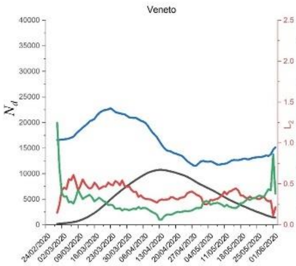


Figure 29c: N_d (black line) compared with L_2 (red line), I_2 (blue line), and R_2 (green line) for Veneto.

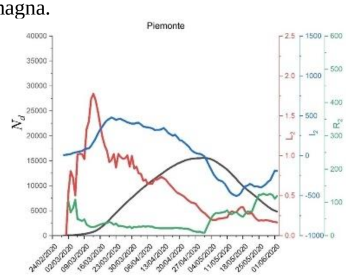


Figure 29d: N_d (black line) compared with L_2 (red line),I_2 (blue line), and R_2 (green line) for Piemonte.

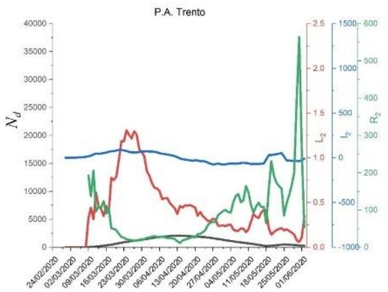


Figure 29e: N_d (black line) compared with L_2 (red line), I_2 (blue line), and R_2 (green line) for P.A. Trento.

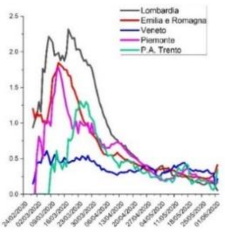


Figure 30a: L_2 for the regions studied.

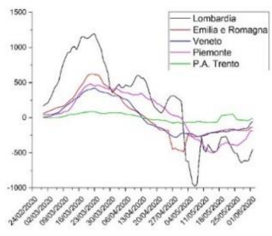


Figure 30b: I_2 for the regions studied.

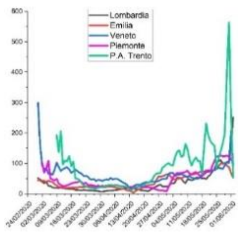


Figure 30c: R_2 for the regions studied.

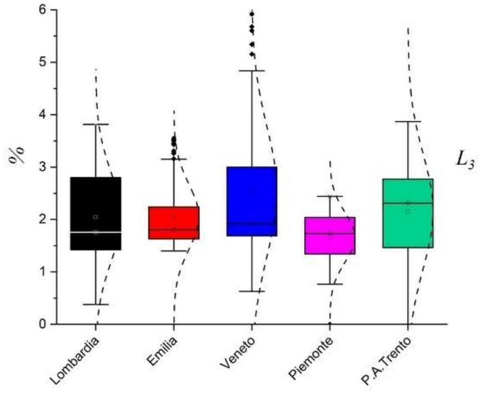


Figure 31: Distribution in quartiles of L_3 for the regions belonging to the North macro area.

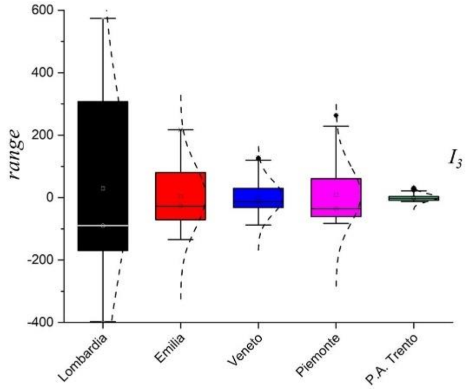


Figure 32: Distribution in quartiles of I_3 for the regions belonging to the North macro area.

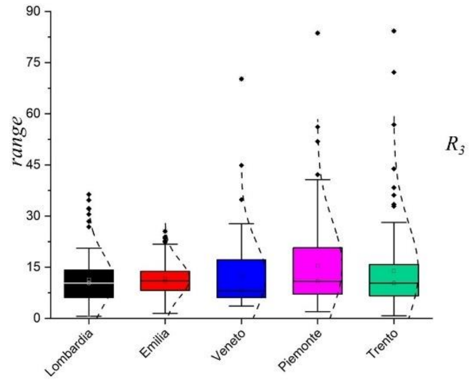


Figure 33: Distribution in quartiles of R_3 for the regions belonging to the North macro area.

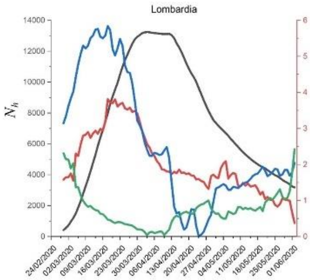


Figure 34a: N_h (black line) compared with L_3 (red line), I_3 (blue line), and R_3 (green line) for Lombardia.

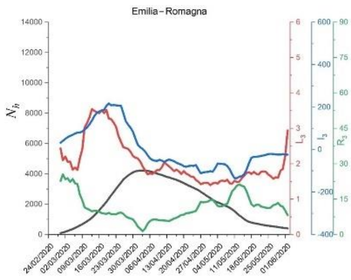


Figure 34b: N_h (black line) compared with L_3 (red line), I_3 (blue line), and R_3 (green line) for Emilia-Romagna.

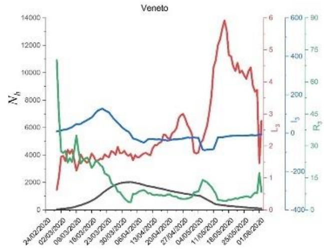


Figure 34c: N_h (black line) compared with L_3 (red line), I_3 (blue line), and R_3 (green line) for Veneto.

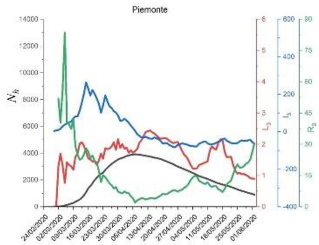


Figure 34d: N_h (black line) compared with L_3 (red line),I_3 (blue line), and R_3 (green line) for Piemonte.

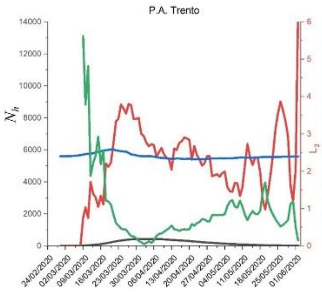


Figure 34e: N_h (black line) compared with L_3 (red line), I_3 (blue line), and R_3 (green line) for P.A. Trento.

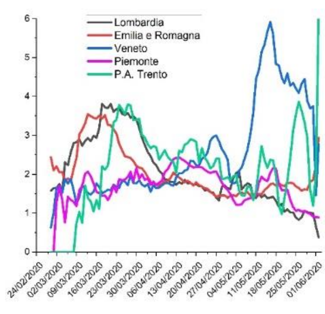


Figure 35a: L_3 for the regions studied.

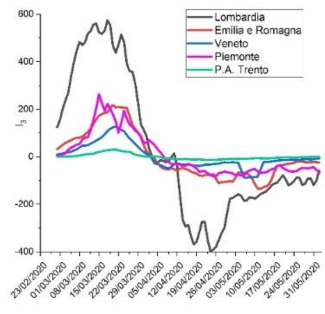


Figure 35b: I_3 for the regions studied.

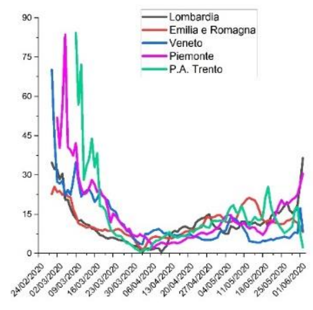


Figure 35c: R_3 for the regions studied.

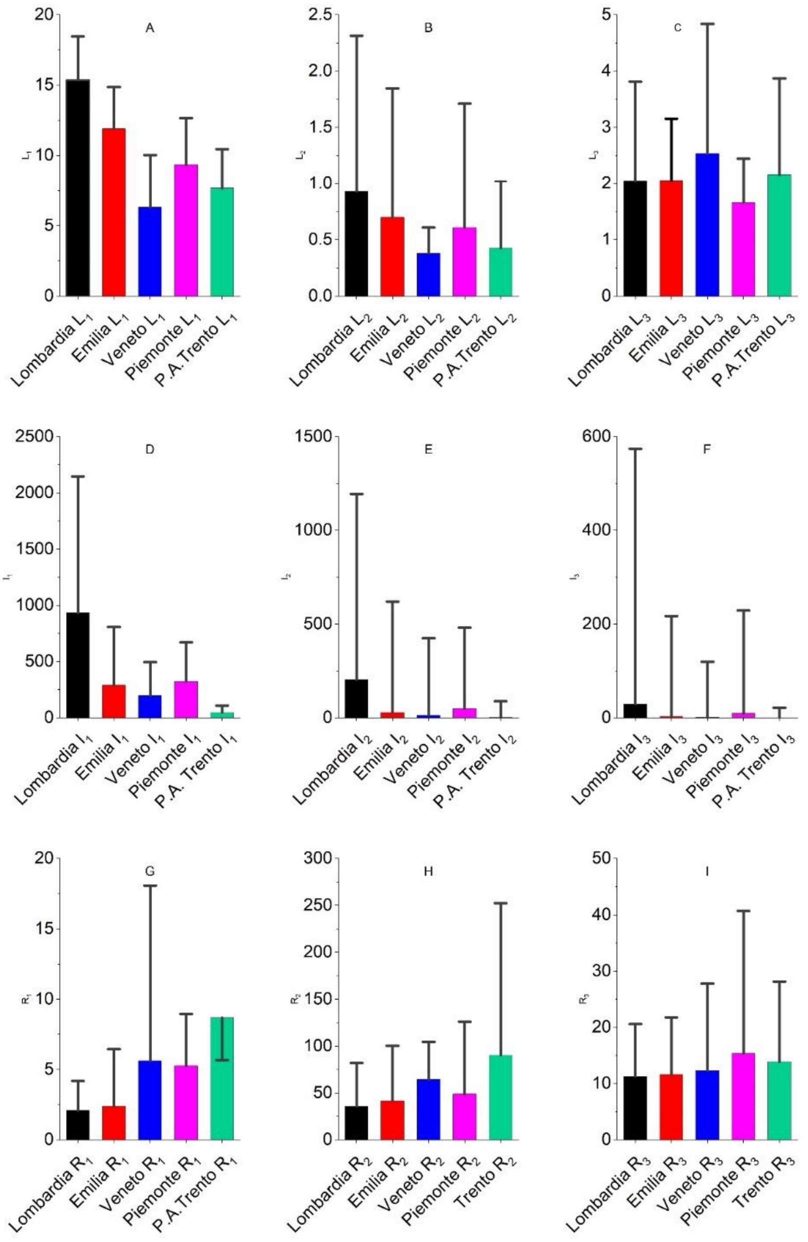


Figure 36: Synthetic representation of all the considered parameters in terms of mean and standard deviation;
graphs A-B-C: L_1, L_2, L_3 for Lombardia, Emilia-Romagna, Veneto, Piemonte, P.A. Trento;
graphs D-E-F: I_1, I_2, I_3 for Lombardia, Emilia-Romagna, Veneto, Piemonte, P.A. Trento;
graphs G-H-I: R_1, R_2, R_3 for Lombardia, Emilia-Romagna, Veneto, Piemonte, P.A. Trento.

5.4.2 Center Italy macro area

Figure 37 shows the ANOVA results for L_1 (F=89.04, p<0.001), confirmed by Tukey only for Marche versus the other two regions. Figure 38 shows the ANOVA results for I_1. Statistical differences (F=6.84, p<0.05) are evident only for Toscana versus Lazio and Marche, behavior confirmed by Tukey (p<0.01). Figure 39 shows the ANOVA results for R_1. A significant statistical difference (F=4.34, p<0.05) has been found, confirmed by Tukey only for Toscana versus Marche. Figure 40a-c reports N_c (black line), L_1 (red line), I_1 (blue line), and R_1 (green line) respectively for Toscana, Lazio, and Marche. Figure 41a-c summarizes the L_1, I_1, R_1 behaviors for all the sites under examination. While N_c follows the usual logistic S-shaped function with only quantitative variations, qualitative differences are evident for L_1: the highest L_1 value is present in Marche, region where the pandemic suddenly penetrated from Emilia-Romagna; L_1 shows a rapid increase in Lazio, with an almost linear growth after the initial step; several slope changes are detectable in the other regions. Again, none of the regions studied shows a L_1 constant behavior. The I_1 peak coincides with a L_1 slope change in Toscana. Marche shows a different trend with respect to all the other regions (considering also the North macro area): its I_1 peak coincides both with the N_c ad L_1 growing phase. The maximum I_1 value is detectable in Toscana, while it has a comparable order of magnitude in Lazio and Marche; this result is partially in contrast with what seen for Marche (greatest L_1). These data confirm the different healthcare system effectiveness among the regional organizations. R_1, considerable high at the beginning of the pandemic, decreases rapidly, with an exponential function, in all the regions, but with a different slope.

Figure 42 shows the ANOVA results for L_2. Statistical differences are evident among the regions (F=4.95, p<0.05), confirmed by Tukey only between Marche and Toscana. Figure 43 shows the ANOVA results for I_2, with no statistical differences among the regions (F=0.91, p>0.05). Figure 44 shows the ANOVA results for R_2. Consistent statistical differences among the regions (F=26.48, p<0.001) are evident, but this result is confirmed by Tukey only for Lazio versus Toscana and Marche (p<0.01). Figure 45a-c reports N_d (black line), L_2 (red line), I_2 (blue line), and R_2 (green line) respectively for Toscana, Lazio, and Marche. Figure 46a-c summarizes the L_2, I_2, R_2 behaviors for all the sites under examination. Also for the Center macro area, the L_2 peak anticipates always that of N_d, laying in correspondence of the N_d rising phase. Three points are noticing; first in Lazio: L_2 reaches immediately the maximum twenty days before I_2, almost in correspondence with the minimum of N_d, and then decreases exponentially; this L_2 behavior can be explained by the great uncertainty in the medical fight against this new infection at the beginning of the pandemic, rapidly improved; second in Marche: during the very long N_d plateau, L_2 continues to decrease, in spite a constant rate of daily contagion; third: the L_2 maximum values are coincident in Marche and Toscana, but with different amplitude; instead, Marche and Lazio have similar amplitude, but the peaks are shifted in time (about two weeks); these three L_2 functions decay with a similar trend, until approximately 0% in Marche, with a 0.3% increase step in Toscana and Lazio at the end of May. These significant L_2 differences, not detectable in this manner in I_2, can be correlated to the regional healthcare system efficiency response. After a decrease with different slopes, the lowest R_2 value, for almost all the regions, coincides approximately with the N_d peak; then, R_2 starts to grow after the point of minimum I_2. Surprisingly, the lowest R_2 can be detected in Lazio, while it should have been expected also in Marche, due to its high L_2.

Figure 47 shows the ANOVA results for L_3. Statistical differences are evident ($F=49.44$, $p<0.01$), confirmed by Tukey in all the comparisons ($p<0.05$), except for Marche versus Toscana ($p>0.05$). Both for the mean and the median, Lazio shows the lowest level of L_3. Figure 48 shows the ANOVA results for I_3. No significant statistical differences are evident, confirmed by Tukey. Figure 49 shows the ANOVA results for R_3. Again no differences can be noted ($F=0.9$, $p>0.05$), result confirmed by Tukey. Figure 50a-c reports N_h (black line), L_3 (red line), I_3 (blue line), and R_3 (green line) respectively for Toscana, Lazio, and Marche. Figure 51a-c summarizes the L_3, I_3, and R_3 behavior for all the sites under examination. The L_3 trend is enough different in the three regions of the Center macro area; in Toscana, the L_3 initial growth follows that of N_h, then it stabilizes after about three weeks around a 2% mean value, with a final unexpected ramp; in Lazio, the initial L_3 fast ramp stabilizes around a mean value less than 1%; in Marche, the L_3 trend follows N_h, but the maximum value comes a little before; then L_3 decreases, after two weeks, reaching a plateau around the value of 1.5%. In Toscana, the I_3 and L_3 first peaks are almost coincident; the L_3 final ramp occurs when I_3 arrives to zero from negative values; in Lazio, the L_3 peak precedes that of I_3, while the opposite behavior can be seen in Marche; in both Lazio and Marche, the N_h maximum value comes some weeks later. R_3 follows for the three regions almost the same trend; this variable decreases rapidly from the maximum initial value until the N_h peak, then it restart to increase.

Figure 52 presents the synthesis of all the parameters for Toscana, Lazio, and Marche respectively for L_1, L_2, L_3 (graphs A-B-C), I_1, I_2, I_3 (graphs D-E-F), and R_1, R_2, R_3 (graphs G-H-I). Again, all the regions present a non-constant trend with regard to L_1, L_2, L_3, confirming what already stated about the influence of the healthcare system effectiveness in addition to the pandemic virulence; the L_x highest values of Marche, the closest to those computed for the North macro area, can be explained because this place was invested greater and earlier due to its vicinity to Emilia-Romagna; in any case, the L_x values in the Center macro area show less significant statistical differences, maybe thanks to the dam effect of Emilia-Romagna against the virus spread. In general, I_x variables are better correlated with L_x than N_x; it is particularly true for N_d and N_h, which are the most sensible variables to the healthcare efficiency, whose variability is also responsible of the changes shown by R_x.

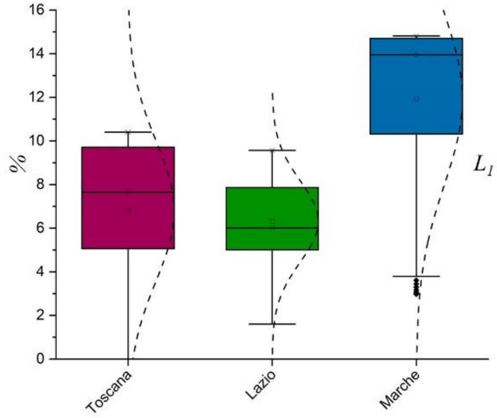


Figure 37: Distribution in quartiles of L_1 for the regions belonging to the Center macro area.

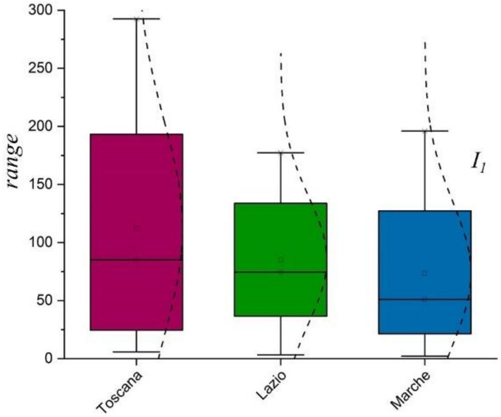


Figure 38: Distribution in quartiles of I_1 for the regions belonging to the Center macro area.

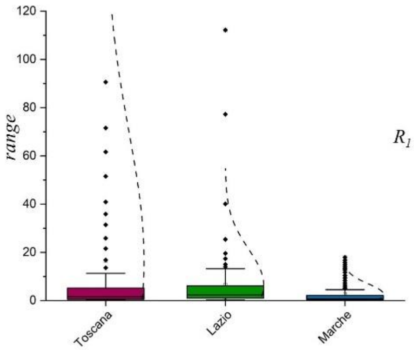


Figure 39: Distribution in quartiles of R_1 for the regions belonging to the Center macro area.

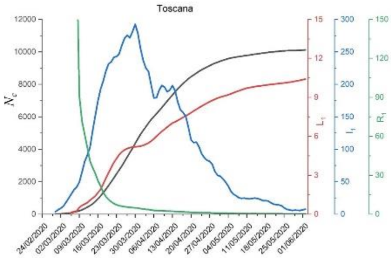


Figure 40a: N_c (black line) compared with L_1 (red line), I_1 (blue line), and R_1 (green line) for Toscana.

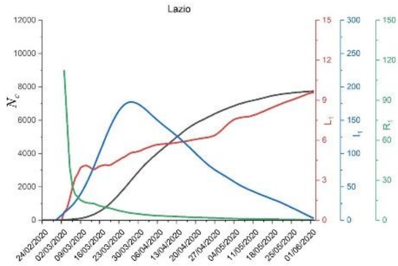


Figure 40b: N_c (black line) compared with L_1 (red line), I_1 (blue line), and R_1 (green line) for Lazio.

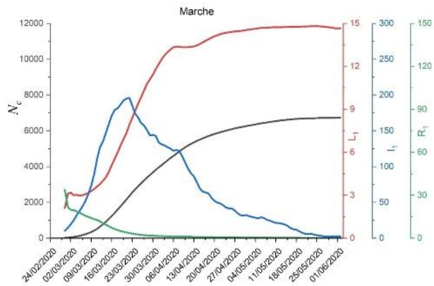


Figure 40c: N_c (black line) compared with L_1 (red line), I_1 (blue line), and R_1 (green line) for Marche.

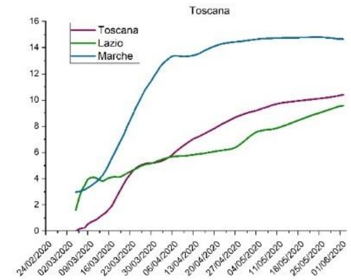


Figure 41a: L_1 for the regions studied.

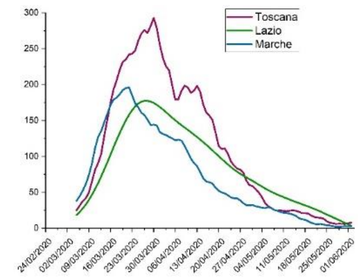


Figure 41b: I_1 for the regions studied.

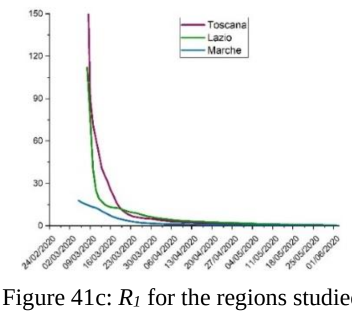


Figure 41c: R_1 for the regions studied.

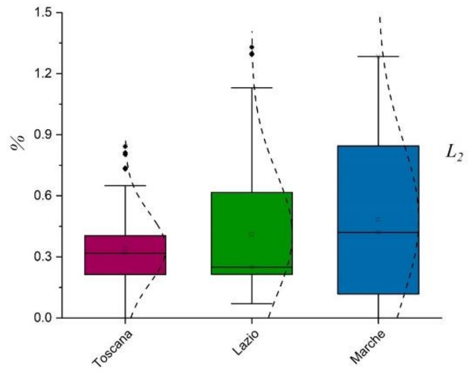


Figure 42: Distribution in quartiles of L_2 for the regions belonging to the Center macro area.

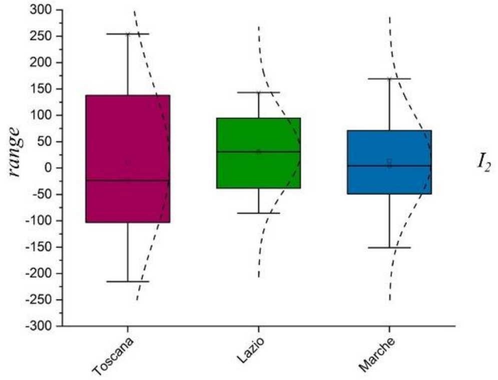


Figure 43: Distribution in quartiles of I_2 for the regions belonging to the Center macro area.

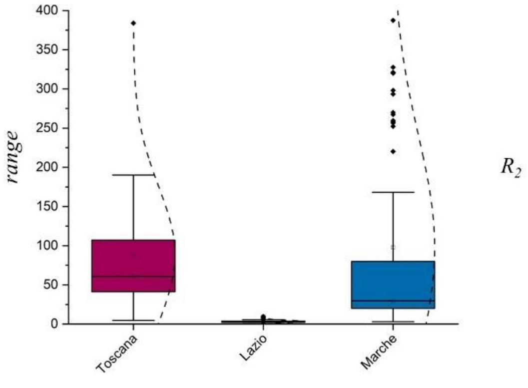


Figure 44: Distribution in quartiles of R_2 for the regions belonging to the Center macro area.

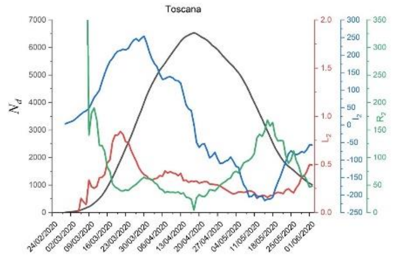


Figure 45a: N_d (black line) compared with L_2 (red line), I_2 (blue line), and R_2 (green line) for Toscana.

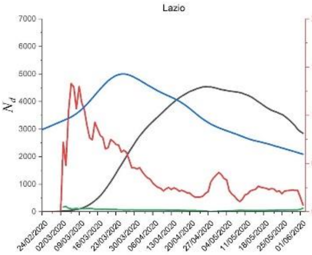


Figure 45b: N_d (black line) compared with L_2 (red line), I_2 (blue line), and R_2 (green line) for Lazio.

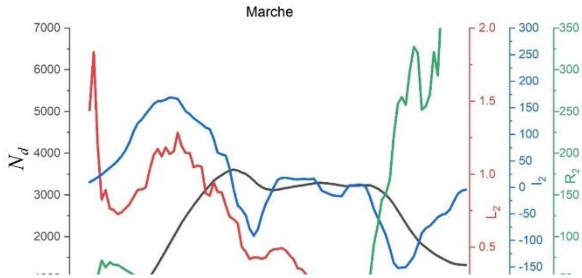


Figure 45c: N_d (black line) compared with L_2 (red line), I_2 (blue line), and R_2 (green line) for Marche.

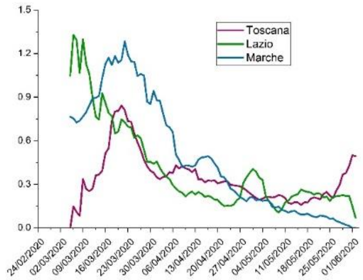


Figure 46a: L_2 for the regions studied.

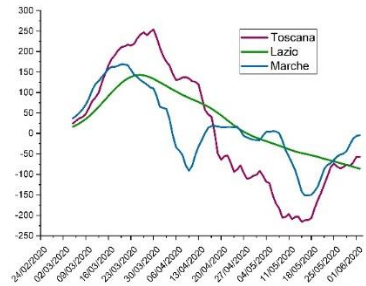


Figure 46b: I_2 for the regions studied.

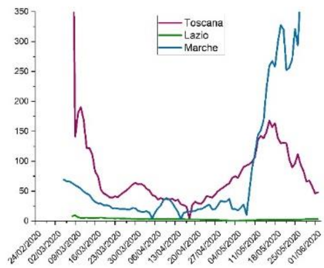


Figure 46c: R_2 for the regions studied.

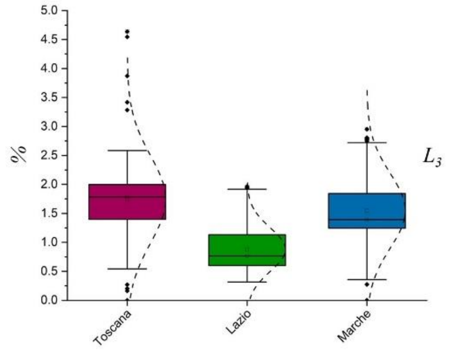


Figure 47: Distribution in quartiles of L_3 for the regions belonging to the Center macro area.

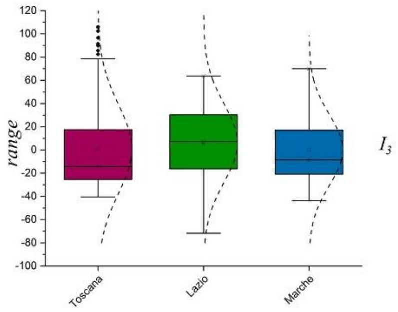


Figure 48: Distribution in quartiles of I_3 for the regions belonging to the Center macro area.

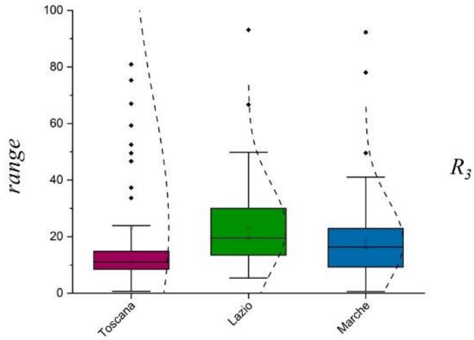


Figure 49: Distribution in quartiles of R_3 for the regions belonging to the Center macro area.

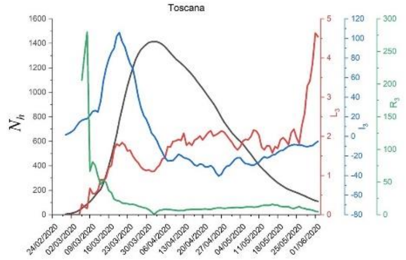


Figure 50a: N_h (black line) compared with L_3 (red line), I_3 (blue line), and R_3 (green line) for Toscana.

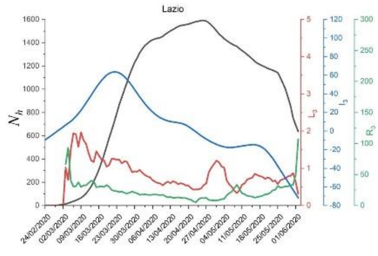


Figure 50b: N_h (black line) compared with L_3 (red line), I_3 (blue line), and R_3 (green line) for Lazio.

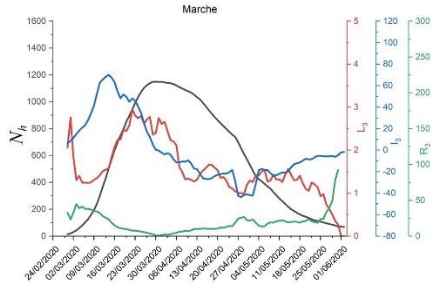


Figure 50c: N_h (black line) compared with L_3 (red line), I_3 (blue line), and R_3 (green line) for Marche.

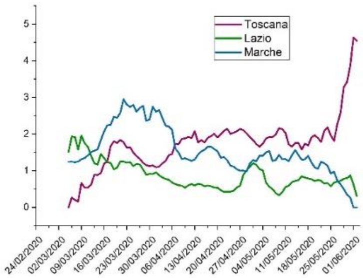


Figure 51a: L_3 for the regions studied.

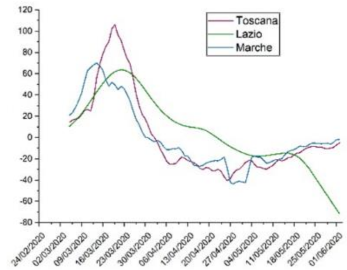


Figure 51b: I_3 for the regions studied.

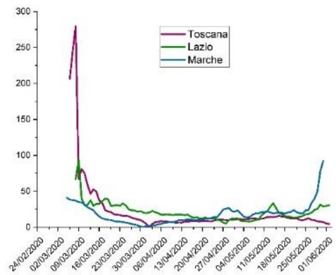


Figure 51c: R_3 for the regions studied.

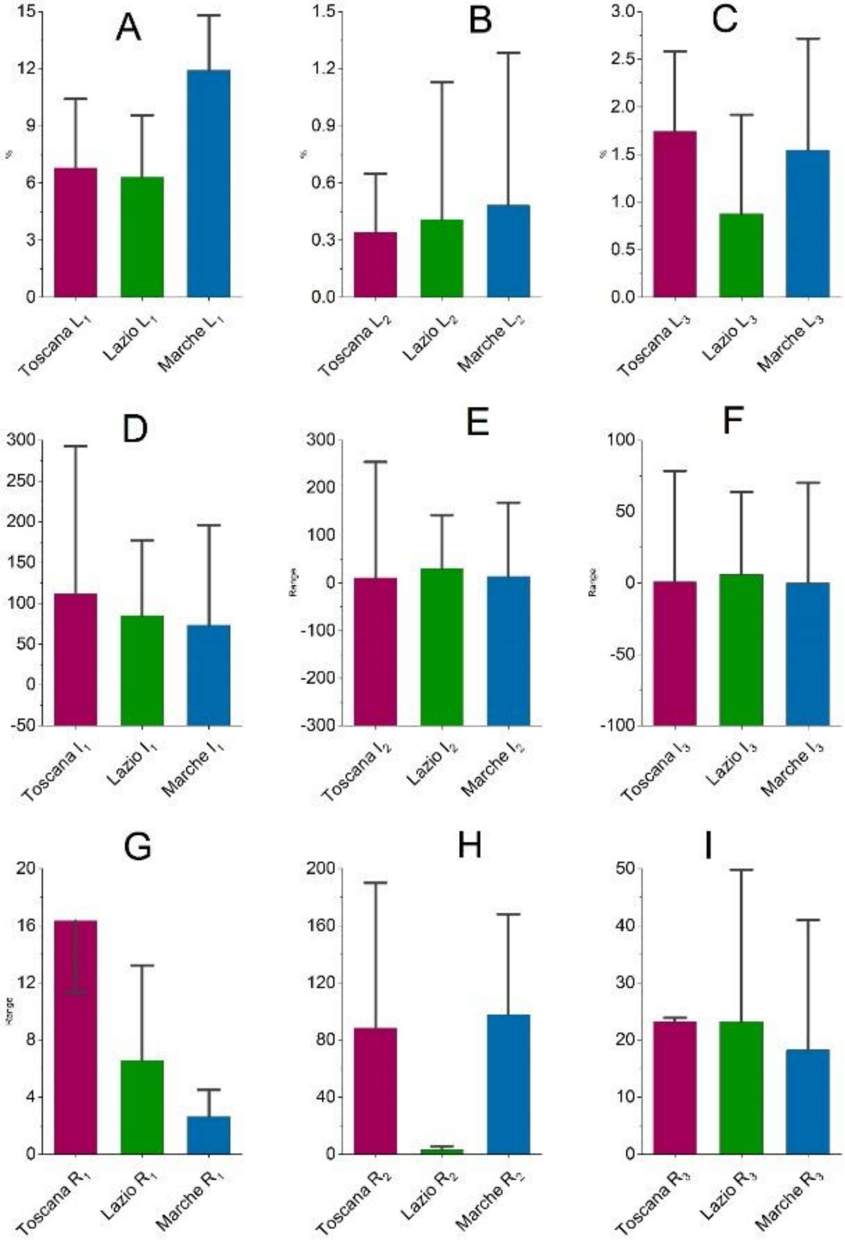


Figure 52: Synthetic representation of all the considered parameters in terms of mean and standard deviation; graphs A-B-C: L1, L2, L3 for Toscana, Lazio, Marche; graphs D-E-F: I1, I2, I3 for Toscana, Lazio, Marche; graphs G-H-I: R1, R2, R3 for Toscana, Lazio, Marche.

5.4.3 South Italy macro area

Figure 53 shows the ANOVA results for L_1 ($F=30.33$, $p<0.01$; the evident statistical differences are confirmed by Tukey only for Puglia versus the other two regions.

Figure 54 shows the ANOVA results for I_1. Statistical differences ($F=3.23$, $p=0.04$) are very low; Tukey speaks of enough sensible variations only for Campania versus Sicilia.

Figure 55 shows the ANOVA results for R_1. No significant statistical difference ($F=4.34$, $p<0.05$) has been found, confirmed by Tukey.

Figure 56a-c reports N_c (black line), L_1 (red line), I_1 (blue line), and R_1 (green line) respectively for Campania, Puglia, and Sicilia.

Figure 57a-c summarizes the L_1, I_1, R_1 behaviors for all the sites under examination. The N_c (S-shaped) and L_1 trends are quite different; again, L_1 is not constant; N_c is greater in Campania with respect to Puglia and Sicilia; L_1 in Puglia reaches a maximum, not only the highest within the group, but comparable with those of North Italy; on the contrary, this variable is sensibly lower in Campania and Sicilia. The I_1 peaks are almost coincident in the three regions (maximum value in Campania), in correspondence of an abrupt change of the respective L_1 slope. R_1 decreases rapidly in all the regions.

Figure 58 shows the ANOVA results for L_2 ($F=14.82$, $p<0.01$); the evident statistical differences are confirmed by Tukey only for Puglia versus the other two regions.

Figure 59 shows the ANOVA results for I_2, with no statistical differences among the regions ($F=0.02$, $p>0.05$), confirmed by Tukey.

Figure 60 shows the ANOVA results for R_2, with consistent statistical differences among the regions ($F=14.74$, $p>0.05$), but this result is confirmed by Tukey only for Puglia versus the other two regions.

Figure 61a-c reports N_d (black line), L_2 (red line), I_2 (blue line), and R_2 (green line) respectively for Campania, Puglia, and Sicilia.

Figure 62a-c summarizes the L_2, I_2, R_2 behaviors for all the sites under examination. L_2 and I_2 peaks always anticipates that of N_d. In Puglia the L_2 value is initially very high, then decreases, showing a secondary peak in correspondence with the I_2 maximum.

Campania and Sicilia show L_2 and I_2 peaks almost in the same time period. With regard to R_2, Puglia is the less resistive. While the maximal R_2 of Campania occurs at the beginning of the pandemic event, the contrary can be seen for Sicilia. In addition, the R_2 time-dependent trend is differently shaped for Puglia.

Figure 63 shows the ANOVA results for L_3 (F=29.13, $p<0.05$); the evident statistical differences are confirmed by Tukey only for Puglia versus the other two regions ($p<0.01$).

Figure 64 shows the ANOVA results for I_3, with no statistical differences among the regions (F=0.25, $p>0.05$), confirmed by Tukey.

Figure 65 shows the ANOVA results for R_3, with consistent statistical differences among the regions (F=14.8, $p<0.01$), but this result is confirmed by Tukey only for Puglia versus the other two regions.

Figure 66a-c reports N_h (black line), L_3 (red line), I_3 (blue line), and R_3 (green line) respectively for Campania, Puglia, and Sicilia.

Figure 67a-c summarizes the L_3, I_3, R_3 behaviors for all the sites under examination.

Again, as seen before: L_3 and I_3 peaks always anticipates that of N_h; in Puglia the L_3 value, as for L_2, is initially very high, then decreases until a very low value; here, L_3 and I_3 restart at the end of the period considered in all the regions, with more evidence in Puglia. Campania and Sicilia show L_3 and I_3 peaks almost in the same time period. With regard to R_3, we can report the same considerations done for R_2: Puglia is again the less resistive; while the maximal R_3 of Campania occurs at the beginning of the pandemic event, the contrary can be seen for Sicilia; the R_3 time-dependent trend is differently shaped for Puglia.

Figure 68 presents the synthesis of all the parameters for Campania, Puglia, and Sicilia respectively for L_1, L_2, L_3 (graphs A-B-C), I_1, I_2, I_3 (graphs D-E-F), and R_1, R_2, R_3 (graphs G-H-I).

Again, all the regions present a non-constant trend with regard to L_1, L_2, L_3, confirming what already stated about the influence of the healthcare system effectiveness in addition to the pandemic virulence. The differences among the South regions are undeniably lesser and at a lower level than those detected for the North macro area, but also in comparison with the Center group, although with a minor evidence. This fact is not unexpected, since a key role is played by the geographical distance and time interval from the initial outbreak.

The similar behavior of almost all the variables between Campania and Sicilia shows that being an island didn't give to Sicilia a particular protection, probably because the social exchange with North Italy has been almost equal to Campania and Puglia. In Puglia, the response has been a little bit weaker during this first wave of the SARS-CoV-2 pandemic (January-June 2020). Campania, with one of the highest population density along its Tyrrhenian coast, reacted well, avoiding the disaster preconized by some political commentators.

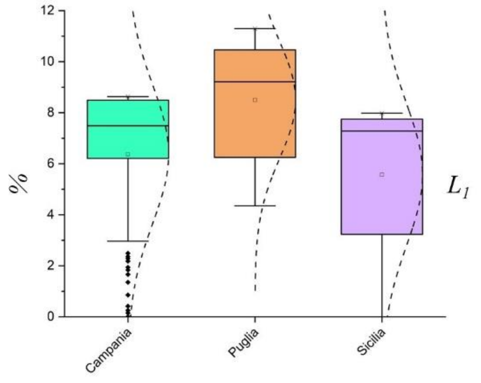


Figure 53: Distribution in quartiles of L_1 for the regions belonging to the South macro area.

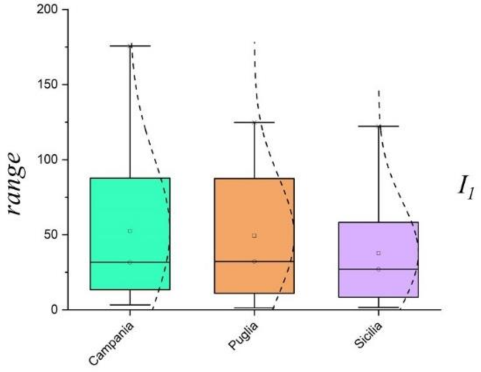


Figure 54: Distribution in quartiles of I_1 for the regions belonging to the South macro area.

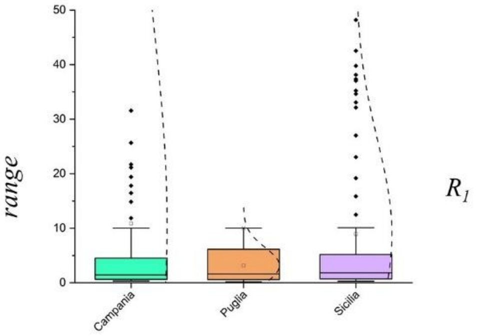


Figure 55: Distribution in quartiles of R_1 for the regions belonging to the South macro area.

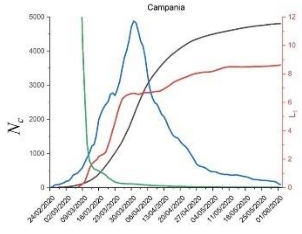


Figure 56a: N_c (black line) compared with L_1 (red line), I_1 (blue line), and R_1 (green line) for Campania.

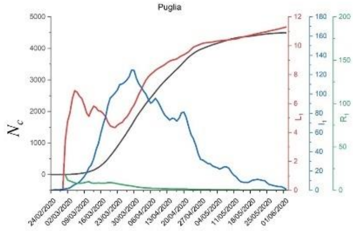


Figure 56b: N_c (black line) compared with L_1 (red line), I_1 (blue line), and R_1 (green line) for Puglia.

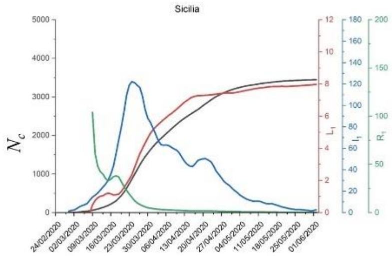


Figure 56c: N_c (black line) compared with L_1 (red line), I_1 (blue line), and R_1 (green line) for Sicilia.

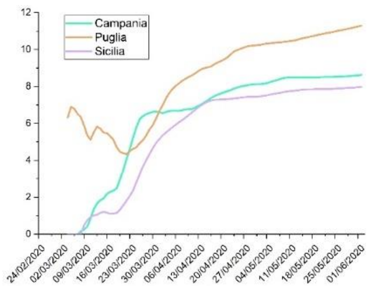


Figure 57a: L_1 for the regions studied.

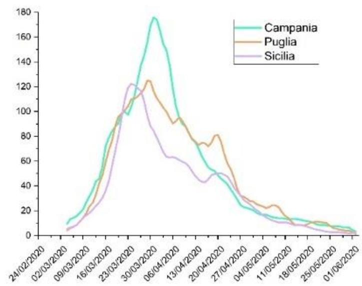


Figure 57b: I_1 for the regions studied.

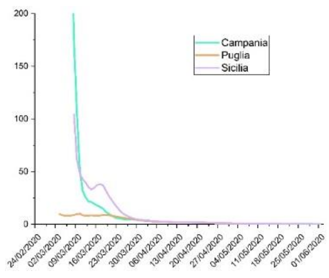


Figure 57c: R_1 for the regions studied.

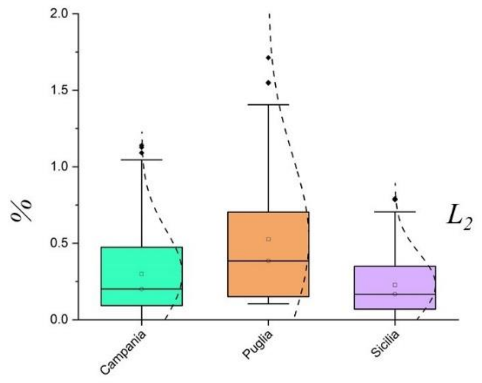


Figure 58: Distribution in quartiles of L_2 for the regions belonging to the South macro area.

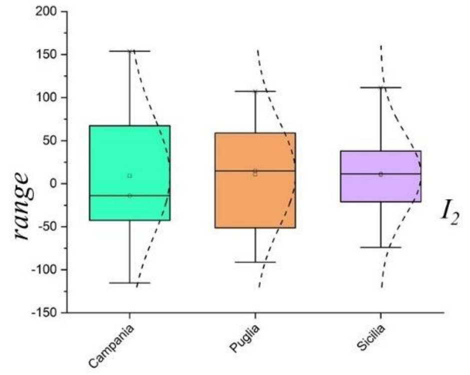


Figure 59: Distribution in quartiles of I_2 for the regions belonging to the South macro area.

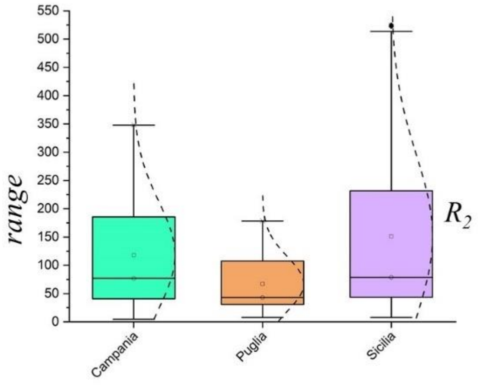
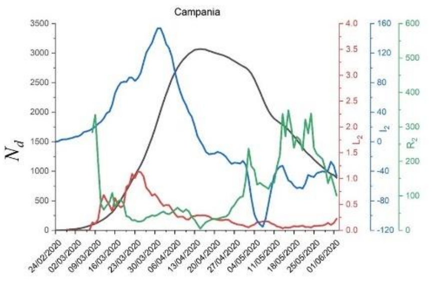


Figure 60: Distribution in quartiles of R_2 for the regions belonging to the South macro area.



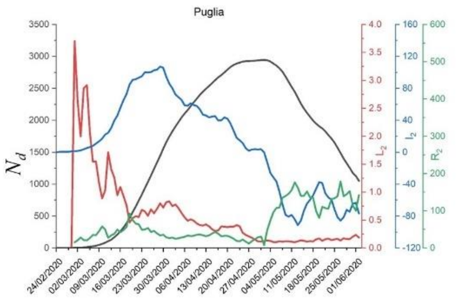


Figure 61a: N_d (black line) compared with L_2 (red line), I_2 (blue line), and R_2 (green line) for Campania.

Figure 61b: N_d (black line) compared with L_2 (red line), I_2 (blue line), and R_2 (green line) for Puglia.

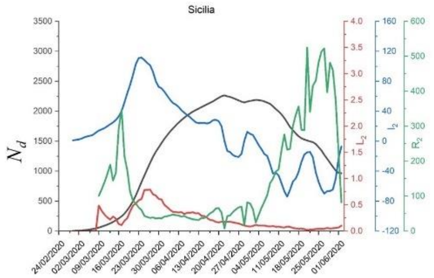


Figure 61c: N_d (black line) compared with L_2 (red line), I_2 (blue line), and R_2 (green line) for Sicilia.

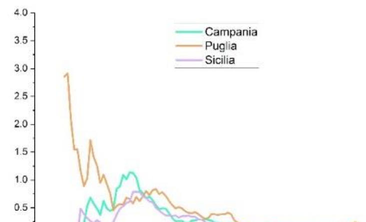


Figure 62a: L_2 for the regions studied.

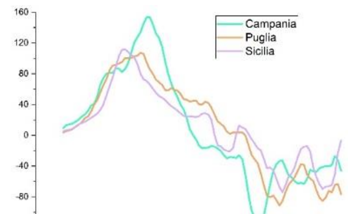


Figure 62b: I_2 for the regions studied.

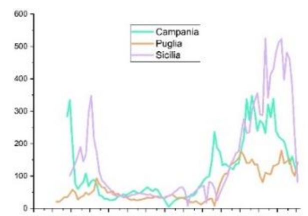


Figure 62c: R_2 for the regions studied.

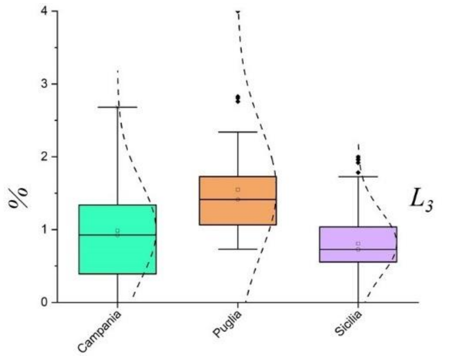


Figure 63: Distribution in quartiles of L_3 for the regions belonging to the South macro area.

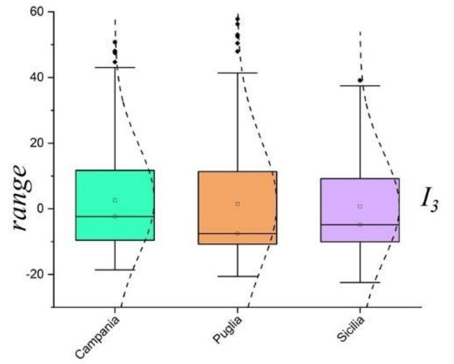


Figure 64: Distribution in quartiles of I_3 for the regions belonging to the South macro area.

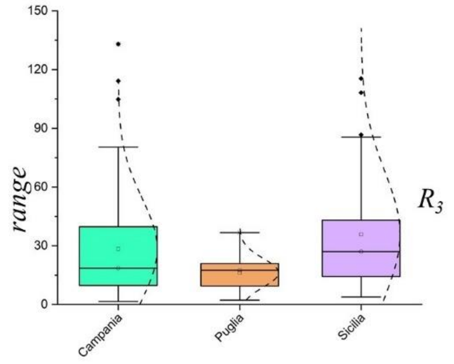


Figure 65: Distribution in quartiles of R_3 for the regions belonging to the South macro area.

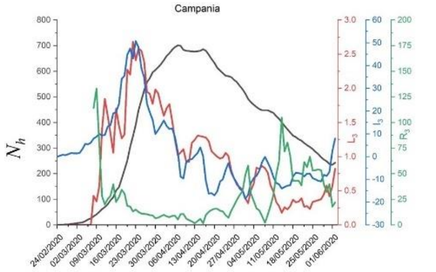


Figure 66a: N_h (black line) compared with L_3 (red line), I_3 (blue line), and R_3 (green line) for Campania.

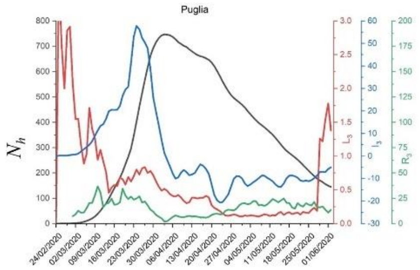


Figure 66b: N_h (black line) compared with L_3 (red line), I_3 (blue line), and R_3 (green line) for Puglia.

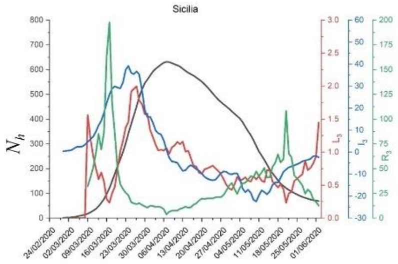


Figure 66c: N_h (black line) compared with L_3 (red line), I_3 (blue line), and R_3 (green line) for Sicilia.

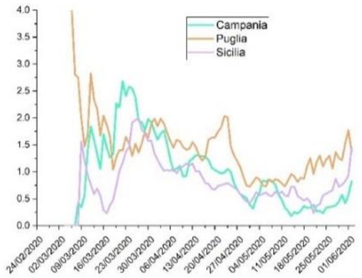


Figure 67a: L_3 for the regions studied.

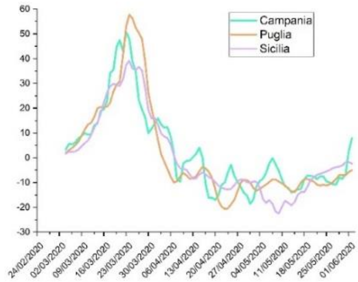


Figure 67b: I_3 for the regions studied.

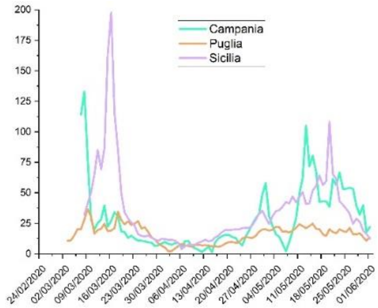


Figure 67c: R_3 for the regions studied.

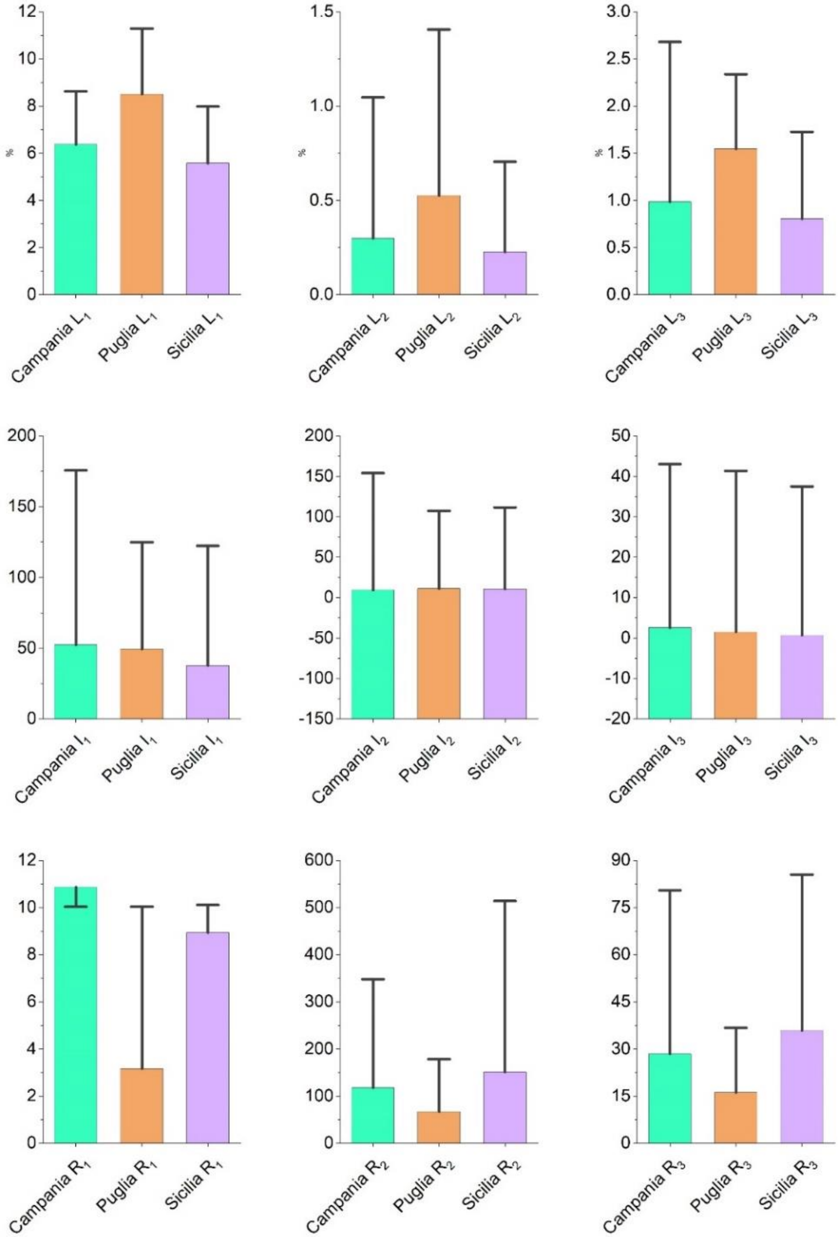


Figure 68: Synthetic representation of all the considered parameters in terms of mean and standard deviation;
graphs A-B-C: L_1, L_2, L_3 for Campania, Puglia, Sicilia;
graphs D-E-F: I_1, I_2, I_3 for Campania, Puglia, Sicilia;
graphs G-H-I: R_1, R_2, R_3 for Campania, Puglia, Sicilia.

5.5 Concluding remarks about Lethality in Italy

The *Lethality L* calculated in Italy during the first phase (January-June 2020) of the SARS-CoV-2 pandemic attracted our attention since it was much higher than the values registered in the same period in other EU and non-EU countries with a comparable development. This fact can be due to various factors, as for example: the initial high underestimate of the individuals found positive in comparison with the total amount of the probably infected people (about 1/10 in Lombardia); the mean high age of infected people; an inhomogeneous implementation of rules/protocols among the country (i.e. how to register the casualties, death *because of* SARS-CoV-2 or *with* it); other significant factors, as the effectiveness of the healthcare system, a duty of the regional government, while control/coordination (even more under emergency) is a task of the central state. Therefore, we have investigated different definitions of *Lethality* (L_1, L_2, L_3, L_4) in Italy and in three groups of regions (North, Center, and South) with relevant differences in the socio-economic structure and healthcare management response.

Firstly, we can say that *Lethality* L_1 [see equation (2), results for Italy in Figures 14 and 15a] is not a constant, does not depend solely on the disease virulence, does not oscillate around a mean value, but grows with a logistic function similar (but not equal) to that seen for N_c (cumulative number of infected people, results for Italy in Figure 15a). A possible cause is the rapid increase of the number of infected people itself, a real tsunami towards the medical facilities, influencing the quality and forcefulness of the Italian health system, which is appreciably good in normal times. For this reason, we have introduced *Lethality* L_2 [see equation (3), results for Italy in Figure 15b], depending on N_d (daily number of infected people, results for Italy in Figure 15b). In fact, N_d is a variable that can take into account the stress striking the hospitals, reducing the efficacy to care properly the patients. In order to focus the problem in a better way, we moved towards a third definition of *Lethality* L_3 [see equation (4), results for Italy in Figure 15c], depending on N_h (daily number of people in care facilities, results for Italy in Figure 15c). Finally, in order to evaluate more precisely the consequences on the regional health care systems, we have introduced the *Impact Velocity Factors* I_1, I_2, I_3 [see equation (6), results for Italy in Figures 15a-c], and the *Resistivity Factor* R_1, R_2, R_3 [see equation (8), mean values for Italy in Figures 15a-c]. After the various analyses seen before, the following considerations can be done: i) for each definition of *Lethality* (L_1, L_2, L_3), the *Impact Velocity Factors* I_1, I_2, I_3 differ among the regional macro areas, with few exceptions; therefore, in addition to socio-economic factors, organization and quality of the healthcare system are non-negligible contributions; ii) the regional variations are also very significant inside the same macro-area, suggesting that the differences inside the healthcare system are specific of the territory taken into account, in terms of facilities effectiveness, medical and para-medical staff preparation, and so on; iii) the peaks of *Lethality* (L_1, L_2, L_3) do not coincide with the corresponding peaks of N_c, N_d, N_h, but they are closer to those seen for the impact trends (I_1, I_2, I_3), that precede up to one month before; this fact suggests that the latter probably are the main factor influencing the *Lethality* (L_1, L_2, L_3) behavior, measuring the capacity to respond to the rapid increasing number of infected/hospitalized people, being time a key factor; iv) the North Italy macro-area has the *Lethality* (L_1, L_2, L_3) values closer or higher than those seen for whole Italy; the contrary happens for Center and South Italy; it seems obvious, depending on the vicinity to the infection focus.

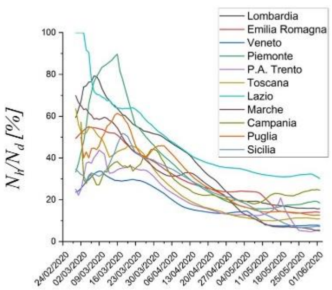


Figure 69: Hospitalization trend of all the regions studied; N_h/N_d [%] in the ordinate; time [days] in the abscissa.

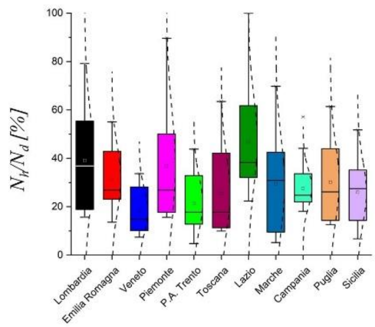


Figure 70: Level of hospitalization N_h/N_d [%] in terms of quartiles for all the regions studied; the box horizontal line is the median; the small square is the mean.

The level of the hospitalized people in comparison with those infected (N_h/N_d [%]) is given in Figure 69 in all the regions studied. Some of them treated COVID-19 patients principally in hospitals, while others did so only if extremely necessary. Thus, the above said factor (N_h/N_d [%]) is quite different among the regions, independently from their macro area; the starting point varies very much, then the behavior is almost exponential in general, but with intermediate peaks in some cases. This inhomogeneity is shown again by ANOVA ($F=25.6$, $p<0.01$) and Tukey post hoc tests (Figure 70). Of course, the variable N_h/N_d [%] has the greatest values at the beginning of the pandemic, while they decrease sensibly at the end of the period, due to the effort to keep asymptomatic/paucisymptomatic people at home, as later discussed in Section 6.2. Table 12 gives the N_h/N_d [%] score among the regions. CV indicates, with a good approximation, the changes of the hospitalization strategy among them (low CV: little changes; high CV: great changes).

Table 12: N_h/N_d [%] score among the regions studied.

score	*Region*	*macro area*	*mean [%]*	*±SD*	*CV*
1	Lazio	Center	46.819	18.773	0.527
2	Lombardia	North	39.192	20.638	0.436
3	Piemonte	North	36.801	23.217	0.481
4	Emilia-Romagna	North	31.297	13.645	0.631
5	Puglia	South	30.125	15.758	0.515
6	Marche	Center	29.415	19.279	0.627
7	Campania	South	27.582	7.802	0.401
8	Sicilia	South	25.967	12.798	0.655
9	Toscana	Center	25.471	15.964	0.283
10	P.A. Trento	North	21.303	10.966	0.523
11	Veneto	North	18.252	8.775	0.493

SD: standard deviation; CV: coefficient of variation.

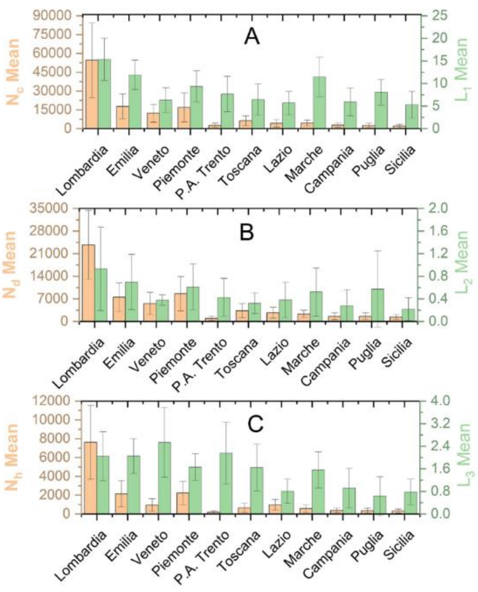


Figure 71: Comparison of N_x and L_x (x= 1,3) in terms of mean and SD for all the regions studied (N_c with L_1; N_d with L_2; N_h with L_3).

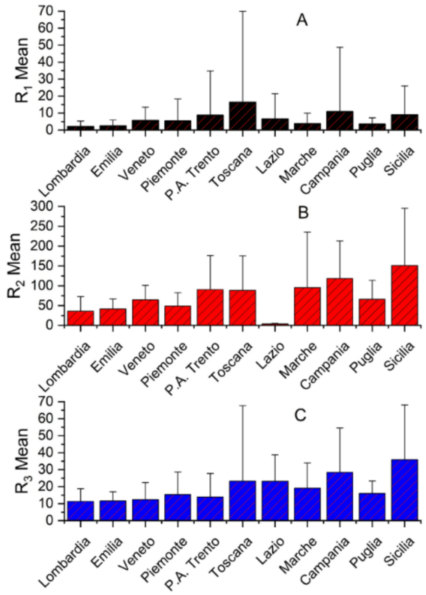


Figure 72: Mean of R_1 (graph A), R_2 (graph B), and R_3 (graph C) for all the regions studied.

In order to also provide a relationship among N_x and L_x (x= 1, 3), a summary of the results is given in Figure 71. N_x (orange bars) always decreases with the distance from the initial outbreak; L_x (green bars), however, doesn't follow a similar trend depending on the geographical position, because other factors should be taken into account, as already said.

In the Tables 13-15 and Figure 72 we give a score of the *Resistivity Factor* R_x (x= 1, 3), calculated for all the regions. In general, the R_X variables show the minimum values in the North macro area, but without a clear geographic clustering. This fact is evident for R_1 in Lombardia and Emilia-Romagna, where the first outbreak started. The variable R_2, very low if compared to R_1, shows again that Lombardia and Emilia-Romagna are sited at the end of the list. In the case of R_3, the geographical clustering seems to be more confirmed, with the exception of Puglia: the South group is the most resistive, probably because it has been the farthest from the pandemic focus, with the lowest levels of pandemic impact on the healthcare facilities in the period January - June 2020; in addition, restrictive measures (internal mobility and travels from North Italy) have been also adopted. However, the South group will be overwhelmed during the following pandemic waves, but this period is not object of this study. The R_x (x=1, 3) lowest values in the North macro area regions are probably due to the unexpected outburst from the first outbreaks, that could have swept up the healthcare system, with dramatic effects in Lombardia, where the red zones have been declared in delay (Lodi Province) or nothing at all (Bergamo and Brescia Provinces), with the aim to avoid economic losses.

Furthermore, the amount of hospitalized people and the availability of effective healthcare services in a given time interval are also fundamental, as shown by the differences among the regions studied. Finally, conflicts between central and local powers certainly have weakened the general response to the pandemic. All these aspects will be discussed in the following Sections.

Table 13: R_1 score among the regions studied.

score	*Region*	*macro area*	*mean [%]*	*±SD*	*CV*
1	Toscana	Center	16.35	53.65	3.28
2	Lazio	Center	6.57	14.78	2.25
3	Campania	South	10.86	37.84	3.48
4	Sicilia	South	8.93	17.06	1.91
5	P.A. Trento	North	8.69	26.23	3.02
6	Veneto	North	5.60	7.89	1.41
7	Piemonte	North	5.28	12.98	2.46
8	Marche	Center	3.70	6.28	1.70
9	Puglia	South	3.50	3.75	1.10
10	Emilia-Romagna	North	2.40	3.52	1.46
11	Lombardia	North	2.08	3.23	1.15

SD: standard deviation; CV: coefficient of variation.

Table 14: R_2 score among the regions studied.

score	*Region*	*macro area*	*mean [%]*	*±SD*	*CV*
1	Sicilia	South	151.24	144.59	0.96
2	Campania	South	118.09	94.98	0.81
3	Marche	Center	95.35	140.26	1.47
4	P.A. Trento	North	90.33	85.88	0.95
5	Toscana	Center	88.35	87.13	0.99
6	Puglia	South	65.67	47.88	0.73
7	Veneto	North	64.40	36.43	0.56
8	Piemonte	North	48.84	33.20	0.68
9	Emilia-Romagna	North	41.58	24.90	0.60
10	Lombardia	North	35.71	36.78	1.02
11	Lazio	Center	3.22	1.61	0.50

SD: standard deviation; CV: coefficient of variation.

Table 15: R_3 score among the regions studied.

score	*Region*	*macro area*	*mean [%]*	*±SD*	*CV*
1	Sicilia	South	35.88	32.27	0.90
2	Campania	South	28.44	26.14	0.92
3	Toscana	Center	23.24	44.40	1.91
4	Lazio	Center	23.18	15.50	0.67
5	Marche	Center	19.13	14.83	0.77
6	Puglia	South	16.00	7.32	0.46
7	Piemonte	Sorth	15.37	13.19	0.86
8	P.A. Trento	North	13.89	13.92	1.00
9	Veneto	North	12.30	10.17	0.83
10	Emilia-Romagna	North	11.62	5.36	0.46
11	Lombardia	North	11.28	7.52	0.67

SD: standard deviation; CV: coefficient of variation.

6. Resilience analysis of COVID-19 pandemic in Italy (first phase, January - June 2020)

6.1 Resilient health systems

Resilient health systems are expected to be able to deliver everyday positive outcomes, effectively respond to crises, and maintain core functions when a crisis hits. COVID-19 (and previous pandemics as SARS and Ebola) occurrence illustrated that several preconditions for a health care resilience were lacking. The crucial points are: i) the recognition of the global nature of severe health crises with the immediate need of a community response; ii) the implementation of International Health Regulations, to guide the response and establish accountability; iii) the presence of a strong and committed health workforce, characterized by trained personnel and redundant equipment; iv) the need of an aware, ductile, self-regulating, integrated, and adaptive system (Kruk et al., 2015). In this paper, we discuss these cornerstones in light of the pluralistic but holistic view of resilience specifically adapted for COVID-19, based on the grid of attributes proposed in Table 1 (i.e. *safety*, *robustness*, *adaptive capacity*, *sustainability*, *governance*, and *anamnesis*). This view considers how technical, personal and social items as well as some historical backgrounds are crucial to properly managing such a pandemic occurrence.

6.2 Safety

6.2.1 Foreword

The World Health Organization (WHO) defines Patient Safety (PS) as "*the absence of preventable harm to a patient during the process of health care and reduction of risk of unnecessary harm associated with health care to an acceptable minimum. An acceptable minimum refers to the collective notions of given current knowledge, resources available and the context in which care was delivered weighed against the risk of non-treatment or other treatment*" (WHO, 2020i). Furthermore, PS is "*a discipline in the health care professions that applies safety science methods toward the goal of achieving a trustworthy system of health care delivery*" and also *"as an attribute of health care systems that minimizes the incidence and impact of* *adverse events and maximizes recovery from such events"* (Emanuel et al., 2008).

For the healthcare organizations, safety is concerned with the myriad ways in which a system can fail to function. Some failures may be well-known, even predictable, but the system may also malfunction in unpredictable ways. Most health care organizations at present have very little capacity to analyze, monitor, or learn from safety and quality information. The area of greatest weakness appears to be the capacity to anticipate and prepare for threats to safety (Vincent et al., 2014).

There is a complex array of international norms, including those that are binding, or "hard" (e.g., treaties), and those that are nonbinding, or "soft" (e.g., codes of practice). WHO is the most important institution for negotiating international health agreements (both treaties and recommendations), and regulations on a range of health topics, including sanitation and quarantine, nomenclatures of diseases, and standards for the safety, purity, and potency of pharmaceuticals. The regulations (that enter into force after adoption by the WHO Assembly) govern surveillance and containment of diseases within countries, at borders, and in international travel. The regulations encompass a broad spectrum of health hazards of international concern, regardless of their origin or source (Gostin and Sridar, 2014).

The WHO Director General convenes Emergency Committees (ECs) to provide their advice on whether an event constitutes a PHEIC (public health emergency of international concern). Over the last 11 years, nine public health outbreaks have been analyzed, and six PHEIC declared (2009 H1N1 swine flu; 2014 Poliovirus; 2014 and 2019 EVD Ebola; 2016 Zika; 2020 COVID-19). Anyway, the EC rationales have been sometimes criticized for being nontransparent and contradictory, with an interpretation of the evaluation criteria often vague and inconsistent (Mullen et al., 2020).

Despite the potential of soft/hard instruments to set norms and mobilize multiple actors, global health laws have major limitations. First, governments are loath to constrain themselves and, therefore, often reject international law or agree only to weak norms. Second, high-income countries are reluctant to finance capacity building in lower-income countries or to provide funding to WHO without specific earmarks. And third, compliance mechanisms for such laws are often weak or nonexistent (Gostin and Sridar, 2014).

6.2.2 The International Health Regulations

The world cooperation on health initiated at the International Sanitary Conference in Paris in 1851, after the cholera that hit Europe in 1830 and 1847. Although the 1918-1919 Great Flu Pandemic was overshadowed by the Great War (Beiner, 2020), one of the WHO's favorite success stories is the role it played in eliminating smallpox, a disease that was still killing millions each year in the 1950s, despite the existence of a vaccine; in 1979, WHO declared smallpox eradicated, a first achievement in world history. The Revised International Health Regulations (WHO-IHC, 2005), were adopted in 2005, in the aftermath of the severe acute respiratory syndrome (SARS) outbreak. Under the director-general Gro Harlem Brundtland, former prime minister of Norway, the WHO's response to SARS was considered a great success. The disease infected 8,098 and killed 774 people, despite it reached 26 countries (Gostin and Sridar, 2014; Zidar, 2015; Fidler, 2020; Buranyi, 2020). The IHRs empower the WHO Director-General to proclaim a PHEIC and issue temporary recommendations of health measures to states parties. However, although the regulations and related health measures inevitably touch upon human rights of affected individuals, the regulations contain but a few allusions to the international human rights framework (Zidar, 2015). IHRs are the sole binding global legal instrument dedicated to the prevention and control of the international spread of disease (Burci, 2020).

"*The purpose and scope of these Regulations are to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks…*" (Article 2 of IHRs). Furthermore, "*Each State Party shall develop, strengthen and maintain* […] *the capacity to respond promptly and effectively to public health risks and public health emergencies of international concern…*" (Article 13). In case of public health emergency, WHO shall issue temporary, and can make standing, recommendations of appropriate health measures (Articles 15-18). Each State Party shall manage points of entry (airports/ports) in its territory (Articles 19-29) and provide special provisions for travelers (Articles 30-32) and goods (Articles 33-34), including isolation and quarantine (Article 40).

IHRs' Annex 1 says: "*States Parties shall utilize existing national structures and resources to meet their core capacity requirements…*" and "*...States Parties shall develop and implement plans of action to ensure that these core capacities are present and functioning throughout their territories*". The capacities should be provided also at the local community level and/or primary public health response level. In specific, core capacity requirements should be provided for designated airports, ports and ground crossings. The updated IHRs, in force to this day, represent a radical document, asking its members to prepare for public health threats according to WHO standards, and report any outbreaks and all subsequent developments (Fidler, 2020; Buranyi, 2020).

Although not a treaty, the additional Pandemic Influenza Preparedness (WHO-PIP, 2011) Framework is an innovative hybrid, a soft law instrument that nonetheless can create binding obligations. The PIP objective "*…is to improve pandemic influenza* [not applied to seasonal influenza viruses] *preparedness and response, and strengthen the protection* […] *by improving and strengthening the WHO global influenza surveillance and response system…*". WHO coordinates the global influenza surveillance and response system (GISRS). Member States should provide WHO with biological materials from all influenza viruses, and contribute to a benefit-sharing system (BSS). BSS shall provide pandemic surveillance and risk assessment, appropriate capacity building, early warning information, and shall prioritize important benefits, including antiviral medicines and vaccines. WHO Reference Laboratories will provide to National Influenza Centers Diagnostic with reagents/test kits and reference reagents for potency determination of vaccines. Member States with advanced capacity should work with WHO and other Member States, particularly developing countries, improving and strengthening capacity building. WHO coordinates Member States in order to maintain and further develop stockpiles of antiviral medicines and associated equipment for use in outbreak containment of influenza viruses with human pandemic potential.

6.2.3 WHO's role from 2009 onwards

In spite of the success against SARS, most of the world States refused to transfer real power to WHO. From 2009 onwards, WHO faced condemnation from the press and the international community for its handling of successive crises, all during a decade when the financial and diplomatic order that sustained it began to break down. First, there was the outbreak of H1N1, or "*swine flu*", detected in Mexico in March 2009. By June, when WHO declared a pandemic, there were more than 28,000 cases in 74 countries. Over the next year, WHO coordinated the global response and declared the pandemic over on 10 August 2010. Almost immediately, the WHO's approach came under scrutiny. The death toll, 18,500 confirmed deaths worldwide, was far lower than initially expected, particularly given the disease reached more than 200 countries. The media and several prominent European politicians demanded inquiries as to whether WHO had mistakenly rung the alarm. In fact, WHO is always at risk of being criticized as doing too much or too little, i.e.: acting slowly, being criticized for failing to stop preventable deaths; acting aggressively, stopping an outbreak before it becomes serious, being accused of having overreacted. Furthermore, the 2008 financial crisis produced a big funding shortfall for WHO, with cuts made to the emergency response programmes and personnel. Entire offices were shut, including a team of social scientists working on pandemic response. When the Ebola outbreak struck West Africa in 2014, the combination of the WHO's greater caution and reduced budget resulted in disaster. The outbreak killed 11,310 people, the vast majority in Guinea, Liberia and Sierra Leone, paralyzing their health systems for months, and causing panic across the world. The proactive culture established after SARS had seemingly faded.

6.2.4 WHO and COVID-19

The 30 December 2019 unheard alarm of Dr. Li Wenliang (Zhou, 2020; see also Fang, 2020) caused in China a tragic delay until the Zhong Nanshan shocking report (January 22, 2020), and the consequent Wuhan lockdown a day after. On January 22, the WHO chief told the world to take the outbreak seriously. However, members and advisors (belonging to People's Republic of China, USA, Thailand, Russia, France, Republic of Korea, Canada, Japan, the Netherlands, Australia, Senegal, Singapore, Saudi Arabia, Sweden, New Zealand, and Italy) of the WHO emergency committee (EC) declined to declare a PHEIC, missing the unanimity or at least a great majority (meeting of 22-23 January; WHO, 2020c), due to the lack of evidence, for a half of the participating experts, of the infection outside China. Only on January 30, after a second meeting, the PHEIC was issued (WHO, 2020d), with recommendations for countries around the world (Fidler, 2020; Buranyi, 2020; Pérez-Peña and McNeil Jr, 2020). The WHO Director General defined SARS-CoV-2 a global pandemic on the following March 11 (WHO, 2020e). A third meeting of the WHO Emergency Committee (April 30; WHO, 2020f) confirmed the PHEIC. "*Such caution is a standard - if often frustrating - fact of life for United Nations agencies, which operate by consensus*" (Pérez-Peña and McNeil Jr, 2020). In February-March 2020, the crisis moved on, spreading fastest and furthest the COVID-19 pandemic with particular strength in US and Europe. However, several countries, at the center of the crisis, didn’t follow the WHO’s advice. Therefore, WHO moved in an uncharted territory during the COVID-19 crisis. It was accused to react too slowly to the virus, believed responsible to show favoritism towards China. However, in contrast to the 2003 SARS outbreak, China, after an initial delay, showed greater transparency in communicating on a daily basis its epidemiological situation. This nation shared the genomic sequence of the virus on an open-access database (January 12, 2020), accepted the presence of a WHO support team (February 16-24), and took draconian control measures, including the quarantine of millions in Wuhan and other cities (Burci, 2020).

WHO was born during the moment of hopeful internationalism that followed the chaos of the second world war; nowadays, current aggressive nationalism becomes normalized around the world; the international context was already hyper-politicized for geopolitical purposes before the COVID-19 explosion, putting objectively WHO in a difficult position (Fidler, 2020; Buranyi, 2020).

In essence, WHO hesitation resulted in a certain delay to declare the PHEIC, but its recommendations remained unheard for weeks in several countries. The current COVID-19 outbreak is testing again the effectiveness and credibility of the IHRs (WHO-IHR, 2005), not only as a legal instrument but also as a public health tool and a framework to channel into a health narrative political challenges and tensions having to do with sovereignty, economic interests and national security considerations (Burci, 2020).

Furthermore, WHO showed inconsistencies in some specific recommendations of its guidelines, specifically on: person-to-person contagion; mask wearing for healthy people (WHO, 2020j; WHO, 2020k; Martinelli et al., 2021): execution of swabs only on symptomatic patients (see WHO, 2020l; at least one among fever, cough, respiratory distress; and, at the beginning of the pandemic, only on passengers coming from China and selected Far East Countries); infection due to asymptomatic spreaders; airborne transmission trough breathing aerosol; duration of quarantine; treatment with hydroxychloroquine; and so on. However, the WHO guidance has been gradually adjusted, thanks to the increased knowledge about an unknown virus. Indeed, the same confusion was evident also within the scientific community, often with sudden opinion changes during the media exposure.

Moreover, a tsunami of preliminary results, often as pre-prints without peer review, flooded in many scientific journals.

Global experts complained travel restrictions (done by a long list of Nations: Africa, 6 countries; Americas, 16 countries; Asia, 15 countries; Australia; New Zealand; Middle East, 4 countries; Europe, 24 countries, including Italy) on China during the beginning of the COVID-19 pandemic, considering such measures groundless, ineffective and against humanity. In a published paper, scholars argued that imposing travel bans on China is a flagrant violation of the Article 43 of the IHRs (Habibi et al., 2020). Anyway, WHO didn’t criticize explicitly this decision. On the contrary, some experts agreed with the effectiveness of prompt travel restrictions of people and goods, not only during the early phase of the infection, but especially when the pandemic spread out with different levels of gravity in different countries.

A well-balanced sentence about WHO support has been expressed by Dr. Anthony Fauci, director of the US National Institute of Allergy and Infectious Diseases: “*it is an imperfect organization. It certainly has made some missteps, but it has also done a lot of good. The world needs a WHO*" (LeBlanc, 2020).

6.2.5 WHO inconsistencies and public decisions taken in Italy

The above said WHO inconsistencies reverberated on the public decisions taken locally, even in Italy, of course, with the further responsibility of National and Regional governments, in particular Lombardia (FROMCeO, 2020), sited in the pandemic focus. At Codogno and Vo’, the first swabs have been made in February against the current protocol, foreseen at that time only on people coming from abroad. Health care facility personnel and family doctors operated unprotected for weeks. Many patients were left alone at home for days without any check and help, infecting their relatives. Several hospitals and healthcare residences for elder people missed effective confinement measures of the disease. The lack of territorial garrisons led to an enormous pressure on the hospital Emergency Rooms. And finally, the scarcity of resources in qualified medical staffs, devices as masks/swabs, assessment centers, equipment, etc., drove to the dramatic acme of March-April. The Pandemic Plan, formulated by the Italian Ministry of Health against A/H5N1 (CCM, 2008), never really updated after 2006, has been ignored in its fundamental objectives (see the point 6 of the Plan). In this scenario, the virus of COVID-19 entered and circulated freely in Italy for weeks, taking the health care system by surprise, without any activation of the epidemiological expertise and a weak performance of the national/regional surveillance networks. The insufficient resources allocated to the National Public Health Prevention Programme (much less than 5% of the National Health Fund) in the last decade, even favoring private sectors, led to an inadequate level of robustness, as described in the next Section 6.3.

6.2.6 Evaluation of the safety parameter in Italy first phase January - June 2020)

Following accurately the WHO/ECDC recommendations, Italy incorporated some undeniable drawbacks since the beginning of the pandemic, both in the underground (September 2019-January 2020) and in the subsequent revealed course (from February 2020 onwards) of the infection.

First, the WHO delay in declaring the PHEIC induced the Italian government to consider SARS-CoV-2 a “foreign virus” extraneous to the country, to be fought with travel restrictions and border control on passengers, although in conflict with the IHRs and official experts’ opinions. This fact led to underestimate the danger and neglect a prompt in-depth monitoring of the resident population. On the other hand, no one would have guessed that Italy would become the second most affected country in the world after the Chinese original outbreak. Moreover, at the beginning of the pandemic, some months were lost to put in place a broadened facemask wearing in public for healthy people, considered by WHO of doubtful usefulness until June 2020. Another important weakness point regarded the evaluation of person-to-person contagion; in fact, the SARS-CoV-2 transmission through asymptomatic spreaders was a COVID-19 crucial novelty to be handled immediately through wide testing, tracing, isolating, and treating capacity, in order to keep the disease under strict control. Unfortunately, the WHO recommendations foresaw only the check of patients with at least a clear symptom. Therefore, with the initial exception of the little village of Vo’ Euganeo and a few zones later, and even more in the whole Italian territory during the lockdown, SARS-CoV-2 spread almost uncontrolled for long time intervals and wide spaces, because only symptomatic patients underwent oropharyngeal swabs by molecular analysis. The issue was questioned over and over again among the scientific community, representing the core of divergent COVID-19 fighting strategies (see Table 4).

A specific weakness point of Italy was the serious inadequacy of the national pandemic plan, originally approved after SARS in 2006, reconfirmed in 2017 but never really updated. However, it provided Italy with a legal and normative framework to react to COVID-19, but its fundamental objectives were ignored; planning remained more theoretical than practical, with little investment or translation of intentions into concrete measures. Therefore, the onset of the COVID-19 pandemic took Italy completely by surprise. After the lockdown declaration, the safety situation improved, until the relaxation measures of late Summer 2020.

Table 16: Values of COVID-19 resilience's attributes; safety.

values of the resilience's attributes: *safety*	**very poor**	**poor**	**medium**	**good**	**very good**
	1	**2**	**3**	**4**	**5**
		S_a (September 2019-January 2020)	S_b (February 2020-June 2020)		

Table 16 presents our evaluation of safety at first glance, with different scores *S* in the periods September 2019-January 2020 ($S_a = 2$), and from February 2020 onwards ($S_b=3$) respectively. The average calculated value $S = (S_a + S_b)/2 = 2.5$.

6.3 Robustness

6.3.1 Foreword

In the period of January - June 2020, COVID-19 hit Italy with a very high virulence, i.e. with an impressive number of victims/ICU cases with respect to a relatively low amount of infected people, the contrary of the 2009 A/H1N1swine flu and 2019 A/H3N2-A/H1H1 flu strains (Figure 73). Moreover, the number of COVID-19 infected patients has grown much faster than previous diseases (SARS: severe acute respiratory syndrome; MERS: Middle East respiratory syndrome). However, at the early beginning of the pandemic (January 2020), the COVID-19 fatality rate was considered lower than that of SARS and MERS (Paules, Marston, and Fauci, 2020).

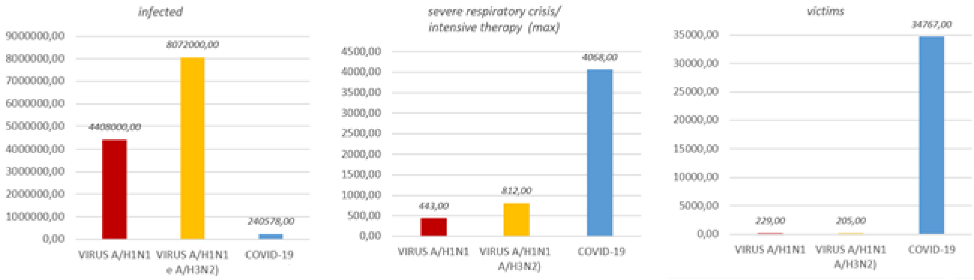


Figure 73: COVID-19 cases in comparison to 2009 A/H1H1 and H1H1swine flu and 2019 A/H3N2-A/H1H1 flu strains.

6.3.2 The Italian pandemic Plan and shortage in strategic medical equipment/staff

Italy was taken by surprise with specific regard to strategic medical equipment at the beginning of the COVID-19 pandemic, causing a global surge in demand for personal protective equipment (*PPE*), medical products and therapeutics used in ICUs. For example, the shortage of protective facemasks, tested and validated according to EU safety standards, was a real constraint (Federfarma.it, 2020). This situation, driven not only by the number of COVID-19 cases but also by misinformation, panic buying, and stockpiling during a pandemic, had tremendous concern especially for the health community at greatest risk for exposure (Boškoski et al., 2020). The bottleneck was due to scarce offer and high demand; EU countries had abandoned since years the facemask production, considered not very profitable, and the supplies should have been found abroad (firstly in China), in a predicament of extreme hoarding. Later, the push of the Italian Department of Civil Protection (DPC) and the effort of hundreds of Italian SMAs (mainly of the fashion field, quickly reconverting their plants), allowed to overtake the difficult contingency, producing every day two million of pieces in July 2020. The same happened for lung ventilators. A unique company, sited in Emilia-Romagna, pushed its production in March under the pressing demand, with the help of specialized technicians belonging to the Italian Army. Later, other hi-tech electro-mechanical companies and big automotive corporations supported the production. The supply of disinfectant gel increased thanks to the cosmetics industry. Therefore, the globalized ‘supply chain’ proved its fragility under the COVID-19 blows, forgetting fundamental strategic issues and sustainability values.

Anyway, a more recent draft of an Italian National Plan against COVID-19 has been discovered by a RAI3 TV investigation (Report, 2020). During the COVID-19 emergency, this plan, very late in birth, was then downgraded to a simple scenario analysis, without real management objectives.

Towards the pandemic acme, "*Italy deployed an array of instruments to contain and mitigate the epidemic. This included case-detection and contract-tracing, isolation and quarantine, physical distancing and mobility restrictions, a set of new individual behaviors, a massive expansion of health-care infrastructure and equipment, and redeployment of staff. The measures were steered by the legal and regulatory instruments emanating from the national command-and-control structures and from regional and local initiatives*" (quote from WHO, 2020h).

Table 17: Number of Intensive Care Units (ICUs, N_{ICU}) for each Region/Autonomous Province.

REGION/AUT. PROV.	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*
Piemonte	339.00	333.00	335.00	340.00	327.00	319.00	320.00	316.00	317.00	327.00	367.00
Valle d'Aosta	10.00	12.00	12.00	12.00	13.00	13.00	12.00	12.00	12.00	10.00	20.00
Lombardia	755.00	798.00	794.00	825.00	836.00	831.00	848.00	860.00	859.00	861.00	983.00
Alto Adige/Süd Tirol	36.00	36.00	36.00	36.00	34.00	36.00	39.00	37.00	40.00	37.00	55.00
Trentino	20.00	21.00	21.00	29.00	29.00	29.00	29.00	32.00	32.00	32.00	51.00
Veneto	460.00	466.00	464.00	477.00	488.00	464.00	458.00	467.00	487.00	494.00	825.00
Friuli-Venezia Giulia	114.00	114.00	108.00	108.00	112.00	117.00	116.00	120.00	127.00	120.00	175.00
Liguria	187.00	186.00	185.00	187.00	177.00	179.00	179.00	178.00	186.00	180.00	209.00
Emilia-Romagna	419.00	463.00	465.00	465.00	451.00	453.00	447.00	443.00	449.00	449.00	516.00
Toscana	326.00	326.00	336.00	335.00	370.00	364.00	387.00	384.00	377.00	374.00	415.00
Umbria	61.00	61.00	61.00	61.00	63.00	63.00	65.00	69.00	70.00	70.00	70.00
Marche	116.00	116.00	117.00	117.00	118.00	116.00	117.00	117.00	115.00	115.00	127.00
Lazio	537.00	551.00	536.00	533.00	536.00	536.00	519.00	511.00	557.00	571.00	747.00
Abruzzo	120.00	114.00	114.00	115.00	110.00	109.00	115.00	109.00	109.00	123.00	133.00
Molise	39.00	37.00	30.00	31.00	34.00	36.00	36.00	35.00	31.00	30.00	34.00
Campania	408.00	446.00	442.00	488.00	496.00	487.00	495.00	490.00	506.00	335.00	427.00
Puglia	217.00	252.00	251.00	266.00	269.00	301.00	300.00	301.00	302.00	304.00	366.00
Basilicata	41.00	42.00	42.00	42.00	42.00	51.00	49.00	49.00	49.00	49.00	73.00
Calabria	122.00	128.00	129.00	137.00	137.00	137.00	139.00	143.00	153.00	146.00	152.00
Sicilia	374.00	361.00	370.00	378.00	384.00	373.00	386.00	389.00	392.00	418.00	538.00
Sardegna	113.00	109.00	116.00	126.00	125.00	122.00	124.00	123.00	123.00	134.00	175.00
ITALY	*4814.00*	*4972.00*	*4964.00*	*5108.00*	*5151.00*	*5136.00*	*5180.00*	*5185.00*	*5293.00*	*5179.00*	*6458.00*

* 9 October 2020.

The first strategic indicator to be checked is N_{ICU}, i.e. the number of Intensive Care Units (N_{ICU} absolute amount: Table 17; $N_{ICU-100000}$ per 100,000 inhabitants: Table 18) for each Region/Autonomous Province, values available from 2010 to 2019 and after the implementation registered on 9 October 2020 (elaboration from: ISTAT, 2020b; AOGOI, 2020; Italian Ministry of Health, 2010-2018a-b; Today.it, 2020; TPI, 2020h; Sky24, 2020 a,b)[2]. At the end of 2019, it is evident that all the Regions/Autonomous Provinces revealed a $N_{ICU-100000}$ around or under 10, very far from the safety threshold over 14 fixed by the experts, and against a European Union-EU average of 12 (WHO, 2020h). In addition, after October 9 (Figure 74), only Valle d'Aosta, Veneto, and Friuli-Venezia Giulia reached a more reassuring value, being necessary a further robust effort to face the pandemic second wave (start in October 2020, not object of this research). About the March-April 2020 COVID-19 peak (elaboration from: DPC, 2020b)[2], when the ICUs request increased exponentially, Table 19 shows the saturation rate S_R (ratio between $N_{ICU-OCC}$, maximum ICUs occupied by COVID-19 patients at the peak, and N_{ICU}, maximum ICUs available at that period). Except Molise, Sardegna, Sicilia, Calabria, the alert threshold (30% of occupancy) was always exceeded.

Table 18: Number of ICUs ($N_{ICU-100000}$) per 100,000 inhabitants for each Region/Autonomous Province.

REGION/AUT. PROV.	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*
Piemonte	7.62	7.63	7.69	7.77	7.37	7.21	7.27	7.19	7.24	7.51	8.45
Valle d'Aosta	7.82	9.46	9.48	9.39	10.11	10.13	9.42	9.46	9.51	7.96	15.94
Lombardia	7.68	8.22	8.18	8.42	8.38	8.31	8.47	8.58	8.56	8.56	9.73
Alto Adige/Süd Tirol	7.15	7.13	7.13	7.06	6.59	6.94	7.49	7.06	7.58	6.97	10.34
Trentino	3.81	4.00	4.00	5.47	5.41	5.40	5.39	5.94	5.93	5.91	9.40
Veneto	9.36	9.59	9.56	9.77	9.91	9.42	9.32	9.52	9.93	10.07	16.81
Friuli-Venezia Giulia	9.24	9.35	8.86	8.83	9.10	9.52	9.49	9.84	10.44	9.87	14.45
Liguria	11.57	11.84	11.80	11.95	11.12	11.31	11.39	11.37	11.95	11.61	13.54
Emilia-Romagna	9.53	10.66	10.71	10.62	10.14	10.18	10.05	9.96	10.08	10.07	11.55
Toscana	8.74	8.88	9.16	9.07	9.87	9.70	10.34	10.26	10.09	10.03	11.15
Umbria	6.77	6.90	6.91	6.88	7.03	7.04	7.29	7.76	7.91	7.94	7.95
Marche	7.44	7.53	7.59	7.57	7.60	7.48	7.58	7.61	7.51	7.54	8.36
Lazio	9.45	10.01	9.75	9.59	9.13	9.10	8.81	8.66	9.45	9.71	12.74
Abruzzo	8.96	8.72	8.73	8.76	8.25	8.19	8.67	8.24	8.29	9.38	10.19
Molise	12.18	11.80	9.58	9.89	10.80	11.49	11.54	11.27	10.05	9.82	11.25
Campania	7.00	7.73	7.67	8.46	8.45	8.31	8.46	8.39	8.68	5.77	7.38
Puglia	5.31	6.22	6.20	6.57	6.58	7.36	7.36	7.41	7.46	7.55	9.13
Basilicata	6.96	7.27	7.27	7.29	7.26	8.84	8.54	8.59	8.64	8.71	13.11
Calabria	6.07	6.53	6.59	7.00	6.92	6.93	7.05	7.28	7.82	7.50	7.90
Sicilia	7.42	7.22	7.40	7.56	7.54	7.33	7.61	7.69	7.80	8.36	10.83
Sardegna	6.76	6.65	7.08	7.68	7.51	7.33	7.48	7.44	7.46	8.17	10.73
ITALY	7.98	8.37	8.36	8.56	8.47	8.45	8.54	8.56	8.75	8.58	10.72

* 9 October 2020.

Table 19: Maximum ICUs ($N_{ICU\text{-}OCC}$) occupied by COVID-19 patients at the peak in the period January - June 2020, maximum ICUs (N_{ICU}) available on 2019, ICUs saturation rate, for each Region/Autonomous Province.

REGION /AUTONOMOUS PROVINCE	*max ICUs occupied on 2020*	*date of max ICUs occupied on 2020*	*max ICUs available on 2019*	*S_R saturation rate*
Valle d'Aosta	27	*01.04.2020*	10	270.00%
Trentino	81	*04.04.2020*	32	253.13%
Alto Adige/Süd Tirol	65	*08.04.2020*	37	175.68%
Lombardia	1381	*03.04.2020*	861	160.39%
Marche	169	*31.03.2020*	115	146.96%
Piemonte	453	*01.04.2020*	327	138.53%
Liguria	179	*31.03.2020*	180	99.44%
Emilia-Romagna	375	*05.04.2020*	449	83.52%
Toscana	297	*01.04.2020*	374	79.41%
Veneto	356	*30.03.2020*	494	72.06%
Umbria	48	*03.04.2020*	70	68.57%
Abruzzo	76	*03.04.2020*	123	61.79%
Campania	181	*24.03.2020*	335	54.03%
Puglia	159	*05.04.2020*	304	52.30%
Friuli-Venezia Giulia	61	*03.04.2020*	120	50.83%
Basilicata	19	*28.03.2020*	49	38.78%
Lazio	203	*11.04.2020*	571	35.55%
Molise	9	*27.03.2020*	30	30.00%
Sardegna	31	*08.04.2020*	134	23.13%
Sicilia	80	*25.03.2020*	418	19.14%
Calabria	23	*26.03.2020*	146	15.75%
ITALY	***4068***	***03.04.2020***	***5179***	***78.55%***

As reported by WHO (2020h), "*In 2006, after the first severe acute respiratory syndrome (SARS) epidemic, the Italian Ministry of Health and regions approved a national pandemic influenza preparedness and response plan, reconfirmed in 2017*" (see also: WHO, 2005; Italian Ministry of Health, 2006; Gazzetta Ufficiale, 2006; Italian Ministry of Health, 2007; CCM, 2008) "*with guidelines for regional plans. More recently, the H1N1/09 virus in 2009 and the Ebola virus in 2014 drew attention to the risk such phenomena could present. The 2014-2018 National Prevention Plan*" (see: Presidenza del Consiglio dei Ministri, 2014) "*the leading framework for strategic public health planning and financing, therefore called for greater pandemic preparedness. Planning, however, remained more theoretical than practical, with little investment or translation of intentions into concrete measures*" (quote from WHO, 2020h; and reference therein: Curtale, 2020). *"The process nevertheless provided Italy with a* *legal and normative framework to react when the arrival of the COVID-19 epidemic in Europe took many by surprise*" (quote from WHO, 2020h).

The pandemic focus was confirmed (Valle d'Aosta, Trentino, Alto Adige, Lombardia, Marche, Piemonte). Veneto, Emilia-Romagna, Toscana, Umbria, Abruzzo show an average impact, a combination between infection/equipment levels.

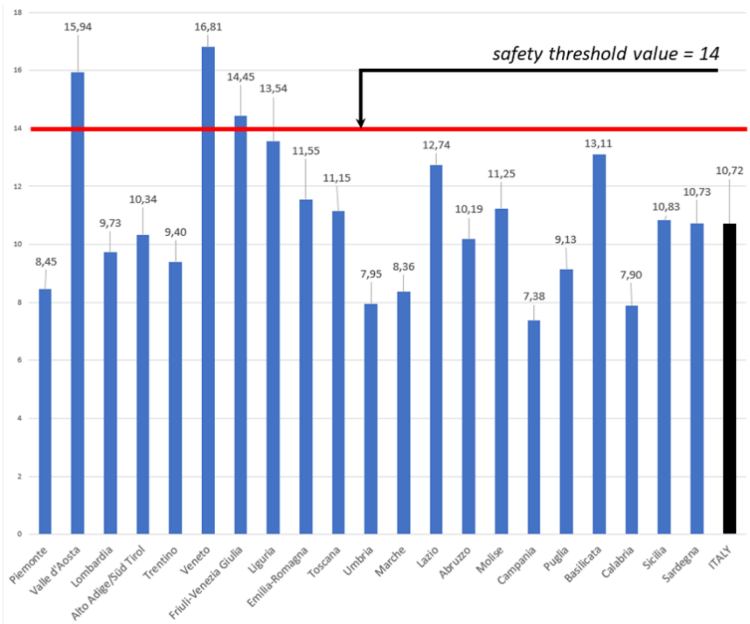


Figure 74: N_{ICU} - number of ICUs per 100000 inhabitants in Italian Regions/Autonomous Provinces on 9 October 2020.

Moving towards Southern Italy, those Regions were relatively unaffected by the virus: a lucky circumstance, considering the weakness of their health care system (as revealed later during the pandemic's second wave). Friuli-Venezia Giulia is a case by itself (lower impact/better welfare). Anyway, the authorities of South Italy Regions, having more "*time to intervene at an earlier stage*" … "*were on the alert. Physical distancing measures and case-finding started as soon as the first clusters appeared … before the epidemic got to full-blown exponential expansion. More prompt intervention allowed these regions to contain far better than had been the case in the regions of the more industrialized north, where control efforts started at earlier dates but at a later stage in the development of the epidemic*" (quote from WHO, 2020h).

“*Temporary hospitals exclusively dedicated to intensive care for COVID-19 patients were set up in the hardest-hit regions. The largest of these, in Milan, was planned to have up to 205 ICU beds for patients needing respiratory support. ... The Civil Protection Department played a major coordination role, using its extraordinary legal powers to requisition public and private property considered necessary for the emergency response*” (quote from WHO, 2020h).

“*The sudden crisis situation caused some panic and overwhelmed contact-tracing capacities. Hospitals in the affected areas had to scramble to establish triage and screening procedures and safe patient circuits. They had to ramp up their capacity to care for vast numbers of severely ill patients: nearly 20% of admitted patients would need two weeks or more of ICU care and 88% assisted ventilation* ((quote from WHO, 2020h; and reference therein: Grasselli et al., 2020). “*Authorities had to race against time to scale up the number of ICU beds, supply critical equipment and mobilize health workers*” (quote from WHO, 2020h).

Extreme triage, under the COVID-19 enormous pressure, posed deep dilemmas to the health workers’ conscience regarding the criteria for admission/exclusion to life-saving therapies when the available means and technological equipment became suddenly limited in the urgency, due to excess of service requests (CNB, 2020; SIAARTI, 2020; Riccioni et al., 2020).

“*Agreements were made with the Red Cross and other nongovernmental organizations to help out, mobilizing additional staff and vehicles for rapid hospitalization of patients*”. Under such a flood of ill contagious people, “*the initial reaction of the hospitals was improvised, chaotic and creative. It took some time before formal guidance became available*” (quote from WHO, 2020h). An effective response to reduce the spread of the infection has been the effort to keep asymptomatic/paucisymptomatic people at their home (Figure 75, from WHO, 2020h), but with inhomogeneous results from region to region, with Veneto, for example, over the average of Italy since the beginning of the outbreak. On the contrary, other regions (firstly Lombardia) focused on hospital accommodation, with unlikable side effects, as the contagion among the healthcare personnel and triggering local epidemic clusters inside and outside the facilities. Moreover, in several circumstances, some patients confined at home didn’t receive for days adequate assistance (phone communication difficulties with the general practitioners-GPs and call centers, lack of a swab check), worsened their condition (sometimes until death), infected their relatives, and then arrived at the emergency rooms with a classification from yellow to red.

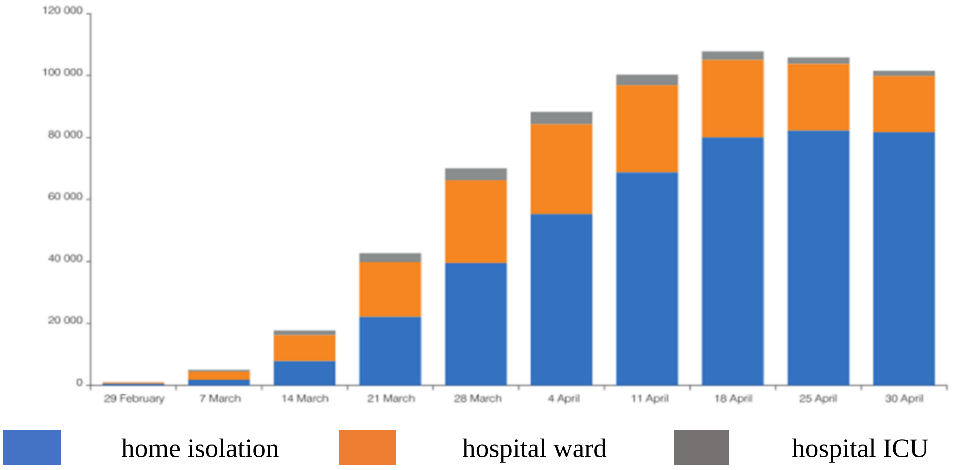


Figure 75: Treatment of COVID-19 ill patients in Italy during the progress of the pandemic (from WHO, 2020h).

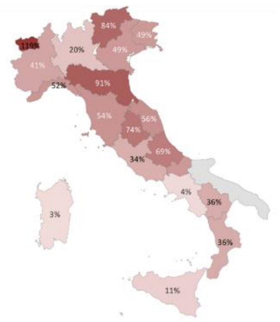
Intensifying the pandemic, "*it became clear that intrafamily close contact could become a considerable source of infection for an infected person in home isolation. … Hospitalization was not an option, as hospitals already were stretched beyond their limits*". In order to monitor these people and protect their families, some *"regions either repurposed intermediate care structures or set up ad hoc 'COVID-19 hotels' or 'resorts' (in Marche and in Emilia-Romagna), with 1-2 hours of support provided by nurses*" (quote from WHO, 2020h).

The Law Decree of 9 March 2020 (Gazzetta Ufficiale, 2020) foresaw the creation of new dedicated structures, i.e. the USCA (Unità Speciali di Continuità Assistenziale [Special Units for the Continuity of Care]). These units, each covering 50,000 inhabitants, "*were staffed with volunteer medical doctors, nurses and administrative staff and were active 12 hours per day, seven days a week. USCAs were tasked with managing the medical follow-up of home care for less severe cases of COVID-19. … The first USCAs were established in Emilia Romagna on 16 March, but the roll-out has remained slow and uneven across regions*" (quote from WHO, 2020h). Thanks to ALTEMS (2020) Reports, on 9 July 2020, the coverage of the Italian territory was about 48%, but with great discrepancies among the Regions (Figure 76).

"*The surge in hospital admissions made it necessary to repurpose health workers to intensive care, infectious disease and respiratory medicine units, while at the same time providing brief courses on non-invasive ventilation and new therapeutic protocols. This, however, was not enough. Three weeks* *after the first hospital admission of a COVID-19 patient, extraordinary regulation and funding with €600 million made it possible to recruit an additional 20 000 health workers, among them medical specialists, medical residents enrolled in the last two years of their medical specialization, medical doctors without board certificates and nurses, for a period of six months. Retired medical and nursing staff were encouraged to return to work to help out in low-risk environments. Medical graduates in their last three months of internship before their state exam were allowed to start practicing*" (quote from WHO, 2020h).

It should be noted that the personnel of the Servizio Sanitario Nazionale (National Health Care Service) was subjected to a significant decrease in the last decade and years before (Figure 77; elaboration from: Italian Ministry of Health, 2010; Italian Ministry of Health, 2011; Italian Ministry of Health, 2012; Italian Ministry of Health, 2013; Italian Ministry of Health, 2016; Italian Ministry of Health, 2017)[2]. To cut the health care budget, also the closure of dozens of small-medium size medical facilities, not always sited in mountainous/hilly areas with low density of population, occurred in a relatively short time, causing the decrease of hospital beds (Figure 78, elaboration from: ISTAT, 2020b; Italian Ministry of Health, 2010-2018a-b)[2]. This lack in care facilities, qualified staff, and equipment (especially in Southern Italy) led to the above said tragic unpreparedness in the crucial days of the disease abrupt landslide.

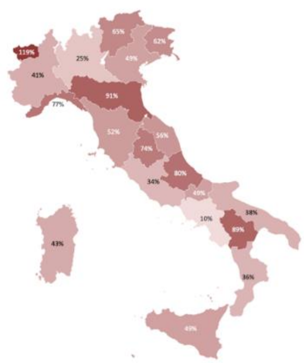
"*Health workers were themselves at great risk of infection*" and became "*potential sources of infection*", with "*direct consequences for the functioning of the hospital*". Subjected to quarantine, this fact further weakened "*the exhausted hospital workforce*" (quote from WHO, 2020h). In general, the healthcare personnel saw more than 20000 infected between their ranks, about 10% of Italy's confirmed COVID-19 cases at the time of the first peak. Medical doctors (186: FNOMCeO, 2020b), nurses (48: AssoCareNews.it, 2020; FNOPI, 2020), and other health professionals (including 15 pharmacists) lost their life fighting on the pandemic front battlefield.



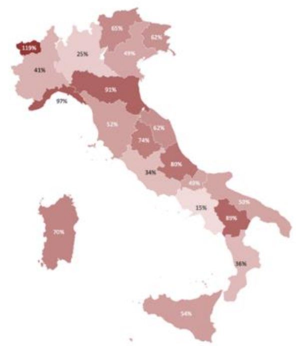
14.05.2020: USCA coverage rate 31%

21.05.2020: USCA coverage rate 43%

28.05.2020: USCA coverage rate 44%



04.06.2020: USCA coverage rate 44%



11.06.2020: USCA coverage rate 47%

09.07.2020: USCA coverage rate 48%

Figure 76: USCA coverage of the Italian territory per 50000 inhabitants in Italian Regions/Autonomous Provinces
(source: ALTEMS, 2020).

The lack of adequate personal protective equipment (*PPE*) "*played a large (and much debated) role in exposing health workers to exceeding avoidable levels of risk. Hospitals were short of key items of PPE - gloves, medical masks, respirators, goggles, face shields, gowns and aprons. All these were missing or in short supply as stocks rapidly ran out. Complicating the situation even more was the fact that many health workers suddenly found themselves working in unfamiliar wards, had the challenge of communicating while wearing almost airtight masks and were making decisions while standard practice protocols were changing continuously. Together, this increased the risk of errors and unsafe procedures. … The PPE question soon became a major source of health-worker disquiet, discontent and frustration that was widely echoed in the media. It would only start to be resolved in April*" (quote from WHO, 2020h; and references therein: BMJ, 2020; QS, 2020a; FNOMCeO, 2020a).

When the risks of contagion in hospital environments became clear to all, "*this was much less the case in community settings. During the first weeks of the epidemic, the contagiousness of asymptomatic or pre-symptomatic people was not yet generally recognized. This meant that health workers dealing with the general public (such as those taking swabs, doing contract-tracing interviews or carrying out general outpatient work) did not realize the extent to which they were exposed and needed to be draconian in matters of physical distancing and hand and respiratory hygiene. This was particularly the case for primary care providers in the regions, where their lack of involvement in the COVID-19 response also meant they were less trained to manage the risks*" (quote from WHO, 2020h). Among the health care personnel who died from COVID-19 infection, general practitioners-GPs paid a high tribute (FNOMCeO, 2020b).

As already told before, the 7400 Italian long-term-care facilities, i.e. residences for older persons (in Italian: *RSA, Residenza Sanitaria Assistenziale*), patients affected by mental disorders or with disabilities/life-limiting illnesses (hosting globally about half million people) *"soon emerged as a big blind spot. The risk of COVID-19 for residents and caregivers was most underestimated"* at the beginning of the pandemic; silent clusters developed in a dramatic way "*in these closed communities*", which suddenly "*experienced excess mortality linked to COVID-19*" (quote from WHO, 2020h; and reference therein: Italian Ministry of Health, 2020i).

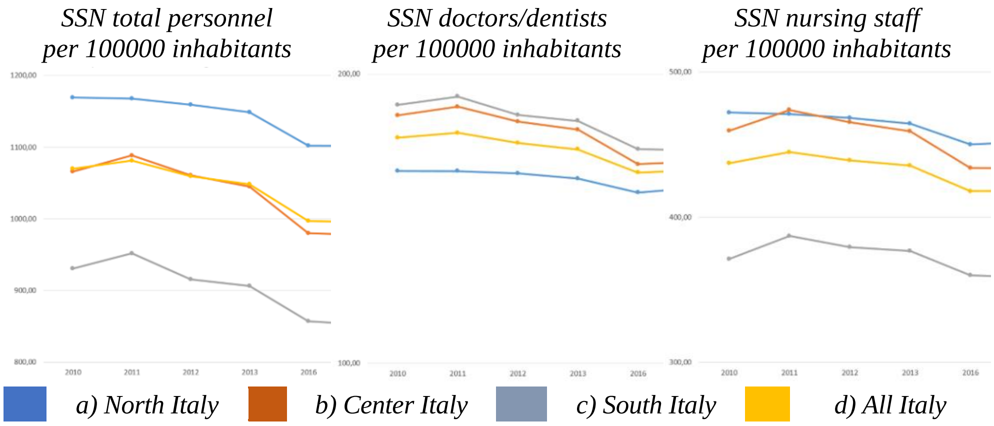


Figure 77: Italian SSN (Servizio Sanitario Nazionale/Italian National Health Care Service) personnel.

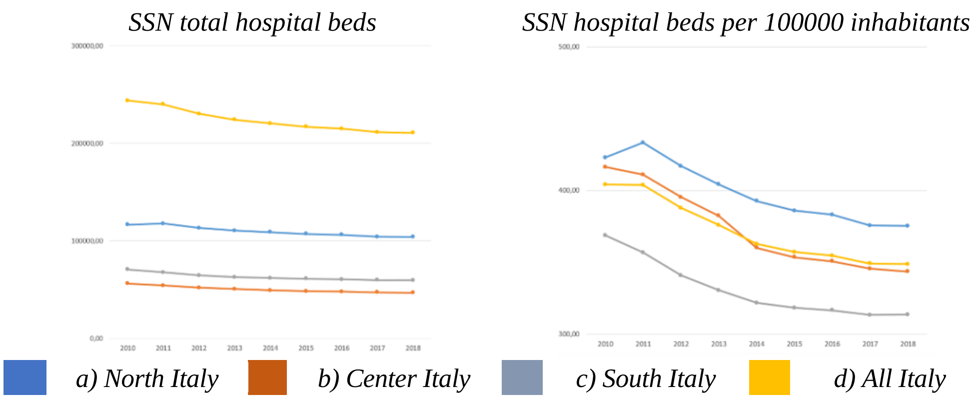


Figure 78: Italian SSN (Servizio Sanitario Nazionale/Italian National Health Care Service) hospital beds.

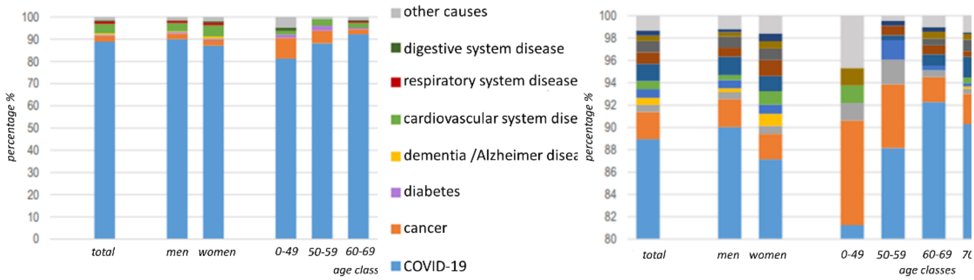


Figure 79: COVID-19 positive patients' casualties, due to death initial cause, with details of comorbidity diseases (Source: ISTAT, 2020c; with original data of ISS, Istituto Superiore di Sanità [Italian National Institute of Health]).

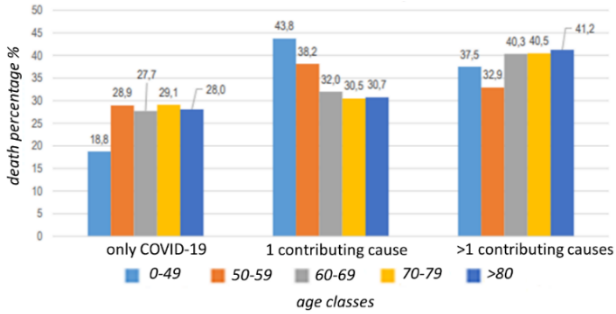


Figure 80: Death percentage distribution of comorbidity diseases on COVID-19 (Source: ISTAT, 2020c; with original data of ISS, Istituto Superiore di Sanità [Italian National Institute of Health]).

6.3.3 COVID-19 and comorbidity factors

Thanks to the ISTAT Report (2020c; data from ISS, 2020b), it is possible to analyze the causes of the COVID-19 casualties, including comorbidity factors (Figures 79-80). Most of the deaths (89% in general; 28% in healthy subjects without pre-existing pathologies) are due to COVID-19 direct infection, the remaining death cases to other diseases. Lethality depended on age (maximum value: class 60-69; minimum value: class 0-49). In addition, at least one contributing cause was found in 31.3% of the victims' amount, two in 26.8%, and three or more in 13.7%. More frequent additional pathologies were hypertensive heart disease (18% of deaths), diabetes mellitus (16%), ischemic heart disease (13%), cancer (12%), other diseases (chronic respiratory system, dementia/Alzheimer, obesity, etc.) being less than 10%.

As for the care of non COVID-19 pathologies, "*a significant drop in admission for cardio-thoracic, gastroenterological, urological, otolaryngologic/ophthalmologic, and traumatological diseases*" was evident. "*Acute neurological conditions registered a slight, but significant, reduction. Interestingly, oncology admissions were stable*" (quote from: Ojetti et al., 2020; see also: Lazzerini et al., 2020). Gastrointestinal, urological, and otolaryngologic diseases were less worrying (being mostly chronic and not acute), because they were easily managed by general practitioners-GPs or specialists with home treatments or telemedicine approaches. A reduced admission for trauma might be attributed to the protective effect of the lockdown. Chemotherapy services remained opened and effective during the peak of the pandemic phase. On the other hand, cardiovascular pathologies (above all myocardial infarction) reported an admission decrease of about 46%, if compared to 2019 data; in Milan, the COVID-19 pandemic has tripled acute coronary syndrome deaths and reduced life-saving procedures by 40%. In addition, the reduction of the number of patients accessing Emergency Departments (EDs) with priority codes 4 (green) and 5 (white) was impressive, probably due to the fear of virus contagion (Ojetti et al., 2020).

A specific report of the ONS working group (Armaroli et al., 2020) on principal cancer pathologies, comparing the first 5 months 2019-2020, speaks about an impressive reduction of screening performance and diagnosis (total: 1,428,949; mammographic: -53.8%; colon-rectal: -54.9%; cervical: -55.28%), even though an inhomogeneous trend among the Italian Regions (South Italy: the worst in prevention screening decrease). Such a decrease has been due to both preventive call reduction and minor participation for high perception of infection risk. The estimate increase of unidentified cancer injuries has been more than 8,000 (breast cancer: 2099; cervical neoplasm CIN2+: 1676; colon-rectal carcinoma: 611; advanced colon-rectal adenoma: 4000; again in Armaroli et al., 2020). Furthermore, care access has been becoming even more complicated, as reported by several associations (OMAR, Osservatorio Malattie Rare [Rare Diseases Observatory]; Fondazione Italiana per il Cuore [Heart Italian Foundation]; Fondazione Giovanni Lorenzini [Foundation Giovanni Lorenzini]; FIRMO, Fondazione Italiana Ricerca sulle Malattie dell'Osso [Italian Foundation for the Research on Bone Diseases]; ANMAR Onlus, Associazione Nazionale Malati Reumatici [Italian Association of Rheumatic Diseases]). A survey by Codice Viola (2020), an association of pancreatic cancer patients, "*showed that up to 37% of first cancer visits were cancelled, 40% of follow-up visits were postponed and, most significantly, two thirds of surgeries were* *postponed to a later date*" (quote from: WHO, 2020h). In fact, about 600,000 surgery interventions skipped, 12 million X-ray scans cancelled.

Psychiatric patients suffered a very difficult period, feeling in an emphasized way the lockdown emotional constraint, sometimes with a restart of uncontrollable crises and panic attacks, and showing more difficulties in following basic rules to avoid infection, such as keeping self-hygiene, security distances, and masks (Martinelli and Ruggeri, 2020).

Finally, because of their behavior, which has been consistent with the ethics of the Hippocratic Oath, despite the above mentioned severe constraints, it is worth considering the health care personnel as truly "*pandemic heroes*". Recently, the President of the Italian Republic, Sergio Mattarella, awarded a group of them as Knight of the Order of Merit of the Italian Republic, honoring their effort in fighting COVID-19 (Avvenire, 2020a). In fact, when ICUs in Italy were overwhelmed by the increasing number of COVID-19 patients, many healthcare providers, often without a strong expertise in infectious disease treatment, voluntarily offered their support to the most affected Italian regions. Fearing the infection and worrying about their loved ones, the healthcare personnel gave a remarkable professional contribution showing a limitless spirit of empathy. This characteristics buffered the burnout effects, was a key factor in fighting the COVID-19 pandemic, and guaranteed the healthcare systems' survival during the crisis acme. Still capable of finding personal gratification from their job under a high work-related pressure, more empathic clinicians, nurses and young women in particular, revealed notable levels of distress and suffered various psychosomatic symptoms (increased irritability, change in food habits, difficulty falling asleep, muscle tension, emotional exhaustion and depersonalization). Because the emotional distress is frequently associated with suboptimal care, the health professionals should be provided by specific supports based on models of psychological adjustment and resilience (Barello, Palamenghi, Graffigna, 2020a,b; Gorini et al., 2020).

6.3.4 Evaluation of the robustness parameter in Italy (first phase January - June 2020)

As already analyzed in Section 6.2.5, the drawbacks due to an ineffective Pandemic Plan led to a serious shortage of strategic medical equipment at the beginning of the COVID-19 pandemic, causing a global surge in demand for personal protective equipment (*PPE*), medical products and therapeutics used in ICUs. Only some months later, the difficult contingency of the globalized ‘supply chain’ was normalized, providing a sufficient amount of pieces (facemasks, lung ventilators, oxygen tanks, disinfectants, etc.).

Furthermore, under the initial tsunami of ill contagious people, the reaction of the healthcare system was improvised, chaotic and creative. Only after the lockdown period, the setting up of case-detection/testing, contract-tracing, isolation, quarantine, physical distancing, mobility restrictions, together with a massive expansion of health-care infrastructure and equipment, permitted to put the situation under control.

All the Italian Regions/Autonomous Provinces revealed a dramatic lack of ICUs; when the pandemic exploded in the Northern Regions, the alert threshold (30% of occupancy) was exceeded almost everywhere. South Italy was less touched by the first virus assault, therefore the shortcomings of the healthcare system were temporarily hidden until the autumnal collapse due to the second wave. Extreme triage, under the COVID-19 enormous pressure, posed deep dilemmas to the health workers’ conscience regarding the criteria for admission/exclusion to life-saving therapies. Despite the above mentioned severe constraints, the health care workers, initially at great risk of infection, behaved as truly pandemic heroes.

During the last decades, the Servizio Sanitario Nazionale (National Health Care Service) was subjected to relevant reduction in personnel units, facilities, and budget, leading to the above said tragic unpreparedness in the crucial days of the disease. As for the non COVID-19 pathologies, they showed a significant drop in admission, with a significant increase in mortality due to missing screening and care.

Table 20: Values of COVID-19 resilience’s attributes; robustness.

values of the resilience’s attributes: *robustness*	**very poor**	**poor**	**medium**	**good**	**very good**
	1	**2**	**3**	**4**	**5**
		S_a (September 2019-January 2020)	S_b (from February 2020 onwards)		

Table 20 shows our evaluation of robustness at first glance, with different scores S in the periods September 2019-January 2020 (S_a = 2), and from February 2020 onwards (S_b = 3) respectively. The average calculated value is $S = (S_a + S_b)/2 = 2.5$.

6.4 Adaptive capacity

6.4.1 Foreword

Until June 30, the first pandemic wave in Italy (first phase January - June 2020) caused the remarkable number of 57.57 deaths per 100,000 inhabitants (population density: 200.64; see Table 14 and Figure 72f). This country was the first in the western hemisphere embracing a strict suppression[10,11] strategy (Table 15); in addition, a 56-day nationwide lockdown initiated after approximately two weeks of hesitancy, on 11 March until to 26 April 2020. These restrictive *NPIs* brought the reproduction number R_t significantly below 1 within two weeks, while the initial values ranged between 1.5 and 3.2 in the most affected areas of North Italy (Guzzetta et al., 2020a,b). Moreover, the government measures were also effective to prevent the outbreak rise in the Center and South (Sebastiani et al., 2020). Other researchers (Ren, 2020) affirmed that the success was not complete and *NPIs* not strictly followed during February and half March 2020 in many cities of the Northern regions, because residents obtained easily auto-certification forms, allowing them to travel for work, health, or unclear other necessities; while the infection started, people still crowded bars in big cities, ski resorts in the Alps, and beaches in coastal towns. The number of cases/deaths cannot be explained simply because the pandemic had begun in Italy earlier compared with other countries. Some factors depended on demographics, having Italy the most elderly population in Europe and the second in the world after Japan, with background comorbidities, such as chronic obstructive pulmonary and ischemic heart diseases, linked to smoking history. With the exception of Vo’ Euganeo, where all 3,300 residents were tested immediately after the detection of the first case (see Section 4 and Lavezzo et al., 2020), elsewhere in Italy, the prevalence of the infection was several times higher due to the absence of a quick effective public intervention (as already reported in Section 4). In addition, the Italian lifestyle is well known for its socialization and frequent congregations and clustering; therefore, at least in early pandemic stages, the adoption of effective hygienic and stay-at-home measures were applied in delay and in a fragmentary way (see also Boccia, Ricciardi, and Ioannidis, 2021). The deficiencies of the Italian healthcare system have been already discussed in Section 6.3.

Hand washing and facemask-wearing were the most widely adopted measures by Italian people, while physical distancing and ventilation of indoor spaces the least. Women tended to be more compliant in adopting personal protection measures, more conservative in their estimation of COVID-19 risk associated with different activities/places, and more open to government interventions than men (De Nadai et al., 2021).

6.4.2 "Andrà tutto bene" [Everything will be fine] and "Io resto a Casa" [I stay at home]

During the March-May 2020 lockdown period in Italy, two sentences appeared immediately everywhere. The first was: "*Andrà tutto bene*" [Everything will be fine], written on papers, post-its, sheets with rainbows and hearts put on doors, windows, doorphones, bus stops, shop windows, garden benches, and so on (Figure 81); this phenomenon began anonymously in the most affected areas of Lombardia, then overflowed in all Italy, as a message of hope, friendship, and resistance; then, national flags flapped and the flash mob of musical balconies started.

The second sentence "*Io resto a Casa*" [I stay at home] proposed by citizens as well as by influencers, including music and movie stars, flooded especially the social networks, as a direct personal compliance with the government guidelines.

Both these attitudes demonstrated a positive response to the dramatic situation due to the COVID-19 pandemic, the severe lockdown restrictions, and the painful effects of the disease. In fact, many quarantined people suffered from moderate to extreme levels of psychological distress, especially due to long self-isolation and drastic work changes, with stressing conditions felt more by female gender. Among the transcendence (i.e. a character strength) properties, the most associated with better mental health and greater self-efficacy were hope (expecting the best for the future), zest (i.e. approaching life with energy and vitality), and love (i.e. appreciating being close to others); if lacking, depression and anxiety were noticed. Two other strengths, forgiveness and prudence, were also significant to enhance people's resilience during the lockdown (Casali et al., 2020).

Most demographic groups, especially the elderly, believed in and followed the government restriction measures, even skeptics about the seriousness of the disease and of the government's messaging. Most people, especially the elderly and infirm, left home only for essential reasons (Barari et al., 2020).

https://www.varesenews.it/photogallery/balconi-disegni-dei-bambini/

https://www.piacenzasera.it/2020/03/tutto-andra-bene-centinaia-di-biglietti-a-piacenza-e-provincia/333323/

https://www.educattepeople.it/2020/03/17/in-collegio-andra-tutto-bene/

https://www.firenzetoday.it/social /inno-mameli-concerto-casa-coronavirus.html

https://www.tp24.it/2020/03/29/lettere-e-opinioni/cosa-insegna-coronavirus/147280

Figure 81: "*Andrà tutto bene*" (up); national flags and musical balconies (down).

6.4.3 Testing Tracking Tracing (TTT) policies in Italy

Testing, i.e. the use of diagnostic tests for identifying the infection of SARS-CoV-2 in a person, had a very variable trend in Italy (Table 21, see Ourworldindata, 2021), probably depending on the infection rates during the pandemic course. Except the already cited case of Vo' Euganeo (where all inhabitants were quarantined and controlled, see Section 4 and Lavezzo et al., 2020), the testing amount could had been considered in average insufficient, especially at the beginning of the disease. For this reason, a group of 292 Italian scientists wrote an open letter to the Prime Minister, Giuseppe Conte, and other addressees (March 2020: see IEO Research, 2020; Pistoi, 2021), in order to expand the current low COVID-19 diagnostic capacity by harnessing the potential of academic research centers, offering their laboratories and personnel at no additional cost. The call remained unanswered. It was discussed (March 30, 2020) at CTS (Comitato

Tecnico Scientifico [Technical Scientific Committee]), who rejected the proposal and recommended that molecular tests were done only by the certified laboratories and run by each region. But that network was insufficient: in March, Italy was only doing about 15,000 COVID-19 tests per day. The scarcity hampered efforts to trace and slow the spread of virus, especially in Lombardia and Piemonte. CTS also hesitated before giving clear advice on testing asymptomatic people.

Table 21: COVID-19 tests per thousand people from March 22, 2020 to June 2, 2021.

March 11, 2020	March 22, 2020	August 15, 2020	November 21, 2020	January 7, 2021	March 17, 2021	June 2, 2021
0.10	1.05	0.73	3.58	1.99	5.45	3.40

A few months later (20 August 2020), another proposal was sent to CTS, written by Andrea Crisanti (author with others of the study on the population of Vo’ Euganeo, see again Section 4 and Lavezzo et al., 2020). The plan (see Lettera150.it, 2020), subscribed by 150 academics, foresaw to process up to 400,000 molecular tests a day (including asymptomatic checking), a seven-fold increase over the national capacity at that time. Crisanti did not receive any reply and CTS meetings minutes didn’t mention any discussion about his proposal.

As a consequence, tracking (identifying where people infected are) and tracing (locating all the people that were in close contact with a person infected by COVID-19) coverage was far from the necessary, because as the COVID-19 incidence increased, the contact-tracing capacity decreased (De Nadai et al., 2021).

A contact-tracing App (voluntary, non-mandatory, and open source; *Immuni*, see Italian Ministry of Health, 2020k; and also: Tropea and De Rango, 2020), developed in compliance with Italian and European legislation to protect privacy, was digitally downloadable since June 1, 2020, in order to support the COVID-19 emergency. In the first month after the launch, the App has been downloaded by 4 million people (more than 10% of the potential users). However, *Immuni* played a very limited role; only a very small fraction of a survey reported having had a close contact with an infected individual discovered it via the App; in addition, a small fraction of those got tested (De Nadai et al., 2021). It depended on various factors: technological limitations, low integration with local health policies, delayed notifications, but also privacy reasons and boycott by center-right leaders and presidents of regions (Il Fatto Quotidiano, 2020k).

The effective isolation of all positive cases was problematic (De Nadai et al., 2021), due to sharing their home with others, but also due to additional age and gender-dependent reasons (taking care of children amongst women; socialization with friends in high-risk indoor environments, mainly at home, without adequate *PPE*; lack of specific structures for quarantine).

6.4.4 Lockdown and psychological consequences

As in case of natural disasters, war, fires, and terroristic attacks, the Italian general population revealed significant levels of depressive, anxiety, and stress symptoms, but the current pandemic was an unprecedented event in terms of impact on the mental health. The effects were higher than those found in China, difference probably due to the type of health response in the two countries: clear immediate lockdown measures since the beginning in China; a more fragmented preventive approach in Italy, increasing the levels of fears and uncertainty. Moreover, mental sufferance grew over time, being more severe in the last weeks of the confinement. Women, in particular housewives, showed a higher risk of developing distress symptoms, as unemployed or retired people; anxiety-depressive disorders increased in more fragile individuals affected by pre-existing mental health problems. Increasing time spent on Internet was associated with higher risk of developing mental health problems, may be due to the diffusion of uncontrolled information and fake news, especially in people alone or with lower levels of education (Fiorillo et al., 2020). Also younger adults were more exposed to infodemia and, therefore, to stress attributable to a massive and uncontrolled exposition to pandemic information (Prete et al., 2020).

Against the assumption that isolation caused by physical distancing can lead to feelings of loneliness that can negatively affect human mental and physical health, an on-line survey was conducted during the ascending phase of the pandemic from 4 to 24 March 2020 in Italy (Kopilaš et al. 2021). The psychological and emotional states of adult participants were investigated. A high self-perceived scores for depression, stress, post-traumatic intrusion, and avoidance related to lock-down was detected. Quite interesting, this study also focused on the correlation between digital activity and physical distancing. The novelty of COVID-19 pandemic, in fact, is that it is occurring in a globalized society enhanced by digital capabilities. Pointing out the importance of socialization to humans, respondents’ levels of digital activity resulted enhanced, to compensate epidemiological isolation.

A real-time survey, conducted on a large group of adolescents across Italy, revealed their excellent ability to live situations of insecurity and deal with unfavorable and adverse conditions, finding alternative solutions of daily life. This new generation was subjected to the stress of existential precariousness and uncertainty of the future much more than the previous ones. It led them, much more than adults, to adapt to the confinement conditions (Buzzi et al., 2020).

Another survey showed that, in general, adolescents were not particularly afraid of contracting COVID-19; they considered the possibility of getting the disease to be low (60.3% of the sample), but with serious consequences (36.0%). Young persons living in a red zone presented a higher perceived risk compared to those of other Italian places. Furthermore, females showed a higher perceived risk than males. A very high percentage agreed on the need to avoid public transport (train and bus), confined spaces (bars, restaurants, cinemas, theaters), school classrooms, and to attend to gyms or swimming pools. Almost the totality of the respondents answered that it was necessary to avoid going into shops if not indispensable, and only with *PPE* such as a facemask. However, adolescents did not think it will be necessary to maintain social distancing in the second quarantine stage. During the lockdown, most of the adolescent sample declared to have felt physically well (68.7%), males better than females but with a small difference. However, quarantine decreased their sense of security and self-confidence, again with females less secure. About 40% of students reported feeling tenser and sadder (42.6%), and more irritable (49.6%) than usual. A high percentage declared difficulty concentrating (55.9%) and sleeping (55.6%). However, only a small percentage of them suffered eating difficulties (13.7%), disturbances in heartbeat (18.7%), crying frequently (34.4%), or other symptoms of pathological stress. Females, older adolescents, and those living in Northern Italy or in a red zone, tended to have more negative feelings. Interestingly, the responses showed great empathy and interest in socialization. They missed most meeting friends, staying with relatives, and being out late in the evening. About their expectations for the immediate future, more than 20% adolescents of the sample said that next summer would have been different or with limitations, full of anguish, doubts, and perplexity; but friends were enough to feel good. In some cases, quarantine highlighted pre-existing problematic situations. In general, the teenagers in the sample looked to the future with the hope of overcoming the difficult period of the pandemic and resuming a normal life, even if different from the previous one (Commodari and La Rosa, 2020).

Home confinement played an important role on sleep quality, leading to major risk for acute insomnia, thus for negative health outcomes, including depression and anxiety. A study (Bacaro et al., 2020) proved, among a statistical sample, that the insomnia increase was observed with a higher prevalence in females, the 18-30 age group, those living with parents, mourning persons, and individuals reporting mental disorders. Furthermore, most of the sample (82.5%) reported increased use of electronic devices. With the lack of social activities, as regular work, sleep-wake rhythms markedly changed, with people going to bed and waking up later, spending more time in bed, but, paradoxically, experiencing a lower sleep quality (Cellini et al., 2020).

6.4.5 Lockdown and gender-based violence (GBV) and equality

D.i.Re. network members (Donne in Rete contro la violenza [the Italian National Women's Network Against Violence]) reviewed the women who had contacted 58 anti-violence centers during two time periods (2 March-5 April 2020; 6 April-3 May 2020), in comparison to the antecedent years (Figure 82 from Lundin et al., 2020).

While the trend was relatively stable in 2016-2018, a sharp increase was observed during March and April 2020. Women with a history of previous contacts accounted for less than one third of cases during 2016- 2018, but over two-thirds called the services from March to April 2020.

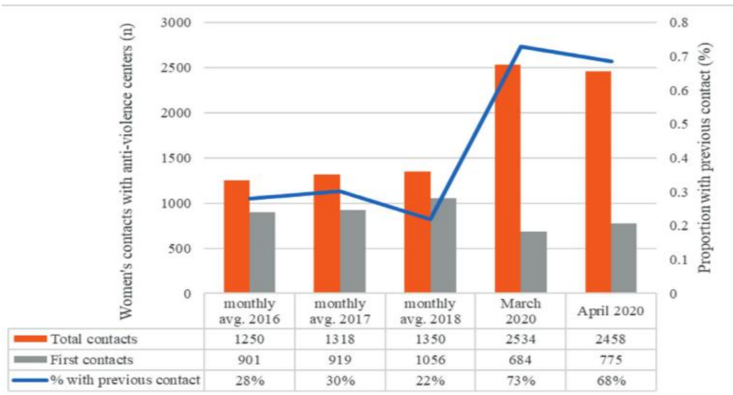


Figure 82: Women's contacts with anti-violence centers in Italy, 2016-2020. Data not yet available for 2019 (from Lundin et al., 2020).

These findings are in agreement with data published by the Italian National Institute of Statistics (ISTAT, see Stat-today, 2020), indicating a +59% increase in calls to a hotline for GBV victims from 1 March to 16 April 2020. Most of calls (93.2%) were made by women with a long-term GBV history (Lundin et al., 2020).

Rising of Intimate Partner Violence (IPV, including physical and sexual violence, emotional/psychological abuse, and controlling behaviors) during the lockdown probably was due to exacerbated pre-existing psychological disorders of violent partners, highlighted by the indirect consequences of COVID-19, including economic uncertainty, social instability, increased alcohol and psychotropic substance abuse. The SVSeD (Soccorso Violenza Sessuale e Domestica [Rescue against Sexual and Domestic Violence]) Center of the Milan Policlinico Hospital surprisingly observed a decrease in the number of women who asked in-person assistance and phone counseling. These data have been considered very alarming, because perpetrators took advantage of the restrictive measures in order to increase their control power over women, being therefore completely trapped at home for most of the time and unable to seek help during the lockdown. Maybe abusers had less reasons to exercise physical violence, thanks to their augmented power on the victims, being more effective psychological denigration and control, with devastating consequences on women's emotional conditions and identity (Barbara et al., 2020). In fact, a dramatic explosion of the requests for antiviolence help occurred after the COVID-19 emergency, with a peak between June and July 2020. Always Stat-today (2020) indicated that 69% of women victims of violence had sons, often minors (59% of cases). The house is the place where the violence mostly occurred (93.4%), often not sporadic but repeated during the time (years: 74.6%; months: 18.6%), at presence or directly done on minors.

About gender equality, the COVID-19 crisis, having a big impact on service occupations, affected more severely the women's employment, contrary to "regular" recessions (such as the one in 2008), which usually interested men. In addition, closures of schools and daycare centers massively increased child care needs, with a large impact on working mothers. Therefore, it is desirable that a long-run progress towards more gender equality, together with changes in social norms and expectations, will lead towards a more equal division of labor within the home (Alon et al., 2020; Wenham, Smith and Morgan, 2020).

6.4.6 Lockdown and mobility

The great part of the Italians followed the March-May 2020 lockdown restrictions; therefore, the mobility drastically decreased, with 70 million movements less than the same 2019 time interval among the population between 14-80 years (-60÷65% displacements; -80÷85% passengers per routed km).

However, approximately 50% of the population carried out allowed daily walking journeys (short proximity, for a restricted number of needs), with the exception of 30÷45-year-old active professionals without smart working, which showed still a substantial mobility rate. Clusters with the lowest mobility were aged and unemployed persons, housewives, but also young and very young students, due to the school closure. Displacement reasons changed from work-school (down from 34% to 17%) mainly to family management, with a growth of private car use, biking, walking, and a relevant contraction of the public transport attendance (from 12.2% to 4.1%), due to the fear of contagion. Biking and walking increased until 10% more than 2019, in particular in the North-East and the major cities (ISFORT, 2020).

The changes in the human activities and anthropogenic sources during the lockdown were also registered by seismic monitoring networks that can be easily used to track variations in the ambient noise. A sharp decrease was common in remote sites (as ski resorts), where the lockdown caused an immediate stop of any activity. Progressive reduction was measured in large cities such as Milano or Firenze, and a homogeneous drop in the COVID-19 most affected areas was found (Piccinini et al., 2020).

6.4.7 Lockdown and food

Soon after the adoption of the March-May 2020 lockdown measures, Italians changed a lot their consumption habits, constrained to stay at home and reduce the shopping frequency, but also due to psychological concerns, according more to the perception of risk than the risk itself. On average, total food retail sales increased by +18%, if compared to the previous year in all the national territory. Purchases slightly increased in supermarkets (until + 15% in discounts), while hypermarkets lowered their sales (-3%), due to the distance from residential areas. Small shops also regained the consumers' attention (+40%), due to their spatial proximity and deliveries organized by phone or e-mail. The e-commerce channel rocketed (+160%)

in all age groups; this trend is supposed to last long after the health crisis, due to the familiarity that Italians have built with this sale channel during lockdown, thanks to the use of online and apps delivery services both from consumers and producers.

Most of the people didn't change the quantity of their daily meals, but the quality, dedicating more time to cooking, with greater consideration for the healthiness and share of waste. Rush in stockpiling essentials and panic buying didn't occur in Italy (the contrary in USA and China), because shop shelves remained constantly filled; only a few cases occurred sporadically in the Milan area. No difference were found in the consumers' attitudes between areas hardly hit by COVID-19 and other parts of the country. Three interesting behaviors were registered in the lockdown course: "shelter", "comfort" and "MasterChef" effects. The shelter effect was associated to a situation of health emergency and utilitarian motives of safety and security, in order to face an uncontrollable emotion of anxiety; consumers stored preventively commodities, medicine, and food, also due to the need of lowering the shopping frequency, buying more storable foods associated with prevention and products with supposed health benefits. Sales of cupboard and beneficial goods (canned meat: +66%; canned tuna: +36%; cured meat: +32.4%; UHT milk: +62%; pasta: +66%; oranges: +25%; yogurt and probiotics: +11%) peaked especially in the lockdown first weeks, when consumers quickly made stockpiles, attitude slowly weakened during April and the following days. The comfort effect, triggered by stressful events, was associated to a sort of emotional eating and hedonic desire, in order to get psychological rather than physiological support. Sales of popcorn (+89.9%), crisps (+31%), confectionery (+61%), chamomile tea (+76.3%), wine (+18.5%) and alcoholic beverages (+180%) had considerably risen, the latter also due to fake news claiming the alcohol preventative effects against the disease. The MasterChef effect was related to the kitchen role as a place of entertainment during the meal preparation, another emotional regulation strategy, satisfying the desire for recreation or pleasure, in the middle of a daily routine drastically modified. This phenomenon led to the only two substantial stockouts regarding flour (peaks at +212.7%) and yeast (peaks at +226.4%). Increases also occurred for other recipes ingredients (eggs: +53%; butter: +85.9%; mascarpone +99.5%; +50%). Inversely, cut-fresh vegetable sales decreased (around -20%), because preservability became a priority. Internet searches for the recipe word substantially increased (top-five: pizza; bread; pancake; custard; and pie). The risk of obesity, however, triggered: more consume of comfort food; reduction of physical activity; school catering shut-down, exposing children to unhealthy food, especially for lower income families. In conclusion, most of the Italians kept their usual number of meals, but using food as a shelter, comfort, and entertainment, in the completely different daily routine during the lockdown period. The strong role of food as emotional regulator can explain the relevant behavioral changes in particular moment of life, also shadowing vegetarian and healthy food preferences that were largely expanding before the crisis. The rare presence of stockpiling behaviors could be explained by the social trust in institutions, reducing the risk perception of possible food shortages. People changed sale channels towards a resilience buying, trusting food supply chains, and adapting to the shift in consumption due to the COVID-19 pandemic emergence (Cavallo et al., 2020).

Due to the closure of spaces supporting social activities, the ho.re.ca. (Hotellerie, Restaurant, Café) sectors dramatically suffered from this situation (-40% of out-of-home consumption), subjected also to the loss of demand from abroad. Agritourism and rural tourism were completely suspended. About the agri-food sector, the growth in food retail sales only partially compensated the losses in non-domestic consumption. Fruit and vegetables, despite the difficulties encountered in the harvesting phase during the lockdown, managed to obtain a growing trend; wine decreases significantly (-37%), with a downturn not recorded in over 30 years, as a consequence of the ho.re.ca. closure; when the shortages of sanitizing products became critical, wineries began to distil disinfectant alcohol; anyway, the wine supply chain was resilient: the original prices remained essentially stable, especially thanks to the fact that it is a storable product. Moreover, olive oil was characterized by a dramatic drop, affected the most by the interruption of exports and the ho.re.ca. blocking of demand. In addition, there was a general reduction of non-food goods, in particular flowers and plants (-39%). The Italian fishery industry lost a substantial part of the revenues during this period, due to the ho.re.ca. crisis, fishing prohibitions, and fish markets closure. Livestock sector slowly adapted to the market changes (about -25% for restaurants closure); with the restrictions to cafes and ice-cream bars, fresh milk consumption lowered (-25%); the bovine meat sector didn’t absorb completely the ho.re.ca. contraction, while pork meat, principally sold through supermarkets, showed a decrease due to distancing measures taken in the production structures; rabbit, sheep and goat meat suffered the drop in demand of the Easter period. The gradual reopening of activities starting from May 2020 allowed for a progressive recovery of the ho.re.ca. sector. However, non-domestic consumption remained at lower levels than those recorded in 2019, due to the decrease of foreign tourists, while home feeding remained significantly higher, thanks to the greater diffusion of smart-working and prolongation of the state of emergency until 31 December 2020. The COVID-19 pandemic will have longer-lasting effects on the nature of food supply chains; they highlighted a general resilience, but also the fragility of some sectors. Digital transformation and new technologies without big investments played an important role for small farms and local shops, enjoying a human relationship with their customers and guaranteeing home deliveries to the elderly and most vulnerable people. On the contrary, the model of hypermarkets proved unsuccessful. The barriers to online shopping were definitely broken down, with an evolution that will persist after the COVID-19 crisis. Thus, it is possible to presume that these trends will continue after the crisis, suggesting the strengthening of a new relationship of trust between the inhabitants and the local sales network. These aspects underline the possibility of moving towards more sustainable and convenient economic and social models for humankind and the environment as a whole (Cavallo et al., 2020; Coluccia et al., 2021).

6.4.8 Evaluation of the adaptive capacity parameter in Italy (first phase January - June 2020)

In general, Italian people reacted enough well during the lockdown core period, but some notable inconsistencies took place from January to the first decade of March 2020 (a certain lack of compliance with the first *NPIs*) and in the month of June 2020 (mainly drop of TTT procedures). The contact-tracing App *Immuni* substantially failed, after a promising launch, due to technological limitations, low integration with local health policies, delayed notifications, but also privacy reasons and boycott by some politician representatives. Italian people widely adopted measures as hand washing and facemask-wearing, while physical distancing and ventilation of indoor spaces were less practiced. Women followed in a better way the measures requested by the government, being more conservative in the COVID-19 risk estimation. Mobility drastically decreased, remaining only short proximity journeys for a restricted number of needs, except for people without smart working, employed in the still running essential services. After the initial positive reactions addressed to hope, friendship, and resistance ("*Andrà tutto bene*" [Everything will be fine] and "*Io resto a Casa*" [I stay at home]), a certain level of psychological distress grew in some fragile sectors of the society, with particular regard to violence on women and minors trapped at home during the confinement. On the other hand, adolescents reacted surprisingly in a very positive way. Food habits changed, leading to the interesting phenomena of “shelter”, “comfort” and “MasterChef” effects, towards a resilience buying, with a rare presence of stockpiling behaviors.

Food supply chains faced the crisis in a satisfactory way, but with a remarkable inhomogeneity, especially with regard to the ho.re.ca. sector, which suffered very much.

Table 22: Values of COVID-19 resilience’s attributes; adaptive capacity.

values of the resilience’s attributes:	**very poor**	**poor**	**medium**	**good**	**very good**
	1	**2**	**3**	**4**	**5**
adaptive capacity		S_a (January 2020-March 2020)		S_b (from March 2020 onwards)	

Table 22 gives our evaluation of adaptive capacity at first glance, with different scores S in the periods January 2020-March 2020 ($S_a = 2$), and from March 2020 onwards ($S_b = 4$). Then, the average calculated value is $S = (S_a + S_b)/2 = 3.0$.

6.5 Sustainability

6.5.1 Foreword

During the COVID-19 pandemic, the lockdown restrictions, imposed on personal, social and economic activities by the National Governments (from January to May 2020, and peculiar in the various countries), led to a relevant decrease of traffic mobility and industrial production. Shipping declined worldwide too, reducing impacts on marine systems.

6.5.2 COVID-19 and pollution

Compared with the same period of 2019, satellite pictures of USA, China, and India (Figure 83; source: NASA, 2020) showed an evident reduction of pollutants, and therefore a consequent improvement of the Air Quality Index (AQI). In particular, nitrogen dioxide (NO_2, a clear indicator of human activity rates) and *PM2.5* (tiny particles or droplets in the air, i.e. particulate matter less than or equal to 2.5 microns in diameter) reduced greatly their concentration in the atmosphere. Also the concentration of other NO_x, SO_2 (sulfur dioxide), CO_2 (carbon dioxide), *CO* (carbon monoxide), *PM10* and *VOCs* (Volatile Organic Compounds) decreased significantly. However, O_3 (ozone) did not show any important reduction (Chen et al., 2020; Cicala et al., 2020; He, Pan, Tanaka, 2020; Le Quéré et al., 2020; Li L. et al., 2020; Mahato et al., 2020; Rui Bao and Zhang, 2020; Wang P. et al., 2020; Wang Q. and Su, 2020). A similar strong reduction was estimated in Europe and Italy (Collivignarelli et al., 2020), as shown by the pictures coming from the Copernicus Sentinel-5P satellite (ESA, 2020; see Figure 84). In Argentina, a country which issued a prolonged lockdown, the reduction of emissions was also consistent (up to 37% for *PM10*, *PM2.5*, and *BC*, Black Carbon, and up to 160% for *NOx*, *CO*, *NMVOC*, non-methane volatile organic compounds, and *Sox*, see Bolaño-Ortiz et al., 2020a,b). Such lockdown effects were greater in colder, richer and more industrialized areas, with a partial decline in greenhouse gas emissions. Despite these temporary improvements, the pollution levels remained much higher than the values recommended by the Paris Agreement (United Nations, 2015) to combat climate change and adapt to its effects. Anyway, this phenomenon indicates the role of industrialization on greenhouse gas emission and how robust measures are necessary to obtain quick and effective results to face the global warming effects.

The COVID-19 restrictions on transport and economic activities also constrained the supply-side capacity, resulting in significant increases in food loss and waste, especially of perishable agricultural produce. Due to labor shortage and exposure risk, human and animal waste has become a challenge under the COVID-19 crisis.

Moreover, new environmental threats came from households, services, and medical facilities, with an additional source of pollution from personal protective equipment *PPE* (facemasks, plastic gloves, disinfectants, etc.) to be urgently treated. For example, approximately 11 Million Wuhan inhabitants produced 200 tons of medical waste on a single day (on February 24, 2020), four times higher than the city's incineration capacity (Patrício Silva et al., 2020; Sarkodie and Owusu, 2020; Zambrano-Monserrate et al., 2020). Italian WWF (World Wildlife Fund) warns that if only 1% of the used facemasks will be spread in open places, 10 million devices (i.e. 40000 kilos of not recyclable materials) will be dispersed in the environment.

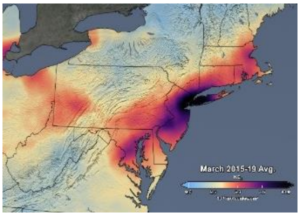
6.5.3 COVID-19 and the apparent resurgence of wildlife

During the COVID-19 extensive lockdowns worldwide, media emphasized several anecdotal news regarding the apparent resurgence of wildlife, occupying the voids left by the humans. Just some examples: coyotes, bobcats and black bears wandering through empty campgrounds (Yosemite National Park, California, USA); mountain lions resting in trees (Boulder, Colorado, USA); buffalos taking possession of deserted highways (New Delhi, India); penguins walking near desert restaurants (Cape Town, South Africa); mountain goats filling up the streets of Llandudno (Wales, UK). Italy saw similar phenomena, too, after establishing hard lockdown measures: wild boars in the middle of towns, dolphins in the port of Cagliari, ducks in the fountains of Rome, fishes and water birds in the (newly) clean Venice canals. Data coming from various sources (social media, in-field data, science projects outputs, and questionnaires addressed to managers of protected areas) confirmed some positive effects on wildlife conservation due to the reduction of human disturbance.

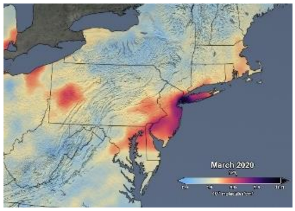
In addition, invasive alien species (IASs) could have been beneficiated, lacking actions of management and control (Manenti et al., 2020). Moreover, in protected areas, declines in visitor numbers caused by travel restrictions and park closures have reduced stresses on sensitive species. On the other hand, the pandemic caused the decrease of funding to conservation grants/programs and ecotourism collapse in crucial biodiversity sites, raising fears of a surge in poaching, illegal fishing and deforestation. In addition, ecological research has been almost disrupted: training weakened and large part of field/lab work shut down; research projects, academic meetings and important conferences were cancelled or postponed; young conservation scientists’ careers and seasonal jobs (employees recruited both by governmental and NGOs to manage biodiversity sites) lost (Corlett et al., 2020).

Northeast USA

Tropospheric NO_2 Column, March 2015-2019 Average

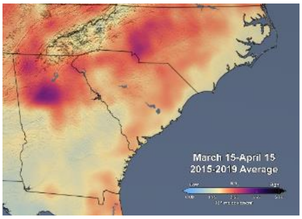


Tropospheric NO_2 Column, March 2020

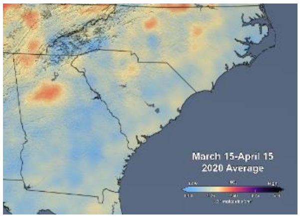


Southeast USA

Tropospheric NO_2 Column, March 2015-2019 Average

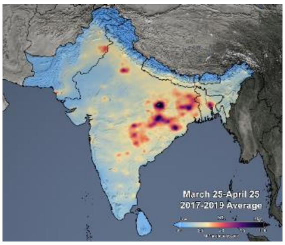


Tropospheric NO_2 Column, March 2020

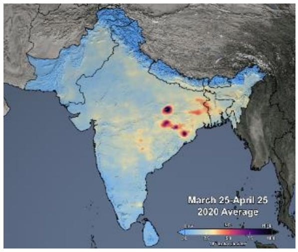


Indian Subcontinent

Tropospheric NO_2 Column, March 2015-2019 Average

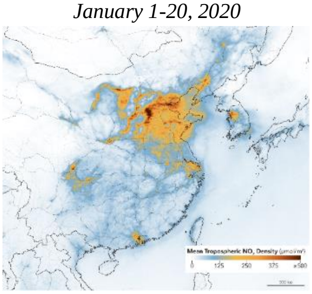


Tropospheric NO_2 Column, March 2020



People's Republic of China

Mean Tropospheric NO_2 Density, January 1-20, 2020



Mean Tropospheric NO_2 Density, February 10-25, 2020

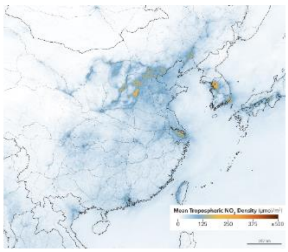


Figure 83: Reductions in NO_2 pollution in USA, India and China, resulting from COVID-19 mitigation (Source: NASA, 2020).

NO_2 Tropospheric column, March 2019 *NO_2 Tropospheric column, 14-25 March 2020*

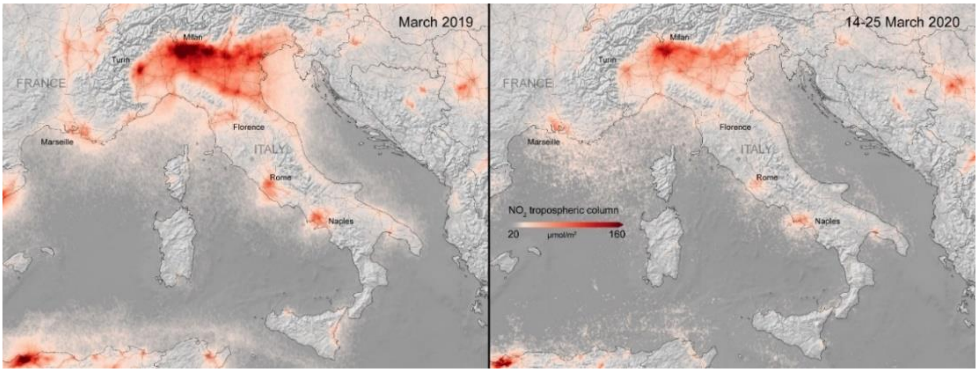


Figure 84: Reductions in *NO_2* pollution in Italy resulting from COVID-19 mitigation (Source: ESA, 2020).

6.5.4 Possible correlation between atmospheric pollutions and COVID-19 mortality rates

Another important and controversial question regards a possible correlation between the concentration of atmospheric pollutants (mainly Particulate Matter *PM2.5* and *PM10*) and the higher mortality rates due to COVID-19, observed in Northern Italy and other countries. On 16 March 2020, a group of researchers (Setti et al., 2020) presented a position paper regarding the *PMx* potential role in the pandemic spreading. This hypothesis, suggesting that pollution could be considered at least an additional co-factor, has been supported by further studies (examples: Coker et al., 2020; Comunian et al., 2020; Conticini et al., 2020; Contini and Costabile, 2020; Lolli et al., 2020; Magazzino et al., 2020; Pozzer et al., 2020; Wu X. et al., 2020). However, a few days later (20 March 2020), the Italian Aerosol Society (IAS, 2020) questioned that the atmospheric *PM* could act as a “carrier” substrate for the virus transport, due to the limited knowledge currently available, and necessitating wider research. ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale [the Italian Institute for Environmental Protection and Research]) shared this position, requiring utmost caution in interpreting the available data. Several studies showed that the SARS-CoV-2 virus survival rate on the surface and in aerosols is reduced by increasing solar radiation, temperature and humidity. This is true especially in the middle latitudes and in areas with sub-tropical and tropical climate, but the pandemic intensity may only be attenuated and does not disappear in the warm seasons. Furthermore, observations and laboratory experiments indicated that SARS-CoV-2 could be transmitted by aerosols in specific indoor conditions, but the relative importance of aerosols compared to droplets and fomites is not yet established. So far, the relationship between environmental factors (including atmospheric pollution) and the COVID-19 pandemic has not been fully established (Dobricic et al., 2020). On April 2020, an Italian scientific alliance (ENEA, Agenzia Nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile [Italian National Agency for New Technologies, Energy and Sustainable Economic Development]; ISS, Istituto Superiore di Sanità [Italian National Institute of Health]; and SNPA, National System for Environmental Protection, composed of ISPRA and the Regional Agencies) launched *PULVIRUS* (ENEA, 2020), a joint research project with the aim to offer institutions and citizens information, answers and indications, based on scientific data, skills and experiences in the field of air pollution and COVID-19.

6.5.5 SARS-CoV-2 spillovers and panzootic risks

Finally, experts in emerging infectious diseases have been warning that human impacts on natural systems increase the risk of disease spilling over from wildlife into domestic animals and human populations. Habitat destruction, fragmentation, and degradation, intensive livestock rearing and hunting, trade and consumption of wild species in wet market, together with the amount and speed of movements in a globalized world, are intensifying the risks of future zoonotic outbreaks (Corlett et al., 2020; Honigsbaum, 2020). SARS-CoV-2 is the most recent example of an emerging infectious virus that has converted 'pandemic potential' to reality, having successfully crossed the species barrier.

The risk of multiple spillover episodes in animal populations and then to humankind is high. Notably, cases of SARS-CoV-2 transmission to domestic dogs/cats, tigers, and lions have been reported. Except dogs, the other cited animals presented some clinical signs. Therefore, the virus could develop the ability to become endemic in some domestic pets and wild populations. Furthermore, SARS-CoV-2 struck American (Neovison vison in Utah) and European (Mustela vison in Spain, Denmark, Netherlands) minks, which are the first intensively farmed animals to experience outbreaks.

Current evidence indicates that the virus was transmitted to the animals through infected workers. Until now, other intensively farmed species didn't suffer any contagion. This fact suggests that mustelids (widely distributed across a number of habitats, both aquatic and terrestrial) may exhibit a higher susceptibility to the infection. Some of them, such as ferrets, are considered cute and affectionate pets. In order to avoid further failures, the SARS-CoV-2 pandemic and subsequent panzootic potential highlight the need for a '*One Health approach*', through harmonized guidelines for surveillance and intervention in wild, captive, and companion animals, including quarantine and care packages for infected animals. "*With the current information available it is not possible to predict if SARS-CoV-2 will cause a panzootic. However, not being prepared for such an event would represent a second major preparedness failure during the same public health emergency*" (quotes from Gollakner and Capua, 2020; Manes, Gollakner and Capua I., 2020; and references therein).

6.5.6 Evaluation of the sustainability parameter in Italy (first phase January - June 2020)

Despite the too much emphasized feedback due to the worldwide confinements, the pollution levels returned quickly almost at the same pre-pandemic levels. Indeed, this phenomenon indicated how crucial is the industrialization and transportation on greenhouse gas emission. However, still temporary NPIs have demonstrated as how robust measures could lead to effective results in a reasonable short time interval to face the global warming effects.

In Italy, the economic recovery associated to the easing phase didn't show any stabilization of the weak but clear and beneficial short-term effects of the lockdown on the environment. On the contrary, the worrying contraction of the public transport attendance was a bad signal for the future. In addition, the pandemic consequences on conservation grants/programs, ecological research, and ecotourism have been disastrous and supporting actions really inadequate.

Some hopeful sign came from the PNRR (Piano Nazionale di Ripresa e Resilienza [Italian National Plan of Recovery and Resilience]; see PNRR, 2021), which contains, among the Missions, three very important topics (Mission 2: Green Revolution and Ecological Transition; Mission 3: Infrastructure for a Sustainable Mobility; Mission 4: Education and Research). The PNRR, already accepted by the European Union, foresees a series of strict provisions to be complied within a few months. If quickly approved and financed, the PNRR will return important results in a medium term perspective. However, the Italian environmental associations gave judgements with different levels of criticism: a significant but insufficient step towards (WWF Italia); not incisive for climate change (Kyoto Club); weak and partially inadequate with respect to the European objectives (Legambiente); biodiversity and nature completely forgotten (LIPU); an ecological pretense and disappointing (Greenpeace).

Table 23: Values of COVID-19 resilience's attributes; sustainability.

values of the resilience's attributes: *sustainability*	**very poor**	**poor**	**medium**	**good**	**very good**
	1	**2**	**3**	**4**	**5**
		S (January 2020-June 2020)			

Table 23 gives our evaluation of sustainability at first glance, with a unique score *S* in the period January 2020-June 2020 ($S = 2$).

6.6 Governance

6.6.1 Foreword

As discussed in Section 6.2, WHO have faced a series of great constraints in managing the COVID-19 pandemic. Nationalist governments weakened its authority, reduced the budget, and blocked a coordinated United Nations (UN) response. Isolationist policies divided the world, putting obstacles to the global solidarity. The fragmentation of health governance saw hundreds of actors involved: WHO, Global Fund, President's Emergency Plan For AIDS Relief, United Nations Programme on HIV and AIDS, United States Agency for International Development, World Bank, the Gates Foundation, the Clinton Foundation, and so on. This fact resulted in uncoordinated programmes missing an effective global health policy. Although the International Health Regulations (WHO-IHR, 2005) are the primary WHO instrument to govern pandemic threats, they were not fully implemented by several countries (also in EU, including Italy, due to limited financial resources and political will), and often violated. The COVID-19 pandemic, causing the semicollapse of many national health systems, revealed a profound lack of prevention and preparedness, in particular concerning equipment and critical care beds (Gostin, Moon, and Meier, 2020; Paul, Brown, and Ridde, 2020). The threat was to be expected, but ignored, despite repeated warnings, such as the 2016

Report of the "High-level Panel on the Global Response to Health Crises", as well as the position of the 2019 Global Preparedness Monitoring Board, an independent body. Important gaps have been identified, both in the WHO governance, as well as at national levels (Renda and Castro, 2020). The COVID-19 pandemic has vividly demonstrated that the underlying challenge of improving global health is not one of poor coordination among scientists, nor even one of lack of scientific cooperation, but a lack of political cooperation on a global-scale, as needed for climate change, for example. WHO is now a body not enough equipped for the complex challenges it has to face (Benvenisti, 2020). During the COVID-19 management and debate, and the *infodemics* associated with the worldwide spread, interdisciplinary global health concerns and expertise were often neglected. Virologists and epidemiologists dominated the scene, and later economists and business experts arrived second on stage, to create awareness of economic consequences. The intrinsic complexity of global health (and related experts' voices with in-field experience of recent epidemics) was unable to achieve sufficient impact in the media. Key societal questions relevant for people's welfare, such as the distribution of resources, equality of opportunities, political power relations, social justice, human rights, although aggravated by the pandemic, stayed in the background. Other major threats facing today's world, such as climate emergency, ecological degradation, armed conflicts, immigration crisis, poverty, and growing epidemic of non-communicable diseases, were obscured.

After many years of dominant neoliberal ideology talking about state's role reduction, the COVID-19 crisis exhibited, on the contrary, the resurgence of the strong state, as the only authority capable of guaranteeing and enforcing the right to health, intervening in individual and social life, restricting economic and entrepreneurial activities, and imposing lockdowns or other interventions (quarantines, social distancing, border closures), however justified to protect people's health. To emerge stronger and more visible from the current COVID-19 crisis, global health must become more explicit, more straightforward and ultimately more politicized (Holst, 2020). Anyway, the severe measures taken by the governments (right to move, assemble, demonstrate, and attend religious services) pose a serious question of civil and political freedom, in order to avoid the risk that the state of emergency could become the new norm. Furthermore, the increase of the 'bio-surveillance', depending on big data control, is another crucial aspect of the democracy. On the other hand, reactionary ideologies as populism, nativism, sovereignty, can strengthen and polarize social division during the pandemic, finding scapegoats like migrant, homeless, and queer persons. Nevertheless, in a larger spectrum of human response as it happens during a crisis, there has been also the evidence of worldwide expressions of support, and healthcare check towards vulnerable communities, asylum-seekers, unaccompanied children and victims of domestic violence.

6.6.2 WHO and EU main actions

COVID-19 tested the efficacy of the different levels of federal, national and subnational decision-making. Federal and unitary states, with a range of populations alongside a spectrum of liberal democratic and authoritarian variants, have all been criticized for their failings to respond to the pandemic. Austerity measures, sclerotic leadership and civic repression have all been cited as likely causes of political inadequacy. The overall picture is complicated and cannot be explained by the formal structure of political systems per se (Dodds et al., 2020)

Table 24: WHO (World Health Organization) main actions (January-June 2020).

	WHO (World Healthcare Organization)
1	December 31-January 3: WHO's Country Office in China picks up a media statement by the Wuhan (China) Municipal Health Commission from its website on cases of 'viral pneumonia'; WHO requests information on the reported cluster from the Chinese authorities, activating its Incident Management Support Team (IMST); WHO offers to China its support and repeats the request for further information; Chinese officials provide information to WHO on the cluster of cases of 'viral pneumonia of unknown cause' identified in Wuhan (source: WHO, 2020a).
2	January 4: WHO reports on social media that there was a cluster of pneumonia cases – with no deaths – in Wuhan, Hubei province (source: WHO, 2020a).
3	January 10-12: WHO publishes a comprehensive package of guidance documents for countries, covering topics related to the management of an outbreak of a new disease (source: WHO, 2020a).
4	January 12: China publicly shared the genetic sequence of COVID-19 (source: WHO, 2020a).
5	January 13: first COVID-19 recorded case in Thailand outside of China (source: WHO, 2020a).
6	January 14: WHO technical officials note a possible COVID-19 human-to-human transmission in the confirmed cases, mainly through family members, with risk of a possible wider outbreak (source: WHO, 2020a).
7	January 20-21: a WHO delegation conducts a field visit to Wuhan to learn about the response to COVID-19; a day after, the mission issues a statement saying that there is evidence of human-to-human transmission in Wuhan (source: WHO, 2020a).
8	January 22: WHO Director-General convenes an Emergency Committee (EC) to assess whether the outbreak constitutes a PHEIC; EC members don't reach an agreement (source: WHO, 2020c).

9	January 22-23: interim guidance; no facemask for healthy general people, with distance ≥ 1 m (source: WHO, 2020j).
10	January 30: WHO declares COVID-19 a PHEIC (source: WHO, 2020d).
11	February 16-24: WHO-China Joint Mission on COVID- 2019 takes place, travelling to Wuhan and two other cities (source: WHO, 2020b).
12	March 11: WHO declares COVID-19 a pandemic (source: WHO, 2020e).
13	March 19: WHO releases interim guidance; testing symptomatic patients or asymptomatic only if high contact occurs (source: WHO, 2020l).
14	May 12: WHO Report "An unprecedented challenge; Italy's first response to COVID-19" (source: WHO, 2020h).
15	June 5: WHO releases interim guidance; encouraging facemask use for healthy general people (source: WHO, 2020k).

Table 25: ECDC (European Centre for Disease Prevention and Control) main actions (January-June 2020).

ECDC (European Centre for Disease Prevention and Control)	
1	January 9: cluster of pneumonia cases associated with a novel coronavirus reported in Wuhan, China; only local people seem to be affected; no indication of human-to-human transmission; risk to travelers considered low; since no cases detected outside of Wuhan, the likelihood of introduction to EU considered to be low, but not excluded; risk of further spread within EU considered from low to very low (source: ECDC, 2020a).
2	January 17: cluster of COVID-19 reported in Wuhan, China; no clear indication of person-to-person transmission, maybe occurred; likelihood of importation to EU considered low, but not excluded (source: ECDC, 2020b).
3	January 23-26: first COVID-19 imported cases in EU identified in France, with a travel history to China; moderate likelihood of further importation into EU (source: ECDC, 2020c).
4	January 28: another COVID-19 imported case identified in Bavaria, Germany (source: ECDC, 2020d).
5	February 23: COVID-19 situation in four Regions in Italy dynamically evolving; more cases expected in coming days; extraordinary public health measures implemented in northern Italy to contain outbreak; no related cases linked to other EU countries; risk associated with COVID-19 infection for EU people considered from low to moderate; probability of further transmission in EU considered to be low, but not excluded; impact of sustained transmission in EU from moderate to high, especially for elderly populations with comorbidities; risk of COVID-19 occurrence in other EU countries from moderate to high (source: ECDC, 2020e).
6	March 2: the COVID-19 risk for EU people currently considered to be moderate to high (source: ECDC, 2020f).
7	March 12: all the EU countries are affected (17 413 cases; 711 casualties); Italy represents 58% of the cases and 88% of the fatalities (source: ECDC, 2020g).
8	March 25: number of COVID-19 cases rapidly increasing in all EU countries (204930 cases and 11 810 deaths); the disease ranges from no symptoms (asymptomatic) to severe pneumonia, that can lead to death; hospitalization rates were higher for those aged 60 years and above (source: ECDC, 2020h).
9	April 1: quick and accurate laboratory testing (through molecular/rapid tests) is an

	essential part of the COVID-19 management for slowing down the pandemic, supporting decisions on infection control strategies, and patient management at healthcare facilities; detecting asymptomatic cases that could spread the virus further if not isolated, is very important (source: ECDC, 2020i).
10	April 8: large increases in COVID-19 cases and deaths in EU countries; excess mortality above the expected rate is showed in Belgium, France, Italy, Malta, Spain, Switzerland and the UK, mainly in the age group of 65 years and above; despite early evidence from Italy and Austria that the number of cases and deaths are declining slightly, there is currently no indication at EU level that the peak of the pandemic has been reached; strain on health and social care systems and healthcare workers continues, with shortages reported in laboratory and testing capacity, personal protective equipment (*PPE*) and healthcare capacity; the risk of severe disease associated with COVID-19 in EU is currently considered moderate for the general population and very high for older people; the risk of COVID-19 increasing community transmission in EU in the coming weeks is moderate if mitigation measures are in place, and very high if insufficient mitigation measures are in place (source: ECDC, 2020j).
11	April 8: use of facemasks in community should be considered complementary measure, not replacement for established preventive measures (physical distancing, respiratory etiquette, meticulous hand hygiene); it may serve to minimize excretion of respiratory droplets from infected asymptomatic or pre-symptomatic individuals; it is not known how much use of facemasks in community can contribute to decrease transmission, in addition to other countermeasures; use of non-medical facemasks made of various textiles could be considered, especially if due to supply problems (source: ECDC, 2020k).
12	April 23: many countries implemented non-pharmaceutical interventions (*NPIs*) such as 'stay-at-home' and physical distancing measures; in 20 EU countries, it appears that the initial wave of transmission has passed its peak, with a decline of newly reported cases; although this decline has been observed, these measures are highly disruptive to society, both economically and socially; this is why there is significant interest in defining a sound approach to adjusting the above said measures (source: ECDC, 2020l).
13	June 11: countries that implemented enforced 'stay-at-home' and physical distancing measures initiated full/partial relaxation of these measures; several begun full/partial reopening of small retail shops and other public spaces; now, just before summer holiday period, there is a risk that people will not adhere firmly to the measures still in place due to 'isolation fatigue'; therefore, continuous efforts are needed to ensure that the remaining physical distancing and infection prevention control measures continue be observed to limit the spread of the disease; the pandemic is not over; hypothetical forecasting indicates a rise in cases in the coming weeks (source: ECDC, 2020m).
14	July 2: there is still community transmission reported in most EU countries, with a resurgence of observed cases or large localized outbreaks; the reasons behind this increase may reflect changes in case ascertainment or may reflect genuine increases in transmission, e.g. associated with the easing of non-pharmaceutical interventions (*NPIs*), or may be due to importation of cases (source: ECDC, 2020n).

Figure 85 shows, with different symbols, the positions of International/EU Organizations, Italian Scientific Institutions/Experts, Italian Government, Italian Opposition, Italian Regions/Provinces/Municipalities, Italian Trade Unions/Entrepreneurs, nativist/sovereigntist/deniers/extreme right organizations. For at-a-glance viewing, in this figure, each actor is labelled with a distinct symbol, the same used in the legends of the Tables form 24 to 31. Neglect/grey/awareness areas are purely qualitative in ordinates, but in time sequence (January-June 2020) in abscises; COVID-19 maximum daily increase/total cases are given in the background.

Table 24 and Figure 85 show the WHO main actions against COVID-19 spread (January-June 2020). This organization reacted slowly, from the first information about the outbreak in China (end of December 2019) to the PHEIC (January 30, 2020), and pandemic (March 11, 2020) declarations. However, due to the member states underestimation, WHO recommendations remained unheard for weeks in several countries, that believed the risk confined only to China and neighboring countries. The European Union (EU) played initially a limited role in the pandemic management. After a lack of solidarity, especially from Northern states towards the Southern ones, on July 2020 the European Council agreed to launch a massive recovery fund of 750 billion €, named Next Generation EU (NGEU), in order to support member states hit by the COVID-19 pandemic. Following with a certain degree of inertia the WHO statements, ECDC (European Centre for Disease Prevention and Control) considered the likelihood of COVID-19 introduction to EU to be low since the end of January 2020 (Table 25 and Figure 85). We decided to locate the WHO and ECDC positions in the top awareness area, except the initial delay and two WHO principal inconsistencies, that rebounded everywhere: i) no facemask needed for healthy people, with distance ≥ 1 m (interim guidance, WHO, 2020j); the general use of facemask has been officially encouraged only six months later (interim guidance, WHO, 2020k); ii) testing needed only on symptomatic patients (with at least one among fever, cough, respiratory distress) or asymptomatic when close contact occurred (interim guidance WHO, 2020l); the question about the necessity of the widest check of asymptomatic/paucisymptomatic people remained unsolved and discussed among the scientific community too.

Table 26: Positions of some scientific institutions and experts in 2020 (January-June 2020).

	Scientific Institutions and experts
1	January 29: Roberto Burioni claims that in Italy the coronavirus is absent and that it is a nonsense to avoid Chinese people, Chinese restaurants, Chinese places. He supports the need to apply quarantine and confinement to travelers coming from China and avoid countries hit by the infection (Il Fatto Quotidiano, 2020c).
2	February 10: Massimo Galli states that the situation in Italy is under control (sanitàinformazione, 2020).
3	February 12: Stefano Merler (FBK) presents to the Italian Scientific Committee a very worrying scenario, predicting the contagion quick increase until millions of infected people and thousands of deaths within a few months (Repubblica, 2020a; Guzzetta et al., 2020a,b).
4	February 21: Roberto Burioni affirms that coronavirus arrived in Italy from contacts with asymptomatic persons coming from China, and that even the first infection cases in Italy are creating panic, it is the moment to keep calm (MedicalFacts, 2020).
5	February 23: Maria Rita Gismondo states that coronavirus is like a little stronger flue (Il Fatto Quotidiano, 2020d).
6	March 20: Massimo Galli admits that he partially underestimated the coronavirus impact in February. He argues that the infection entered Italy from Germany around February 25 and spread silently for the following 4 weeks to Lombardia and Veneto (Fanpage, 2020a).
7	March 22: PTS (Patto Trasversale per la Scienza [Transversal Pact for Science], launched by Roberto Burioni in 2019) sends to Maria Rita Gismondo a legal warning with reference to her minimizing assertions about coronavirus (PTS, 2020).
8	March 29: Open Letter to President Giuseppe Conte signed by 192 Italian scientists claiming to check asymptomatic subjects with the support of several Italian public and private laboratories (Adnkronos, 2020a).
9	May 31: Alberto Zangrillo states that coronavirus clinically doesn't exist anymore (Repubblica, 2020b); Matteo Bassetti supports a similar position (ANSA, 2020a), asserting that SARS-CoV-2 lost its initial firepower; strong reaction by the Technical Scientific Committee (CTS, supporting DPC): "*these are very wrong messages*".
10	July 1: Andrea Crisanti replies to Alberto Zangrillo "*to much euphoria; I hope he regrets what he said within two months*" (OPEN, 2020a).

6.6.3 Conflicting positions within the scientific community

It might be argued that self-critique within the scientific community has been a rare trait. In Italy, on the other hand, especially in the media, there were heated debates between scientists with very different positions. After the COVID-19 severity underestimation of January-February (Table 26 and Figure 85), only the FBK study rightly presented immediately a very worrying scenario (Repubblica, 2020a; Guzzetta et al., 2020a,b; see Section 4). Solely Prof. Massimo Galli sincerely recognized that he partially understated the COVID-19 impact (Fanpage, 2020a). Some others, even acknowledged as experts, occupied the deep neglect area in the various phases of the pandemic: stating at the beginning (February 23) "*coronavirus is like a little stronger flue*" (point 5 of Table 26, Il Fatto Quotidiano, 2020d), and a month after the lockdown end, when the infection temporarily declined (May 31) "*coronavirus clinically doesn't exist anymore*" (point 9 of Table 26, Repubblica, 2020b). In particular, the reductionist opinions generated the strongest reactions from the majority of the scientists (PTS, 2020), and the Technical Scientific Committee (CTS, supporting DPC). Experts' different positions have contributed to confuse the citizens and their evaluation about the severity of COVID-19 and thus the need to adopt health measures. The analysis of public perception (Bucchi and Saracino, 2020; Eurobarometer, 2020) showed that even resulting trust in science high, almost half of Italians have seen the diversity of advice from experts as a potential source of confusion (Battiston et al., 2020). Moreover, although recognizing their substantial competence, 8% negatively evaluates their communicative abilities. TV and radio news were considered trustable sources of information by the two-thirds of Italians, being 14.7 the percentage of those drawing their information mainly from institutional web sources (Health ministry, the Civil Protection Department, or local institutions).

Table 27: Italian Government principal actions (January-June 2020).

	Italian Government (center-left+M5S)
1	January 21: healthcare procedure in Roma-Fiumicino airport with flight connections to/from Wuhan (Italian Ministry of Health, 2020a).
2	January 21: 3 positive cases (including a Chinese couple coming from Wuhan) hospitalized (INMI, 2020a-c).
3	January 22: circular speaking about: some Far East affected areas (China, South Korea, Thailand, and Japan); the ongoing WHO monitoring; the ECDC moderate estimate about the risk of introduction of that infection in Europe (Italian Ministry of Health, 2020b).
4	January 27: prohibition of landing for all flights coming from China in the airports of Ciampino, Roma Urbe, Perugia, Ancona, and Pescara (Italian Ministry of Health, 2020c).
5	January 30: measures against new coronavirus; closure of flights to/from China; (Italian Ministry of Health, 2020d).
6	January 30: press conference; Conte: "*no panic*"; Speranza: "*situation under control*" (Italian Ministry of Health, 2020e).
7	January 31: Council of Ministers declares a six-month state of emergency until July 31, entrusting DPC for emergency response; Decree-Law 25 March 2020 n. 19, approved in Parliament May 21-22 with dissenting vote of center-right, conversion into Law 22 May 2020 n.35; Decree-Law 20 July 2020 n. 83 extending state of emergency to October 15, approved in Parliament September 23 with dissenting vote of center-right, conversion into Law 25 September 2020, n. 124; Decree-Law 07 October 2020 n. 125

	extending state of emergency to January 31 2021 approved in Parliament with no vote of center-right, conversion into Law 27 November 2020 n. 159 (Italian Council of Ministers, 2020a-c; Decree-Law, 2020a-c; Law, 2020a-c; DPC, 2020a).
8	February 21: a 14-days quarantine is applied to all the individuals coming from China or having close contacts with COVID-19 confirmed cases; this decision is taken after the WHO declaration of International healthcare emergency; in that phase, the current idea in Italy is to shut down the country against a "foreign virus" (Italian Ministry of Health, 2020f).
9	February 21: the Italian Ministry of Health and Lombardia Region Authority, in agreement (Italian Ministry of Health and Lombardia Region Authority, 2020), decides a localized lockdown in 10 municipalities sited in the Province of Lodi (Codogno, Castiglione d'Adda, Casalpusterlengo, Fombio, Maleo, Somaglia, Bertonico, Terranova dei Passerini, Castelgerundo, San Fiorano).
10	February 22: the Italian Ministry of Health and Veneto Region Authority, in agreement (Italian Ministry of Health and Veneto Region Authority, 2020), appropriately decided a localized lockdown at Vo' Euganeo, Province of Padua.
11	February 23: Ordinance of the Minister of Health (Italian Ministry of Health, 2020g) regarding confinement measures and schools closure in Piemonte, Lombardia, Veneto, Friuli-Venezia Giulia, Emilia-Romagna; Decree-Law of the Government, with confinement measures, including the schools closure (Decree-Law, 2020d).
12	February 24: Ordinance of the Minister of Health (Italian Ministry of Health, 2020h) regarding confinement measures and schools closure in Liguria; Decree-Law of the Government, with confinement measures, including the schools closure (Decree-Law, 2020d).
13	March 2: ISS confidential communication (TPI, 2020b) regarding the lockdown (not realized) of towns located in the provinces of Bergamo (municipalities of Alzano Lombardo, Nembro, Albino, Seriana Valley) and Brescia (Orzinuovi).
14	March 5: Italian Government promulgates a decree (DPCM, 2020a), obligating the closure of all the schools until March 15 (then postponed to April 3 and later to September); the same act also declares the suspension of all the sport/culture events, and moratorium of workshops/social meetings of medical personnel, smart working features, and other minor duties.
15	March 8: Italian Government imposes a quarantine to the entirety of Lombardia Region, in addition to other fourteen provinces of Piemonte, Veneto, Emilia-Romagna, and Marche (DPCM, 2020b).
16	March 9: the lockdown is extended to all Italy and becomes total (DPCM, 2020c).
17	April 26: end of the lockdown after 56 days and beginning of phase 2 (Decree-Law, 2020e; DPCM, 2020d; DPCM, 2020e).

6.6.4 Italian Government principal actions

The Italian government (an alliance between center-left parties and 5 Stars Movement, Table 27 and Figure 85, since 13 February 2021 when Mario Draghi became the new Prime Minister) usually followed the WHO/ECDC recommendations (except, as already reported in Sections 4 and 6.2, the decision regarding travel restrictions). This led to repeat the same errors cited above for WHO/ECDC, i.e. underestimating the risk in the early stage of the pandemic, delaying the use of facemask for general people, and avoiding to set up a robust campaign to identify asymptomatic/paucisymptomatic infected people (with the exception of the small village of Vo' Euganeo, see Section 4). In addition, the serious inadequacy about the not updated pandemic plan (since 2006, see Section 6.2.5 and WHO, 2020i) permitted the COVID-19 spread to take the country by surprise, with a dramatic shortage of personal protective equipment (*PPE*: facemasks, plastic gloves, disinfectants, etc.), oxygen bottles, ICU beds, medical products and therapeutics. The lack in care facilities, qualified staff, general personnel and the weakness of territorial garrisons (especially in Southern Italy, but in Lombardia too, see Section 6.3) led to a generalized unpreparedness in the first days of the pandemic. Furthermore, the Italian Government, after taking the indisputable decision to declare red the zones of Lodi and Vo' Euganeo (respectively on February 21 and 22), missed the same measure (sharing the responsibility with Lombardia Region and Confindustria, the National Association of Italian Industries) for the other hardly struck municipalities in province of Bergamo and Brescia (see Section 4). After the school closure until September, the highest, but delayed level of awareness has been finally reached on 8-9 March 2020, with the extension of the lockdown to the whole Italian territory. After 56 days, the phase 2 (gradual reopening) began. The Italian government knew remarkable oscillations between opening/closure, under the continuous pressure of the opposition (Table 28 and Figure 85), local institutions (Table 29 and Figure 85), and entrepreneurs (Table 30 and Figure 85), especially in Summer 2020, not object of this study.

6.6.5 Italian opposition principal actions

The Italian opposition (center-right, plus several Presidents of Regions, mainly belonging to Lega in Northern Italy, see Table 28 and Figure 85) policy can be well represented by a rollercoaster trend in February-March (jumps among the neglect/grey/awareness areas). After a very short period of apparent cooperation with the government (middle of March 2020, following the request of the President of the Republic Sergio Mattarella asking for more national unity), this political alignment braided prejudicial attitudes with continuous complains about the lack of democratic discussion in the Parliament, which was operating with reduced ranks and sessions, because of the COVID-19 infection. It was true to some extent, due to the continuous adoption of emergency decrees by the Premier Giuseppe Conte.

Anyway, when the state of emergency (declared on January 31, 2020 until July 31; extended until to October 15; and then to January 31, 2021; see point 7 of Table 27) was approved in the Parliament, it saw all the three times the dissenting vote of center-right. In April-June, this political alliance occupied permanently, at the national level, the lowest belt (neglect), even with square protest with crowding and no-mask people in Rome (point 15 of Table 28, June 2, morning; Repubblica, 2020e). At the end of June 2020, Matteo Salvini (Lega leader) asked for reopening all the activities, there being no danger of a second wave (point 16 of Table 28; Agi, 2020).

Table 28: Italian opposition (center right) principal actions (January-June 2020).

	Italian opposition (center-right)
1	February 21: Salvini (Lega) asks for a closure of all Italian borders (Strisciarossa, 2020).
2	February 27-29: Salvini (Lega) asks for opening all activities (Strisciarossa, 2020); Italy is safe; he invites tourists to come (Wired.it, 2020).
3	February 29: Meloni (Fratelli d'Italia) invites tourists to visit Italy (adnkronos, 2020b).
4	March 5: Meloni (Fratelli d'Italia) accuses the Prime Minister to be a criminal (La7, 2020a).
5	March 10: Salvini (Lega), Meloni (Fratelli d'Italia), Tajani (Forza Italia) ask for closing all to Conte (Il Fatto Quotidiano, 2020e).
6	March 10-11: Salvini (Lega), Meloni (Fratelli d'Italia), Tajani (Forza Italia) ask for a closure of Lombardia Region for 15 days (Avvenire, 2020b); Salvini (Lega) asks for closure of al Italy and Europe.
7	March 19: center-right ready to cooperate with the Italian government, after the request of the President of the Republic Sergio Mattarella pushing towards national unity (RaiNews, 2020a).
8	March 19: center-right stops national unit during the coronavirus emergency; uprising against the Premier Giuseppe Conte (business.it, 2020).
9	March 25: Salvini (Lega) and Meloni (Fratelli d'Italia), say that China researchers created COVID-19 in laboratory (Il riformista, 2020).
10	April 4: Salvini (Lega), reopening churches for Easter (Repubblica, 2020c).
11	April 16: Salvini (Lega), reopening Lombardia Region (Repubblica, 2020d).
12	April 27: Salvini (Lega), reopening as soon as possible (La Stampa, 2020a).
13	May 10: Meloni (Fratelli d'Italia), reopening for age groups, safety areas, respect of safety protocols (adnkronos, 2020c).
14	May 14: Meloni (Fratelli d'Italia), contrary to extension of state of emergency (TGCOM24, 2020).
15	June 2 (morning): Italy, Rome, center-right square protest with crowding and no-mask (Repubblica, 2020e).
16	June 25-28: Salvini (Lega), reopening all, no danger of a second wave, don't terrorize people (Agi, 2020).

6.6.6 Italian Local Institutions principal actions

The actions of the Italian Local Institutions (Table 29 and Figure 85) were enough contradictory, sometimes not depending on the political affiliation. On February 27, 2020, Beppe Sala, Mayor of Milan (center-left), supported the initiative "*Milano non si ferma* [Milano doesn't stop]" (ANSA, 2020c; see Section 4); later, he recognized the mistake (Ilpost, 2020); the same for Giorgio Gori (center-left), Mayor of Bergamo, with "*Bergamo non si ferma* [Bergamo doesn't stop]" (Eco di Bergamo, 2020a; see Section 4).

Table 29: Italian Local Institutions principal actions (January-June 2020).

	Italian Regions, Autonomous Provinces, Municipalities
1	February 3: Zaia, Fontana, Fedriga, and Fugatti (all of Lega), Presidents of Veneto, Lombardia, Friuli-Venezia Giulia, and Trentino Autonomous Province, ask for school confinement of children coming from China (Il Fatto Quotidiano, 2020f).
2	February 21: Fontana (Lega), President of Lombardia, signs with the Government the lockdown for 10 Lodi municipalities (Italian Ministry of Health and Lombardia Region Authority, 2020).
3	February 22: Zaia (Lega), President of Veneto, signs with the Government the lockdown for Vo' Euganeo (Italian Ministry of Health and Veneto Region Authority, 2020).
4	February 22: Padua Province: Schiavonia Hospital closed and 450 people isolated (ANSA, 2020b).
5	February 23: Minister of Health Ordinance, confinement measures/schools closure in Piemonte, Lombardia, Veneto, Friuli-Venezia Giulia, Emilia-Romagna (Italian Ministry of Health, 2020g).
6	February 24: Minister of Health Ordinance: confinement measures/schools closure in Liguria (Italian Ministry of Health, 2020h).
7	February 25: Ceriscioli (center-left), President of Marche at that time, in contrast with the Government, adopts an Ordinance with confinement measures/school closure (Ordinanza Regione Marche, 2020).
8	February 27: Sala, Mayor of Milan, supports the initiative "*Milano non si ferma*" (ANSA, 2020c); the same for Gori, Mayor of Bergamo, with "*Bergamo non si ferma*" (Eco di Bergamo, 2020a); endorsement of Zingaretti, Democratic Party secretary (Repubblica, 2020f).
9	February 27: Fontana (Lega), President of Lombardia, wears a non-compliant facemask live on TV (L'Espresso, 2020b).
10	February 27-29: Cirio, center-right (Repubblica, 2020g), Zaia, Lega (Orizzontescuola, 2020), Toti, center-right (askanews, 2020), Fedriga, Lega (ANSA, 2020d), and Fugatti, Lega (ANSA, 2020e), Presidents of Piemonte, Veneto, Liguria, Friuli-Venezia Giulia, Trentino, intend to reopen schools on March 2, with the will to go back to normality.
11	February 28-29: Fontana (Lega) and Bonaccini (center-left), President of Lombardia (Il Giorno, 2020) and Emilia-Romagna (Il Resto del Carlino, 2020), want to extent the school closure a week more.
12	February 28: Fontana (Lega), President of Lombardia: "*coronavirus like a little flue*" (Il

	Giornale, 2020).
13	February 29: Zaia (Lega), President of Veneto: "*Chinese people eat alive mices*" (RaiNews, 2020b).
14	March 8: Zaia (Lega), President of Veneto (Repubblica, 2020h), is against the confinement of 3 Veneto Provinces; instead Cirio (center-right), President of Piemonte (ANSA, 2020f) asks for including Piemonte provinces in the red zone.
15	March 10: Fontana and Zaia, respectively President of Lombardia and Veneto (both of Lega), want a 15 days closure of transportation and economic activities (Corriere della Sera, 2020b).
16	March 15: De Luca (center-left), President of Campania, takes measures to fill government gaps (La Stampa, 2020b).
17	March 15: Musumeci and Santelli (center-right), President of Sicilia and Calabria ask for the intervention of the army to stop the people exodus from North to South (Gazzetta del Sud, 2020).
18	March 16: Bonaccini (center-left), President of Emilia-Romagna (Repubblica, 2020i), declares red zone the territory of Medicina municipality.
19	March 22: De Luca (center-left), President of Campania (Il Mattino, 2020), ask the government for drastic measures stopping the exodus of people from South to North Italy.
20	March 21-24: Cirio (center-right), President of Piemonte (Regione.Piemonte, 2020), adopts more drastic measures against coronavirus anticipating the Government; the same does Bonaccini (center-left), President of Emilia-Romagna (Repubblica, 2020j), with regard to the area of Piacenza.
21	March 30: Toti (center-right), President of Liguria, wants to reopen activities after Easter (Genova24, 2020).
22	April 11-12: Zaia (Lega), President of Veneto: "*lockdown doesn't exist anymore*" (Il Messaggero, 2020); activities should be reopened, phase 2 anticipated; instead Cirio (center-right), President of Piemonte, maintains severe measures during all April and beginning of May (RaiNews, 2020c).
23	April 26-29: Bonaccini (center-left), President of Emilia-Romagna, asks for reopening yard works (ANSA, 2020g); Santelli (Repubblica, 2020k), and Toti (Liguriaoggi, 2020), Presidents of Calabria and Liguria (both of center-right), push to speed up reopening.
24	May 10: Zaia (Lega), President of Veneto: "*If the virus is weakening, something artificial there is in the way*" (Il Fatto Quotidiano, 2020g).
25	May 17-18: contrasts between Government and Regional presidents about timing and responsibility to reopen activities; the latter ask for more autonomy in decision-making (Fanpage, 2020b).
26	May 17: De Luca, President of Campania (center-left) doesn't sign agreement of Phase 2 (Corriere della Sera, 2020c).
27	May 30: Toti, President of Liguria (center-right): "*pandemic is slackening off*" (IVG, 2020).
28	June 3: Toti, President of Liguria (center-right): "*Liguria is reopened without restrictions*" (La7, 2020b).
29	June 13: Zaia, President of Veneto (Lega): "*all activities will be reopened next week*" (daily.veronanetwork, 2020).

The campaign saw the endorsement of Nicola Zingaretti, the Democratic Party secretary at that time (Repubblica, 2020f), who caught the COVID-19 disease (QS, 2020b), taking a public aperitif in Milan when he supported the initiative. Attilio Fontana (Lega), President of Lombardia, wore a non-compliant facemask live on TV (February 27; L'Espresso, 2020b), and wanted to extend the school closure (February 28; Il Giorno, 2020); the contrary (February 27-29; schools reopening on March 2) has been asked by Alberto Cirio (center-right; Repubblica, 2020g), Luca Zaia (Lega; Orizzontescuola, 2020), Giovanni Toti (center-right; askanews, 2020), Massimiliano Fedriga (Lega; ANSA, 2020d), and Maurizio Fugatti (Lega, ANSA, 2020e), respectively Presidents of Piemonte, Veneto, Liguria, Friuli-Venezia Giulia, and Trentino Autonomous Province. However, the same day Fontana (February 28) stated that "*coronavirus is like a little flue*" (Il Giornale, 2020). On March 8, Zaia (Repubblica, 2020h), was against the confinement of 3 Veneto Provinces, while Cirio (ANSA, 2020f) requested to include Piemonte provinces in the red zone.

Two days after, Fontana and Zaia took sides for 15 days closure of transportation and economic activities (Corriere della Sera, 2020b), and (March 15) Vincenzo De Luca (center-left, President of Campania) arranged more severe measures to fill government gaps (La Stampa, 2020b). Nello Musumeci and Jole Santelli (center-right), Presidents of Sicilia and Calabria respectively, requested the intervention of the army to stop the people exodus from North to South (March 15; Gazzetta del Sud, 2020), and De Luca solicited drastic provisions on the same events (March 22; Il Mattino, 2020). Usually, after the lockdown declaration, the center-left authorities (Presidents of Regions and Mayors) adjusted their policies in agreement with the government's decisions, except De Luca, who didn't sign the Phase 2 agreement (May 17; Corriere della Sera, 2020c), considered too much permissive. On April 11-12, Zaia declared: "*lockdown doesn't exist anymore*" (Il Messaggero, 2020); activities should have been reopened, and Phase 2 anticipated; instead Cirio maintained severe measures during all April and beginning of May (RaiNews, 2020c). On May 30, Toti was on the Zaia's same page: "*pandemic is slackening off*" (IVG, 2020). Anyway, center-right representatives usually agreed with easing restrictions quickly.

6.6.7 Italian societal organizations principal actions

In general, the entrepreneurs' organizations (Table 30 and Figure 85) tried to obstruct any limitation of economic activities, while trade unions threatened a general strike to safeguard the workers' healthcare. Finally, two agreements between the government, CGIL-CISL-UIL (Italian most representative Trade Unions), Confindustria, and other entrepreneurs' organizations, were signed for the workplaces safety (March 14; Il Sole 24 Ore, 2020b) and indispensable industrial activities to keep open (March 25; Il Fatto Quotidiano, 2020i).

Table 30: Italian societal organizations principal actions (January-June 2020).

	Trade Unions, Entrepreneurs
1	March 8: Valeria Ghezzi, ANEF President of Trentino: "*snow is more powerful than coronavirus*" (Il Dolomiti, 2020a).
2	March 14: agreement between the Government, CGIL-CISL-UIL Trade Unions, and Confindustria on the protocol to be adopted for safety at the workplaces in time of coronavirus (Il Sole 24 Ore, 2020b).
3	March 22: Confindustria contrary to extend factories closure; conflict with trade unions (Il Fatto Quotidiano, 2020h).
4	March 25: Government and CGIL-CISL-UIL Trade Unions sign agreement about indispensable industrial activities to keep open in time of coronavirus (Il Fatto Quotidiano, 2020i).
5	March 25: Italian Ministry of Health and CGIL-CISL-UIL Trade Unions sign agreement on prevention and safety for healthcare personnel (QS, 2020c).
6	April 7: Confindustria Lombardia: impossible to set up red zones in Lombardia and stop production (TPI, 2020e).
7	April 24: agreement Government-Trade Unions-Entrepreneurs for safety/health (Italian Ministry of Health, 2020j).

Table 31: Italian extreme right principal actions (January-June 2020).

	nativist-sovereigntist-COVID-19 deniers-extreme right square protests
1	May 16: far right square protests (Rome) with no-mask crowds (Sky24, 2020c).
2	May 30: nativist-sovereigntist-COVID-19 deniers-far right square protests (Milan and Rome) with no-mask crowds (La Stampa, 2020c).
3	June 2 (afternoon): nativist-sovereigntist-COVID-19 deniers-far right square protests with no-mask crowds (Il Fatto Quotidiano, 2020j).
4	June 6: far right extremists and hardcore football fans make violent square protests in Rome (OPEN, 2020b).

6.6.8 Italian extreme right principal actions

There were protests around the world against the responses given by governmental bodies to the ongoing COVID-19 pandemic. In Italy, the first clashes occurred in May-June 2020, with upsurges in the following Fall (the latter not object of this study).

Nativists, sovereigntists, COVID-19 deniers, with wide infiltrations of neo-fascist organizations, made square protests, sometimes violent, with unauthorized no-mask crowds against the government, held accountable of the hard economic downturn due to COVID-19 pandemic (Table 31 and Figure 85). The social categories severely affected by the crisis belonged mainly to impoverished self-employers, precarious workers, out-of-a-job and previously poor people. Exploiting mistrust, insecurity, fear, and rage, these demonstrations have been also fueled by disinformation, misinformation, and ignorance, in which unfounded conspiracy theories and anti-scientific attitudes rooted deeply. Suffering and inequality grew, above all, among young generations (unemployment rate increase: from 23% to 31% in the period May-June 2020; comparison with the global rate in the same time interval: from 7.8% to 9%; see ISTAT, 2020d). Women benefitted very little of the smart working; often holding part-time and low-income jobs, they supported almost completely home/family caring, and gender equality underwent a step backward (Orizzonti politici, 2020). The new poverty incidence soared from 31% to 45% (Caritas, 2020). Therefore, political progressive forces should be conscious that it is indispensable to suture deep social wounds and neutralize dramatic worsened disparities already present before the pandemic.

6.6.9 Evaluation of the governance parameter in Italy (first phase January - June 2020)

It is possible to say that the COVID-19 crisis management in Italy failed in several directions. A crucial weakness can be identified in the conflicting communication of mixed messages from multiple sources, plus the spread of fake news/misinformation. The scientific community provided contradictory messages contributing to chaos, triggering opposite public reactions. The media reported multiple versions of the COVID-19 events, causing a public polarization between “believers” and “sceptics”.

Formally, the government implemented all the necessary measures against the disease, but these efforts were undermined by a lack of coordination between scientific and governmental messages: a quick and univocal reaction by state powers at all levels (from global to local) missed. After the closure of 10 municipalities of Lodi (February 21) and one of Padua (February 22), a same measure was not taken for other outbreaks blowing up in Bergamo and Brescia. The government imposed with considerable delay (March 8) the quarantine to the entirety of Lombardia

Region, in addition to other fourteen provinces of Piemonte, Veneto, Emilia-Romagna, and Marche.

Furthermore, a leak of information before the official declaration caused chaos, panic, and the exodus to South Italy of thousands of people. Paternalistic attitudes, represented by a simple request of not panicking, promoted opposite reactions.

Finally, conflicts in the government (due to Matteo Renzi), in the Parliament (due to Matteo Salvini and the opposition, asking for elections in a moment of great difficulty), with some regional governors (that decided not to follow the national guidelines), severely undermined the COVID-19 crisis management, increased confusion, and created an image of disorder inside and outside Italy (see also Ruiu, 2020).

However, the management of the 56-day lockdown by the Italian government was a real success, supported by the great majority of the Italians, permitting the temporary decline of the pandemic in May-June 2020.

Table 32: Values of COVID-19 resilience's attributes; governance.

values of the resilience's attributes:	**very poor**	**poor**	**medium**	**good**	**very good**
	1	**2**	**3**	**4**	**5**
governance			*S* (January 2020-June 2020)		

Table 32 gives our evaluation of governance at first glance, with an average score *S* in the period January 2020-June 2020 ($S = 3$).

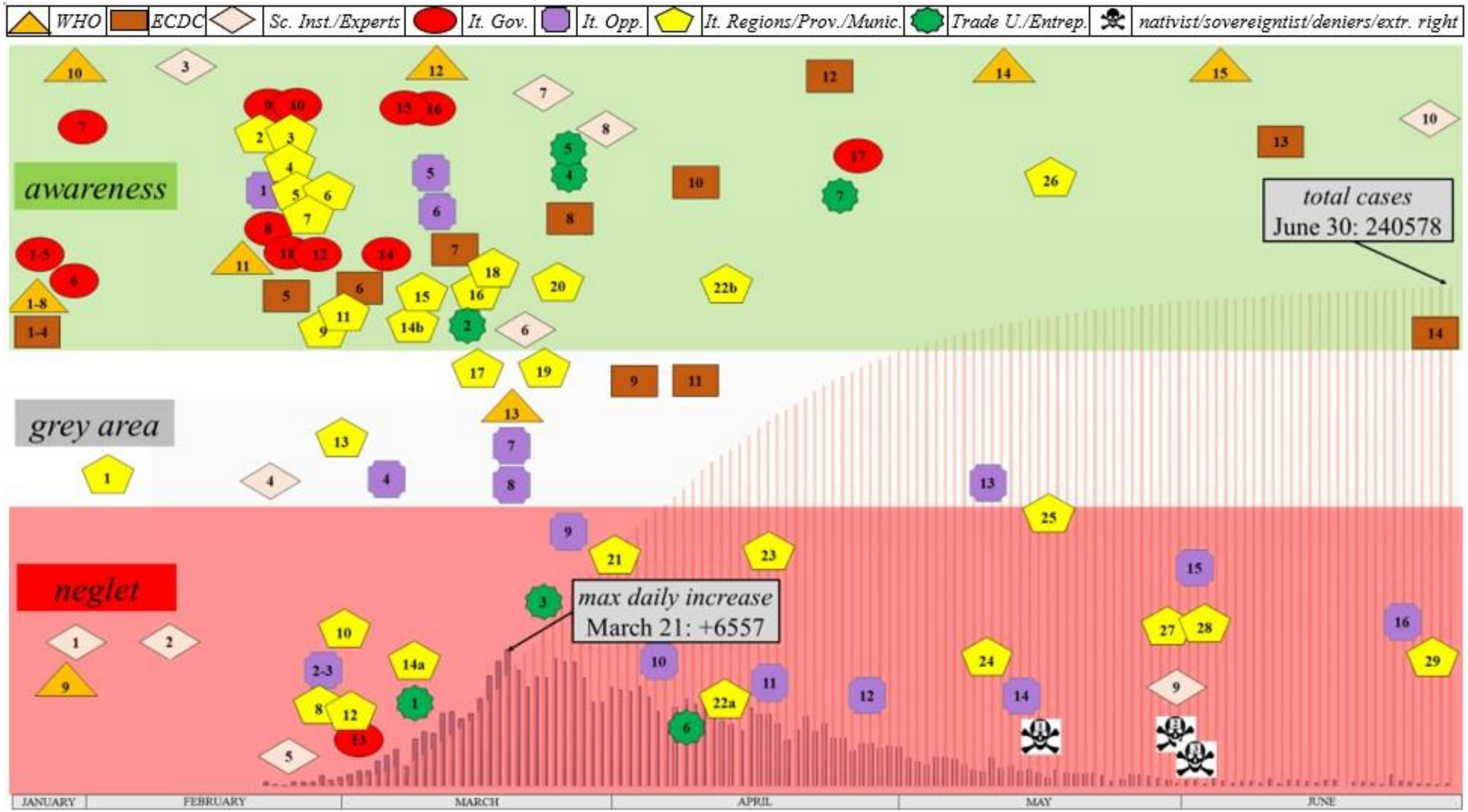


Figure 85: Positions of International/EU Organizations, Italian Scientific Institutions/Experts, Italian Government, Italian Opposition, Italian Regions/Provinces/Municipalities, Italian Trade Unions/Entrepreneurs, nativist/sovereigntist/deniers/extreme right organizations; neglect/grey/awareness areas are purely qualitative in ordinates, but in time sequence (January-June 2020) in abscises; COVID-19 maximum daily increase/total cases are given in the background.

6.7 Anamnesis

6.7.1 Foreword

Critical memory of the experiences of the past is expected to be a necessary tool for interpreting the present and for addressing problems. Therefore, in our analysis, the individual and collective memory of pandemics plays a relevant role.

Among the main viral diseases occurred in the last century (Honigsbaum, 2020), we choose to focus our attention on the Great Influenza Pandemic of 1918-20 (Influenza Encyclopedia, 2020a; CDC, 2020), due to the several important points of contacts with the current COVID-19 infection. These include: worldwide circulation and impact; duration; illness and death toll; social-economic effects. It is worth, accordingly, to remember some crucial aspects of 1918–20 influenza.

6.7.2 The Great Influenza Pandemic of 1918-20 origin and spread

The Great Influenza Pandemic of 1918-20 (caused by the spillover of a new member of the H1N1 family of influenza viruses, with RNA segments of avian origin) was a deadly disease of our recent history (Kolata, 2001; Taubenberger and Reid, 2002; Crosby, 2003; Erkoreka, 2009; Taubenberger et al., 2007; Worobey et al., 2019). Overshadowed by the simultaneous World War I, it is commonly known as the '*Spanish Flu*', because newspapers were free to report its effects only in the nonbelligerent neutral Spain. It is also known as '*Grippe*', in France. It is estimated that this flu killed about 2.5% of those infected, with 21.6 million (lowest estimate; Jordan, 1927, see Table 33), 39.3 million (average estimate; Patterson and Pyle, 1991), and 50 million (highest estimate, Bootsma and Ferguson, 2007) victims from 1918 to 1920 in all the world.

Table 33: Total mortality of 1918 influenza pandemic (source: Jordan, 1927).

North America	1,075,685
South America	327,250
Europe	2,163,303
Asia	15,757,363
Australia and Oceania	965,254
Africa and Madagascar	1,353,428
Total	***21,642,283***

The origin of the infection is still disputed. Some medical historians and epidemiologists have proposed that this pandemic started in Asia, and then spread to Europe when the British government mobilized tens of thousands of Chinese workers for service (Hannoun, 2002; Langford, 2005; Humphries, 2014; Shortridge, 1997). For other researchers there is no evidence of this fact (Reid et al., 1999; Shanks, 2016). Anyway, outbreaks, sometimes of unproven nature, usually occurred in military facilities (listed below) and ships, following the great movements of recruits or troops going/coming to/from the war front, in crowded and scarce hygienic conditions. Jordan (1927), Crosby (2003), and Barry (2004a,b) considered the most likely outbreak sites the following:

i) Funston Army Camp (Figure 86, a subdivision of the Fort Riley military reservation near Junction City, Kansas, USA; also detention camp for conscientious objectors), with many soldiers coming from the Haskell County (Northwestern Kansas: here a suspicious disease was observed by the local doctor Loring Miner since January 1918), where farmers lived in close proximity to domestic animals; the first conventional case (the army cook Albert Gitchell) occurred on 4 March 1918, followed by hundreds of sick people with '*knock-me-down fever*', headache, backache, and heavy lobar pneumonia (until April-May); in general, all the symptoms were evident and several soldiers died (Jordan, 1927; Crosby, 2003; Cody, 2010);

ii) Camp Devens (Figure 87, another overcrowded military facility at Ayer, near Boston, Massachusetts, USA); approximately 14000 infected, over 500 casualties, in the acme 100 deaths per day; influenza arrived completely unexpected at the beginning of September 1918 and lasted at least 4 weeks; characterized by a very aggressive high viscous bronchopneumonia, with impressive cyanosis ('*blue flu*'), dyspnea, and death coming in a few hours; some nurses and doctors died here as well; William Henry Welch (the most distinguished scientist at that time; Welch, 1920; Flexner and Flexner, 1993; Crosby, 2003; Barry, 2004a,b), sent there to investigate with his team, gave strict recommendations to fight the infection, but the machinery of the army continued to function; men, possibly infected, left Devens to other camps (Roy, 1918; Wolbach and Frothingham, 1923; Vaughan, 1926; Crosby, 2003; Fargey, 2019);

iii) the virus moved (September 13, 1918) to Camp Upton, Long Island, the New York port of embarkation for France, housing troops sailing with ships overseas; the facility was precautionary closed after 6131 influenza cases within 40 days, with some patients (with cyanotic or ashy faces) developing quickly heavy pneumonia; the infection struck Camp Merritt (New Jersey) on 16 September 1918, and it took a few days for doctors there to realize that the new flu cases were of far greater severity (265 of 999 pneumonia patients died for a mortality rate of about 26 percent); a day after Camp Meade (Maryland) was hit (from 11,400 to 14,280 illnesses, 607 to 763 deaths, and fatality rates of 4.4 percent to 6.7 percent); the virus arrived at Camp McClellan (about six miles from both Anniston and Jacksonville, Alabama) on 20 September, and the height of the epidemic there was between 10 and 20 October (over 4,900 cases of influenza and pneumonia, and about 228 reported deaths); on September 21 the virus reached Camp Grant (Rockford, Illinois, USA), with a high death rate (1060 deaths among over 10700 flu cases in a population of 40000); on September 23 Camp Greenleaf (Fort Oglethorpe, Georgia) where 325 of 999 pneumonia patients died; on September 26, Camp Cody (Deming, New Mexico, USA), with 165 cases of lobar pneumonia and 2 cases of bronchopneumonia, placed in quarantine until November; on October 8, Camp Fremont (Palo Alto, California, USA), with approximately 2418 cases of acute respiratory disease with temperatures during the next seven weeks; on October 9 Camp Lewis (Tacoma, Washington), with a maximum of about 3024 cases (Byerly, 2010; Soper, 1918; Fargey, 2019);

iv) after jumping camp to camp, then into cities, the infection probably travelled with ships crowded with soldiers (many cases occurred during the sea crossing) from the United States to Brest (France, the largest port of disembarkation for American troops), considered the first outbreak in Europe.

Figure 86: Emergency hospital at Funston Army Camp, Kansas, USA (Source: NMHM, 2020a).

Figure 87: Red Cross volunteers assemble gauze masks at Camp Devens (Source: FDM, 2020).

Figure 88: Aerial view of the Ètaples hospital after bombing (Source: IWM, 2020).

Figure 89: Ward 16 interior of the Cambridge Hospital at Aldershot, c.1912 (Source: FAMM, 2020).

An alternative hypothesis (MacNeal, 1919; Bresalier, 2011; Hammond, 2017; Oxford, 2001; Oxford et al., 2002; Oxford et al., 2005; Oxford et al., 2006; Oxford and Gill, 2019) identifies an earlier source of the disease in two British Army facilities:

v) during the cold winter of 1917 at Ètaples (Figure 88, Northern France, Department of Pas-de-Calais, 20 miles south of Boulogne on the edge of the sea, a British Army Camp for the recruit reception and training, with a space of 12 km2), a 'purulent bronchitis' erupted; at the beginning, it seemed an already known lobar pneumonia, but it has been followed by expectoration, heavy lack of air, pulmonary block, cyanosis ('blue flu') and dyspnea; until February 1918, approximately one hundred and half soldiers were killed, among the 100,000 soldiers housed in the tents or temporary wooden barracks of this camp; the mixture of crowded people, domestic and wild animals and 24 types of war gasses, which were massively used at the war fronts (many of which were mutagenic) might have been the cause of the appearance of the first outbreak of the epidemic between December 1916 and March 1917 (Gill and Putkowski, 1997);

vi) on September 1917, similar symptoms and mortality rates were experienced at the Cambridge Hospital at Aldershot (Figure 89, Hampshire, UK, place defined the ‘Home of the British Army’), with mortality rates of 25-50% (Abrahams et al., 1917 and 1919; Bresalier, 2011); physicians and pathologists described thousands of cases where cyanosis was a sign of imminent death and the patient, suffering acute respiratory damage, became the iconic symbol of the epidemic.

Patterson and Pyle (1991) reported the geographic spread of the 1918 influenza with USA origin (Figure 90). The spring 1918 first wave was relatively mild and the casualties (including those at Camp Funston and San Quentin Prison, San Francisco, California, where ¼ of the prisoners fell sick) ascribed to uncomplicated cases of pneumonia, a perfectly normal way to die before the advent of sulfa drugs and penicillin (Crosby, 2003). After a relatively calm summer, in September (second wave) the infection struck the cited U.S. Army Camps (Devens and others) with extreme virulence, often anticipated by breath-borne measles and pneumonia. The second wave reached also the U.S. Army Camp Hospital No. 43 (Gièvres, Central France, in late October 1918, where patients developed pneumonia and cyanosis, with many deaths especially among African American soldiers; Fargey, 2019) and No. 45 (Aix-les-Bains, France, where in the Fall of the year, influenza and pneumonia made its appearance and necessitated the erection of several wooden barracks to accommodate the large increase of hospital admissions; Figure 91; source: NIH, 2020).

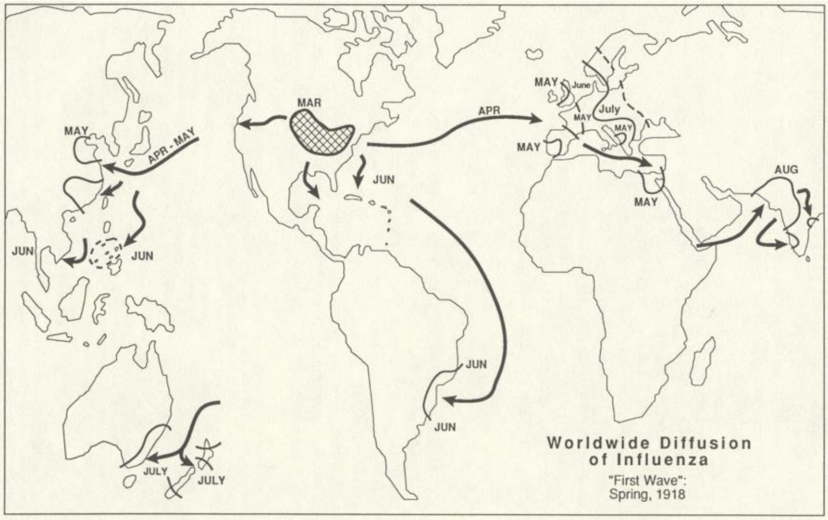


Figure 90: Worldwide diffusion of the influenza 1918 first wave (Source: Patterson and Pyle, 1991).

Figure 91: Influenza Ward No. 1, U.S. Army Camp Hospital No. 45, Aix-les-Bains, France (Source: NIH, 2020).

Three explosions had already occurred in the latter part of August 1918 in the same week in three port cities thousands of miles apart: Freetown, Sierra Leone; Brest, France; and Boston, Massachusetts (Crosby, 2003).

Starting from localized outbreaks, an estimated 85,000 citizens fell sick on the East Coast.

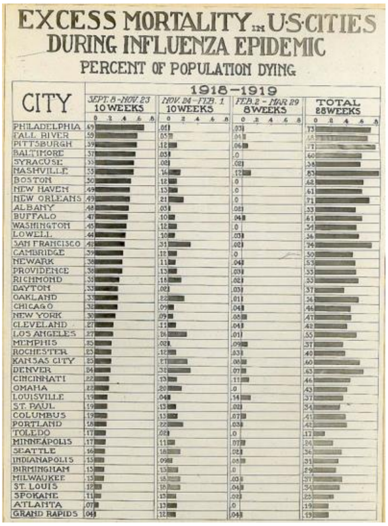


Figure 92: Influenza mortality in 44 U.S. cities (source: NMHM, 2020b).

Figure 93: A photo of mass graves in Philadelphia, August 1918-March 1919 (source: HML, 2020).

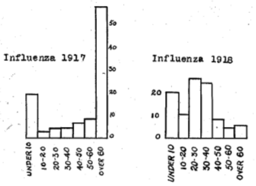


Figure 94a: U.S. influenza deaths, age group % (Jordan, 1927)

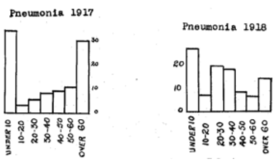


Figure 94b: U.S. pneumonia deaths, age group % (Jordan, 1927).

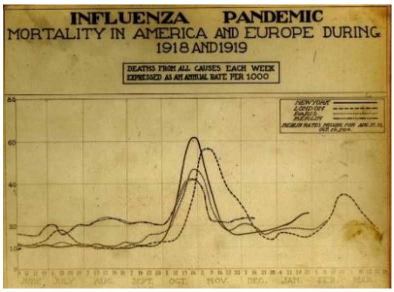


Figure 95: Mortality 1918-19 in America and Europe (source: NMHM, 2020c).

Philadelphia was one of the most affected cities: the illness spread among people, also due to the Philadelphia Liberty Loans Parade on 28 September

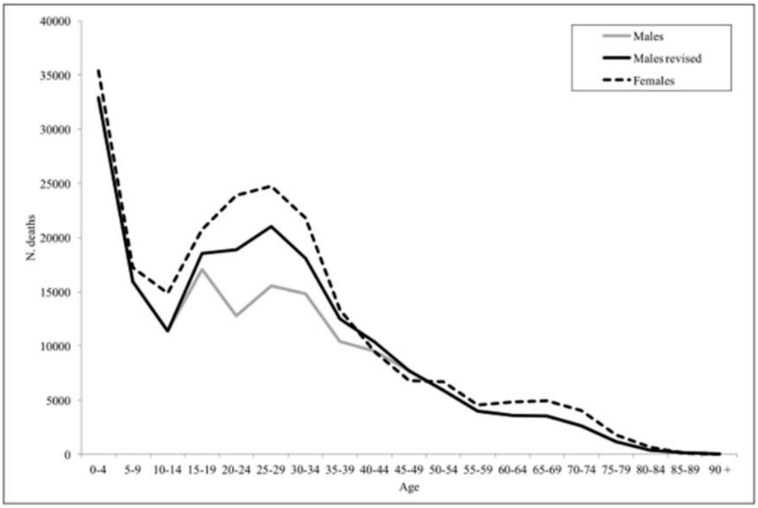
1918; the American Red Cross supplied 54,038 flu masks, 20,444 sheets, 8,919 towels, 605 pairs of pajamas; the order closing public places cost the theatres, motion picture houses, and hotels 2 million dollars and the saloons $350,000; the number of passengers using the streetcars dropped off so much that the transit company lost a quarter of a million dollars (Crosby, 2003); influenza permeated every aspect of life, even plays of young girls, who invented a limerick song jumping rope: "*I had a little bird/And its name was Enza/I opened the window/And in-flew-Enza/*" (Source: Lynch, 1998).

In October-November, the infection developed into a deadly global pandemic spreading to all parts of the United States with a higher-than-expected mortality rate for young adults (Figures 92-94), and the world (Figure 95). A milder third wave occurred during the initial months of 1919, while the fourth and final wave spread attenuated during the first months of 1920 (Erkoreka, 2009). However, observations in Europe and the U.S. differ considerably. In Europe, only one Autumn wave was seen, whereas many U.S. cities saw two peaks in mortality incidence spaced by only a few weeks. Also, far greater variation in mortality was seen among U.S. cities than, for instance, in the United Kingdom (Bootsma and Ferguson, 2007).

6.7.3 The Great Influenza Pandemic of 1918–20 in Italy

In Italy (with 36 million inhabitants at that time), the pandemic was particularly heavy, with approximately 466,000 casualties (Fornasin et al., 2018), one of the highest mortality rate in Europe during 11 months of disease (first milder wave: Spring 1918; second malignant wave: Autumn 1918; third wave: Winter 1919). The consequences were higher in the civil population than the Army, which benefited from better prophylaxis and hygiene (confinement and quarantine, above all), despite the difficult conditions faced at the military front lines. The disease struck mainly young healthy individuals (Figure 96; source: Fornasin et al., 2018; and references therein) and the life expectancy crumbled to 30 years for men and 32 for women (Tognotti, 2015; Spinney, 2019). Statistic data are very inhomogeneous and incomplete. For example, the city of Bologna, in spite of the non-excessive gravity of the disease experienced there with respect to other Italian areas, showed evident peaks in deaths and burials due to influenza (Figure 97; source: Sabbatani and Fiorino, 2007; and references therein). With regard to non-pharmaceutical interventions (*NPIs*; i.e.

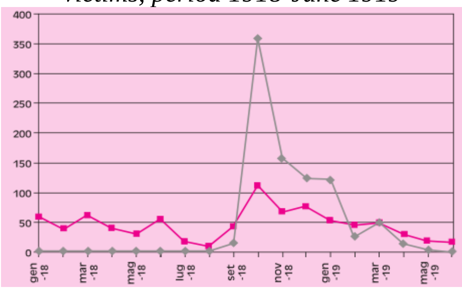
voluntary quarantine of infected households, closure of schools, bans on public gatherings, and other measures) to decrease transmission, the Bologna authorities missed specific provisions (Sabbatani and Fiorino, 2007; and references therein). However, after 22 August 1918, the Italian Ministry of Interior (with the jurisdiction on the public health too) had already established some regulations devoted to identify outbreaks, avoid crowds, clean streets and buildings; other measures followed in October: closure of schools, churches and theatres; suspension of public meetings; prohibition of visit to infected persons, funerals and religious ceremonies, train travelling; embracing, kissing, and handshaking were discouraged, while disinfection recommended, but with shop stockpiles running out and prices skyrocketing. Doctors and nurses became insufficient, because many of them were called to the front line. Although last-year medical students and general practitioners gave a commendable tireless service, many infirms died at home without any treatment. Part of the healthcare personnel became infected and died. Gravediggers lacked, and soldiers were mobilized for transportation and burial. People complained about the obscure language and conflicting opinions among the scientists, often underlined by ironic newspaper comments (Tognotti, 2015).



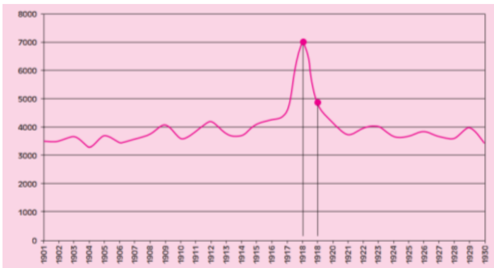
Source: Fornasin et al., 2018, and references therein
Figure 96: Estimation of 1918 influenza deaths in Italy, for each age class.

City of Bologna, Italy

victims, period 1918-June 1919



burials, period 1900-1930



Source: Sabbatani and Fiorino 2007, and references therein

Figure 97a: Victims due to influenza (grey line) and croupous pneumonia (red line); data from local archives.

Figure 97b: Burials at the Cemetery of Certosa; data from local archives.

6.7.4 The Preventative measures in the United States and Europe

The public health authorities in both the United States and Europe took up fundamental measures to control the influenza pandemic, aimed to reduce the transmission of the pathogen through the air by preventing contact. U.S. cities that introduced measures early in their epidemics achieved moderate but significant reductions in overall mortality. (Bootsma and Ferguson, 2007). Authoritative, preventative, and prophylaxis provisions were commonly taken, but varying a lot in their rigidity with the disease severity, local regulations, and social acceptance.

i) The authoritative provisions were above all the controversial and imperative closure of many public institutions and ban of public gatherings, with the avoidance of crowded meetings during the time of an epidemic, favoring good ventilation and fresh air; saloons, dance halls, and cinemas were closed, public funerals prohibited; churches were allowed to remain open with minimum services and intimacy reduced; timetables of stores and factories, people flowing to work were regulated, street cars ventilated and cleaned (Figure 98; source: Flashback.com, 2020); the most frequently debated and not widely accepted measure was the closure of the schools, believed useful but often occurring too late, when most students and teachers fell sick; it was less effective in large urban metropolises than in rural centers, where the school represented the point of dissemination of the infectious agent; the more restrictive controls were quarantines and isolation of the ill, requiring a sacrifice of individual liberty; only severe cases were to be hospitalized while mild influenza patients remained at home (Siegel, 2020).

Source: Flashback.com, 2020
Figure 98: A man sprays an open top bus with an “anti-flu spray”; public transport was suspected of spreading disease.

Source: Influenza Encyclopedia, 2020b
Figure 99: St. Louis, Missouri; The Motor Corps of St. Louis, chapter of the American Red Cross,
on ambulance duty during the influenza epidemic, October 1918.

ii) The preventative way to break the infection spread was droplet and sputum control, avoiding the virus transfer occurring by the contamination of the hands and common eating/drinking utensils; education programs and publicity on respiratory hygiene (about the dangers of coughing, sneezing and the careless disposal of nasal discharges), and hand-washing took place with specific programmes and "*flu posters*"; patients with complications such as pneumonia were kept isolated from the rest, with sheets hung between the beds; key prevention aspects were disinfection and sterilization with antiseptic solutions of public places, hospital wards, conveyance; the use of gauze facemasks was widely adopted in hospitals among health care workers (Figure 99; source: Influenza Encyclopedia, 2020b), but also extended to the entire population; mask wearing often led to a rapid decline in the number of influenza cases; citizens of San Francisco (California) were reminded to don their masks through a popular rhyme of the day: "*Obey the laws/And wear the gauze/Protect your jaws/From septic paws/*" (Siegel, 2020).

iii) Prophylaxis meant efforts to increase the natural resistance to the illness, observing general hygiene, proper rest, good nourishment and fresh air; a more scientific but controversial method was gargling and rinsing out of the nasopharynx with antiseptic solution, with little proof of efficacy (Siegel, 2020).

Masks with layers of gauze and cotton to filter the air were developed for the first time by the Malayan Chinese doctor Wu Lien-teh (nominated for the Nobel Prize in 1935) against the pneumonic plague pandemic occurred in Manchuria and Mongolia in 1910, which killed 60,000 lives; then the mask, with Wu overseeing, was widely produced and distributed; therefore, it became available for the later pandemics (Lee et al., 2014; Ma and Li, 2016; NewScientist.com, 2021.

Since the cause of the 1918 influenza was unknown until the 1930s, when isolation of human and swine influenza viruses occurred (Taubenberger et al., 2007), and effective vaccines could be developed, vaccination could not be proposed as a possible solution. Mitigation strategy[9] (Table 4) was adopted by some US cities in 1918, and by the world more generally in the 1957, 1968 and 2009 influenza pandemics, by using non-pharmaceutical interventions (*NPIs*). Suitably, *NPIs* effectiveness was evident almost everywhere in 1918-20. As regard to the USA, the pandemic total excess deaths and rate of increase varied widely, depending on the choice and timing of *NPIs* implementation. For example, the first cases of disease among civilians in Philadelphia were reported on September 17, 1918, but authorities downplayed their significance and allowed large public gatherings (as the parade already cited before). School closures, bans on public gatherings, and other social distancing interventions were not implemented until October 3, when disease spread had already begun to overwhelm local medical and public health resources. In fact, aggressive early intervention was significantly associated with a lower peak of excess mortality. Comparisons across U.S. cities show that the first peak in excess of Pneumonia&Influenza death rates was 50% lower in cities that implemented multiple *NPIs* than in cities that made such interventions late or not at all (Hatckett et al., 2007).

An interesting sequence of events regarding *NPIs* provisions occurred at San Francisco in California, with the fundamental actions of Doctor William Hassler, chief of the city's Board of Health. First, he immediately persuaded the commandant of the Navy Training Station on Yerba Buena Island to impose a quarantine to all the naval installations in the Bay area 21 September 1918). In the early days of the pandemic, doctors, nurses, and Red Cross workers put on masks, and (October 18) Hassler recommended that all store clerks and barbers wear masks while on the job.

Source: Dublin Heritage Park Museum, 2020
Figure 100: Unknown family from Dublin, California, with facemasks, including the cat.

Source: Theunion.com, 2020
Figure 101: In Nevada City and Grass Valley, as well as in many other communities, failure to wear a mask during the 1918 Spanish Influenza could result in imprisonment and a large fine.

Soon after, the Board of Supervisors (San Francisco's equivalent of a city council) voted the following ordinance, fifteen to zero, that everyone in the city be ordered to wear a mask: "*Every person appearing on the public streets, in any public place, or in any assemblage of persons or in any place where two or more persons are congregated, except in homes where only two members of the family are present, and every person engaged in the sale, handling or distribution of foodstuffs or wearing apparel shall wear a mask or covering except when partaking of meals, over the nose and mouth, consisting of four-ply materials known as butter-cloth or fine mesh gauze*". A full-page (October 22) appeared in the Chronicle in which the Mayor, Board of Health, Red Cross, Postal Department, Chamber of Commerce, Labor Council, and other organizations proclaimed: "*WEAR A MASK and Save Your life!*"; and: a gauze mask "*is ninety-nine percent Proof against Influenza*". Red Cross dispensed in the city 100,000 masks by October 26, and in a few days the great majority of San Franciscans donned the masks (including pets!, Figure 100; source: Dublin Heritage Park Museum, 2020), except the infamous slackers (Figure 101; source: Theunion.com, 2020). Anyway, masks were uncomfortable, inconvenient, fogged up one's spectacles, and, claimed some irate citizens, brought on attacks of neuralgia. Others of a more thoughtful cast called masks a humiliating and unconstitutional interference with personal liberty. When the news of the WWI Armistice (11 November 1918) broke at San Francisco, thirty thousand people (with mask on) gathered at the Civic Center and deliriously paraded down Market Street to the Ferry Building and back. However, an increasing number of people slipped their masks down and the police arrested hundreds whom the courts subjected to punishments ranging from a five-dollar fine to thirty days in jail (Crosby, 2003).

Within a few days, a rise in flu cases occurred. Mayor James Rolph incited for the voluntary readoption of masks, but ninety percent of San Franciscans ignored the call, considering absurd the use of mask in the open air, while its taking off was allowed in crowded restaurants to eat. Masking opponents grew, including Christian Scientists and civil libertarians. They considered the mask as subversive of personal liberty and constitutional rights. Moreover, attacks by medical professionals were most damaging to the pro-mask forces. Masking opponents gathered together and founded the Anti-Mask League, which proved to be composed of public-spirited citizens, skeptical physicians, and fanatics. Therefore, the question of compulsory remasking became a political hot potato. The Board of Health recommendation ordered all teachers and students in the public schools to wear facemasks again. But still frightened parents kept hundreds of children home. By the end of January 1919, another 16,000 cases had been reported, and further 1,453 had died of flu and pneumonia. Neither the morbidity nor the mortality rate declined to normal until the following spring (Crosby, 2003).

This overview points some amazing historic recurrences between COVID-19 and 1918 Influenza. Despite this, however, the memory of the latter disappeared almost completely in our contemporary culture, and undeniable analogies missed any in-depth analysis. During the present pandemic, similar problems have been faced as if it were astonishingly the first time, leading to theoretical incompetence, societal unpreparedness, and political ineptitude. Anamnesis represents the collective medical history, intertwines wisdom and experience, but it is often left behind.

Historical archival analysis of 43 cities in the 1918-19 flu pandemic shows a strong association between lockdowns and delayed or reduced peak mortality rates, as well as reduced cumulative deaths. However, large resurgences after strong, temporary social distancing were detected in the U.S. both after the flu and COVID-19 pandemics (Hatchett et al., 2007; Kissler et al., 2020; Markel et al., 2007; Melnick and Ioannidis, 2020).

Since modern *NPIs* were adopted over a century ago during the 1918-1919 flu pandemic, much of the public debate remained almost unchanged, centering on the *NPIs* efficacy and burdensomeness, and their potential for broader effects on morale and economic stability (Kantor and Kantor, 2020).

6.7.5 Evaluation of the anamnesis parameter in Italy (first phase January - June 2020)

The memory of the previous “Spanish Flu” pandemic in Italy was very scarce, except a few exceptions among experts and media, that retrieved that far experience; in fact, common people had completely forgotten it, the sufferance of their progenitors, and the identical questions faced more than a century ago about hygiene and confinement measures, with a surprising resurgence of debates regarding the facemask use and its effectiveness.

Table 34: Values of COVID-19 resilience's attributes; anamnesis.

values of the resilience's attributes:	very poor	poor	medium	good	very good
	1	**2**	**3**	**4**	**5**
anamnesis		*S* (January 2020-June 2020)			

Table 34 gives our evaluation of anamnesis at first glance, with a unique score *S* in the period January 2020-June 2020 (*S* = 2).

7. Resilience final score in Italy (first phase, January - June 2020)

All the outputs found in the previous Sections about the resilience's attributes are reported in Table 35. The Global Resilience Index (GRI, defined in Section 1) overall value is 2.50, i.e. between poor (2.0) and medium (3.0), but far from very good (5.0). Of course, this evaluation is purely indicative, but it can help to roughly quantify the Italy's resilience (weighted on its selected attributes) during the COVID-19 pandemic in the difficult period between January and June 2020. It is interesting to see that the healthcare system's response (*safety* and *robustness*) has been generally weak especially at the beginning of the outbreak, due to institutional International and National drawbacks, but also to intrinsic vulnerability aggravated over time, nevertheless the commendable efforts of the entire personnel. Furthermore, *anamnesis* and *sustainability* resulted dramatically low, while *adaptive capacity* and *governance* showed a little bit better results, mainly due to the lockdown phase and people's behavior during the confinement.

Table 35: Values of COVID-19 resilience's attributes.

resilience's attributes:	*safety*	*robustness*	*adaptive capacity*	*sustainability*	*governance*	*anamnesis*
values	2.5	2.5	3.0	2.0	3.0	2.0
TOTAL GRI	**2.50**					

Unpreparedness (a non-updated pandemic plan, almost forgotten before the COVID-19 crisis), inexperience (the absence of serious outbreaks in recent years), and inadequate timing (delayed decisions between February and March 2020) were evident.

Italy (as many other Western countries) passed from denial (‘*it is not truly happening’*), to normalization of the risk (“*it will not happen here”*), under-reaction (“*we must do something to show that we are doing something*”), and finally to recognition and reframing (“*it is here, and it is our problem!*”), when effective responses in line with prevailing epidemiological orthodoxy were needed (quotes from Capano, 2020). Other relevant factors were the conflicts between central and regional/local powers and the radicalization of the political clash between the government and the opposition. Conversely, other successful strategies were applied in countries such South Korea, Hong Kong, Taiwan, Australia and New Zealand, showing that effective alternatives were possible.

8. Conclusions

In Italy, the emergency caused by the COVID-19 outbreak is going managing by the Department of Civil Protection, involved in the response to catastrophes usually with good performances. Italy is a country highly prone to natural and human-made hazards.

Worldwide these hazards are processes occurring in the biosphere giving rise to a damaging event (earthquake, tsunami, volcano eruption, landslide, flood, hurricane, extreme wind and snow, storm surge, sea level growth, coastal erosion, salt wedge intrusion, etc.). Also climate change effects characterize some of them. Moreover, wild/human-induced fires, impacts, accidental releases of toxic substances, post-disaster diseases, and, last but not least, great pandemics should be included, the latter with a certain degree of co-occurrence with another crisis; in fact, as example, spreading COVID-19 started disrupting flood response in Japan, Canada, and Pacific countries (Ishiwatari et al., 2020).

In this framework, the accomplishment of an effective pre- and post-disaster risk management is a crucial tool, in order to minimize impacts, implement potent policies and coping capacities of the society or individuals, managing the multifaceted nature of risk, realizing integrated hazard models and adopting appropriate governance (Indirli, 2007). Therefore, it is urgent: i) to develop and deploy the concept of multi-hazard (past/future) disaster scenarios; ii) to evaluate the system overall resilience; iii) to carry out effective actions regarding risk mitigation (tightly interlaced to communication, dissemination, exploitation activities), aimed at increasing consciousness about disasters; iv) to create the best conditions for understanding, exchanging, training, applying protection and prevention measures.

On the contrary, the Italian performance against COVID-19 represents an example of "*un-resilience*", a situation where *emergency-after-disaster* replaces *prevention-before-disaster*. Such approach has been already seen in the case of earthquakes, for example. Here, the seismic assessment and maps are still based on *PSHA* (Probabilistic Seismic Hazard Assessment), an unsatisfactory methodology deeply rooted in practice even in Italy, because it underestimates the earthquake magnitude, while the more updated *NDSHA* (Neo-Deterministic Seismic Hazard Assessment) proved accurate and reliable, also providing an intermediate-term middle-range earthquake prediction (Romanelli, Altin and Indirli, 2021).

Lack of resilience is therefore a tragedy itself, considering the fact that big crises are hitting the whole world more and more frequently and hardely, intermingling political, economic, social, technological, regulatory, and environmental issues. In this context, the COVID-19 pandemic impacted every aspect of our existence, not only the health and wellbeing of the people and planet. This pandemic is also calling into question some assumptions of the democratic societies. *In primis*, a renovated request of governments' intervention in citizen's lives has been claimed to succeed in defending against the pandemic in the thin boundary between saving human lives *versus* economy crashing. Moreover, the adoption of authoritative big data to trace people is going to be accepted as a common practice. On the other hand, barriers have raised: among people for health protection (social distancing, mask usage); within countries with border closures. A new intergenerational dynamic is reversing the current ethical view, where adults must care for next generations' future (i.e. concerning adoption of sustainable attitudes). Due to the COVID-19 threat, in fact, it is the younger ones who are claimed to a responsible behavior to protect the fragile life of the aged ones (see also Krastev, 2020).

We wish that lessons learned from COVID-19 pandemic would push governments and citizens to be better prepared against the emergencies of the future, many of which related to climate changes. A proactive action from public health agencies is required to protect populations, adopting a sustainable behavior in time of global warming and COVID-19 pandemic in all the human activities. Smart industries and agriculture, air quality improvement, access to clean water, propoer waste generation, management and recycling, and halting biodiversity loss are objectives strictly linked to the healthcare enhancement worldwide (OECD, 2020; Sheenan and Fox, 2020; Van Bodegom and Koopmanschap, 2020). Finally, the ‘human-nature’ dichotomy of the Anthropocene era, emphasized by the COVID-19 crisis, should be tackled with great resolution, in order to avoid a dangerous disruption in the near future (Zabaniotou, 2020).

We have really short time to operate effective choices and COVID-19 has been a hard test. Indeed, in this analysis come again the fork (Indirli, 2019) between ‘engineering resilience’ (*homeostatic*) and ‘ecological resilience’ (*autopoietic*) we described at the starting point of this work: will the humanity be able to govern the next changes or shall withstand a new mass extinction, leading to a drastic collapse of the Earth biodiversity? Our analysis focused on the pandemic outbreak that is still ongoing, not yet resolved and expected to be long and complex. Therefore, it is not possible, in this moment, to provide decisive answers to this question. However, we believe we have identified useful tools to evaluate the system's resilience to the present crisis and be prepared for possible future ones. It will be interesting to apply our methodology to the subsequent COVID-19 phases, to evaluate the effectiveness of the measures adopted, including the impact of the vaccination campaign.

Notes

[1] The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the pathogen of the COVID-19 disease.

[2] Italian population data have been taken from ISTAT, 2020b; ICUs data from 2010 to 2018 have been taken from Ministero della Salute, 2010-2018a-b; ICUs data from 2019 to 9 October 2020 have been taken from: AOGOI, 2020; TPI, 2020h; Sky24, 2020a,b; Today.it, 2020. ICUs peak data (January - June 2020) have been taken from: DPC, 2020b**.** Data about the Italian SSN personnel have been taken from: Ministero della Salute, 2010; Ministero della Salute, 2011; Ministero della Salute, 2012; Ministero della Salute, 2013; Ministero della Salute, 2016; Ministero della Salute, 2017; years 2014 and 2015 are missing. Data of hospital beds from 2010 to 2018 have been taken from Ministero della Salute, 2010-2018a-b.

[3] Trigger or cluster-based approach; this methodology is based on the identification of a smaller group of targeted “high risk” individuals, on which detailed evaluations are conducted; it posits that the explosive increase in infected persons is a result of the high transmissibility of certain infected individuals, forming a cluster; they appear from these clusters to form more clusters and infect many others; each cluster is tracked to the original infection source and persons with high transmissibility are isolated to prevent the spread of infection; for this reason, pinpoint testing is carried out and broad testing of the population is not required; the cluster-based approach is conditioned on an environment in which there are only a few infected persons and clusters are detectable at an early stage.

[4] The indicator for Japan is an incidence rate of ≤0.5 cumulative infections per 100,000 people in the past week; in South Korea, the indicators are those of Note [5];

[5] In South Korea, the indicators are based on the three-level physical distancing scheme: Level 1 applies if number of daily new cases is <50; Level 2 for 50-100 cases; Level 3 for >100 cases.

[6] Four-level alert system;

Alert Level 1: travel restrictions are introduced; national case and contact management guidelines are implemented and communication campaigns are launched (e.g. promotion of hand and respiratory hygiene, isolation and testing if symptomatic); government COVID-19 income support and debt relief is initially established;

Alert Level 2: physical distancing is enforced, additional precautions are encouraged for higher-risk groups (e.g. people aged >70 years) when leaving home, and specific gatherings (e.g. weddings) are permitted if no more than 100 people;

Alert Level 3: population is asked to stay within so-called bubbles (comprising household close contacts) that can include additional support (e.g. carers) and encouraged to work from home, businesses must not physically interact with public, public venues are closed, no gatherings of more than ten people are allowed, telehealth services are encouraged, and only essential inter-regional travel is permitted;

Alert Level 4: population is required to stay at home except for essential reasons (e.g. short periods of exercise), businesses are closed unless offering essential services (e.g. supermarkets), educational facilities and public venues are closed, and health-care services are reprioritized; a communication wellbeing campaign entitled Getting Through Together is launched.

[7] In Germany, the indicators used are R and 7-day incidence rate per 100,000 inhabitants.

[8] Herd immunity occurs when a large section of the population (generally between 50% and 90%) becomes immune to a disease or virus, therefore stopping its spread. This occurs when people have enough antibodies to repel the virus, either through having been exposed to the virus and survived, or through vaccination (Habib, 2020). When most of a population is immune to an infectious disease, this provides indirect protection - herd immunity - to those who are not immune to the disease by acting as a bulwark against further population infection surges. This is how vaccines can be effective without 100% population coverage. In the case of SARS-CoV-2, with its 'R' number appearing to be around 3, epidemiologists had estimated that about 70% of the population attaining immunity should be enough to achieve herd immunity. This can happen when a population gets infected naturally or after there is a formal vaccination programme in place (Orlowski and Goldsmith 2020).

[9]Mitigation strategy (applying partly-voluntary measures with the use of *NPIs*) focuses on slowing but not necessarily stopping the epidemic spread by reducing the reproduction number R_0 not mandatorily below the threshold of 1, trying to avoid healthcare overwhelming, and protect those most at risk. It consists in limiting isolation to groups most at risk of developing severe symptoms and letting the virus infect large sections of the remaining population. Mitigation will never be able to completely protect those at risk from severe disease or death and the resulting mortality may therefore still be high. It is also irreversible: after the virus has spread widely, isolation will not be as effective as it would have been in the early stages (Ferguson et al., 2020).

[10]Suppression strategy aims to reverse epidemic growth, reducing the reproduction number R_0 below the threshold of 1 and hence to decrease case numbers to low levels and maintaining that situation indefinitely, as long as the virus is circulating in the human

population, or until a vaccine becomes available. Suppression will require a combination of social distancing of the entire population, home isolation of cases, household quarantine of their family members, and closures of schools and universities. It lead to break the chain of contamination, stop the outbreak earlier, and minimize the number of cases (Ferguson et al., 2020).

[11]In epidemiology the basic reproduction number R_0 of an infection defined as the average number of secondary infections caused by a single infected individual in a completely susceptible population; this definition assumes that no other individuals are infected or immunized (naturally or through vaccination); R_0 is a dimensionless number and not a rate. The effective reproduction number R (usually written R_t [t for time], sometimes R_e) is defined as the average number of secondary infections caused by a single infected individual in the population after there is some immunity or interventions have been put in place (Wikipedia, 2020c; Kissler et al., 2020.).

[12]Scale of lockdown phases in Argentina:

Phase 1: Strict lockdown. Just essential services allowed, the rest of activities are banned; 10% population mobility; doubling rate less to 5 days without geographical segmentation.

Phase 2: Administrated lockdown. Allowances require authorizations; national bans, up to 25% of population mobility allowed; doubling rate 5–15 days; national exceptions.

Phase 3: Geographical segmentation. Allowances might be granted to provincial exceptions; national bans; up to 50% of people mobility; doubling rate more than 15–25 days; segmentation subject to epidemiologic criteria.

Phase 4: Progressive reopening. Allowances might be granted to provincial exceptions; national bans; up to 75% of people mobility; doubling rate higher than 25 days; local restrictions.

Phase 5: New normality. Allowances might be granted to sustained personal hygiene and cares; no national bans; up to 75% of population mobility; no segmentation.

[13]Dynamic quarantine is defined as the Chilean strategy of locking down specific neighborhoods of certain cities, based on the number of active cases in the territory. This lockdown is then weekly reassessed and lifted, prolonged or expanded as a function of these active cases. However, specific cutoff points for such measures are not clearly established, and decision-taking relies heavily on the Ministry of Health.

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This work adopts the concept of resilience and its attributes (*safety*, *robustness*, *adaptive capacity*, *sustainability*, *governance*, and *anamnesis*) to analyze the COVID-19 pandemic, with specific reference to Italy during the first phase, from January to June 2020. The aim is to assess the main features of this pandemic and suggest a suitable tool to evaluate the capability of the Italian system to manage such catastrophe. Before discussing the Italian situation, a general overview about the current COVID-19 outbreak is presented, with special focus on selected countries worldwide, which adopted different intervention strategies such as exclusion, elimination, suppression, mitigation, and no substantive strategy.
With regard to Italy, a Global Resilience Index (GRI), suitable to provide a sense of direction (built or reduced resilience) is also calculated. In our analysis comes again the fork between 'engineering resilience' (*homeostatic*) and 'ecological resilience' (*autopoietic*): will the humanity be able to govern the next changes or shall withstand a new mass extinction, leading to a drastic collapse of the Earth biodiversity?

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ISBN 979-12-80064-21-9

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