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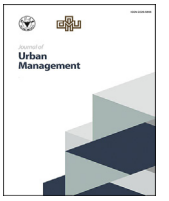

Research Article

COVID-19 and estimates of actual deaths in Italy. Scenarios for urban planning in Lombardy

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ABSTRACT

This research investigates the direct effects of the Covid-19 pandemic in Italy, focusing on Lombardy, the most affected region by the pandemic both in the first wave of infection (March–April 2020) as well as in the second wave (October–November 2020). We analyzed the data of the death tolls provided by the Italian National Institute of Statistics in April 2020 with the aim to provide reliable estimates and maps of deaths due to Covid-19 at the local scale, and hence better guiding decisions on spatial planning.

Firstly, we performed a statistical analysis at the national level, carried out on a region-by-region basis, to compare the total number of deaths in 2020 to the average values of the previous five years. We focused on the last three weeks of March when the lockdown restrictions have been fully applied. We observed that the mortality rate has been much higher than the average recorded in recent years (2015–2019), both in Italy and Lombardy. Additionally, we estimated that the 'excess deaths' in March 2020 are more than fourfold (325% in Italy) the official number of deaths due to Covid-19 reported by the Ministry of Health. This leads to the dramatic consideration that most of the Covid-19-related deaths occurred at home.

Lastly, using geo-referenced data by Geographic Information System analysis at the municipality scale, we investigated the Covid-19 effects by grouping the deceased into five age-groups, aiming to map the correlation between geography and population age. Lombardy is a wide region, characterized by various territories, such as mountains, flat landscapes, metropolitan and touristic areas. The Covid-19 pandemic affected each area in a specific way. For each of them, according to the demographic pyramid's reconfiguration, we should assume an urban planning scenario that is place-based, sustainable and resilient.

1. Introduction

In Italy, the third wave of contagion by Covid-19 is currently taking place (March 2021), and it shows that the Lombardy region (45°35′08″N 9°55′49″E) is still affected by the pandemic. Undoubtedly, we should reflect on the national and regional governmental programs in health planning. Italy is far below the European average for per capita health expenditure in purchasing power parity, and it has only 3.2 beds per thousand inhabitants (OECD/EU, 2018). Considering that the second wave of contagion was likely to occur in autumn, during summer 2020, a deeper understanding of the geography of death was urgent.

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The Italian Government should have considered the data compiled by the Italian National Institute of Statistics (Istat[1]) instead of those provided by the Higher Institute of Health (HIH).[2] Looking at the places where the deaths occurred, the Government would probably have adopted different solutions. For example, it could have been encouraged the use of open spaces (large natural areas) instead of forcing people to stay indoors increasing the housing overcrowding.

On the 20th of October 2010, the United Nations (UN) proclaimed the World Statistics Day for the first time. The aim was to affirm the fundamental role of Statistics in contemporary society (United Nation (UN), 2010, p. 15). Strengthening the system of official statistics enhances the production of high-quality data independently. It increases the trust of citizens, companies, and associations in quantitative information, and therefore in the institutions normally referring to those kinds of information to plan the community (Einaudi, 1955, p. 10). A year after the beginning of the pandemic, the Italian press has denounced the lack of transparency of the regions (responsible for health management) in data communication about swabs processing and the asymptomatic people, influencing the Italian Government decisions on whether to place regions in one risk zone or another (ANSA, 2021 April 19th; Padovese, 2021 April 27th).

This paper aims to investigate the direct effects of the Covid-19 pandemic, specifically in Lombardy. We described the situation based on the Istat data provided in April 2020 to recognize territorial exposure with the aim of fostering place-based planning. The main goal is to estimate the real number of deaths recorded by the Lombardy region and map it at the local scale to inform long-term urban planning. The pandemic has affected both metropolitan and marginal areas, so planning cannot focus on reducing inequalities in fragile contexts; moreover, it must develop new strategies for vibrant, economically strong contexts according to sustainable and resilient development. According to UN « *This current pandemic is challenging planning principles mistakenly confusing density with overcrowding as an accelerator for spread of Covid-19. There is no evidence, however, that relates higher density with higher transmission, rather it is overcrowding and the lack of access to services that is making certain populations more vulnerable and at a higher risk of contracting the virus*» (UN, 2020, p. 2).

Since the end of the nineteenth century, in the industrialization phase in Europe, urban planning faced emerging health problems related to cities' exponential growth. This period was characterized by unhealthy living environments; a rise of diseases; a lack of facilities such as sewerage and water supply; poor hygienic conditions that generated epidemics of cholera, typhoid, etc.; and an increase of pollution due to industries.

Historically pandemics pushed urban planning to adapt cities, including better light and ventilation, reducing the risk of contagious diseases. The Covid-19 emergency animated a broad debate on the future of the entire planet (hyper-connected), especially from an economic perspective, because it re-shapes investments (East, 2020; Stewart, 2020). According to this statement, cities must be much more resilient to pandemics (Abusaada & Elshater, 2020) mapping the flow of goods, labour and markets, improving blue and green networks, and ensuring that residents have sufficient living areas. Many questions have been raised about the cities' destiny at the beginning of 2020, as for instance, whether housing will be larger and public spaces smaller? How public spaces (indoor and outdoor) will be adapted to new health measures? Will it be possible to speed up the design and implementation of public services, as happened for the Chinese Hubei province hospital, built up in just 10 days? What will be the outcome of the pandemic-proof design of the cities? For example, should railways and roads be planned to improve accessibility to hospitals? Will it be possible to create schools surrounded by nature to prevent the spread of viruses in indoor environments? Will 'innovative' tourist activities (as Airbnb) still be competitive, or negatively influenced by given people's fear of traveling?

Considering all these questions, how does urbanism adapt its strategies to places, achieving pandemic-proof planning? Knowledge about the geography of Covid-19 deaths may provide a first evidence.

In the last twenty years, the relationship between health topics and urban planning has increased. In 1999 the World Health Organization report emphasized the importance of developing a 'healthy urban planning' model to ensure the health of the world's growing urban populations (Duhl & Sanchez, 1999). Nevertheless, given the emergence of environmental issues (air, water, and soil pollution) and health disparities, Corburn (2011) emphasized the importance of reconnecting planning and public health using eco-social epidemiology and environmental justice paradigms. More recently, the health and hygiene problems of the contemporary city are changing because health is now understood as complete physical, mental and social well-being and not just the absence of disease. People's well-being is therefore greatly influenced by urban and environmental conditions (Buffoli, 2014).

The paper provides a detailed map of areas affected by Covid-19 in Lombardy to better design urban policies and planning strategies while avoiding simple solutions such as 'back to nature and villages', increasing home isolation, and other social inequalities (Sarbu et al., 2021). The paper could be a common background to test what Sharifi (2020) suggests for improving pandemic-proof design and planning policy considering the geography of Covid-19 deaths. For instance, where to focus on greening transport and industry sectors; where to improve the reduction of air pollution; where to design regulations to minimize negative agricultural, industrial, and traffic impacts on water resources; and where to reduce inequalities and address the needs of vulnerable groups, etc. (Sharifi, 2020).

2. Methodology

Since the outbreak of the Covid-19 crisis in Italy (end of January 2020), the Ministry of Health has provided data for the nation, the regions, and the provinces. This includes the number of swabs carried out, the number of people who tested positive, and the number of hospitalized people. The number of hospitalized people was also split into intensive care patients and healed patients and deaths. Every day, the Civil Protection Department processes the data. Since the 28th of February, the HIH confirmed the number of deaths due to

[1] In Italian *Istituto Nazionale di Statistica*.
[2] In Italian *Istituto Superiore di Sanità*.

Covid-19. The data can be consulted via the Ministry of Health's website.

The regions provide data to the HIH through a specific web platform. The Ministerial Note n. 1997 of January 22nd, 2020, introduced this method and established the surveillance system of suspected Covid-19 infection cases. HIH is the coordinator of this surveillance system. Therefore, these data do not consider deaths from Covid-19 outside the hospital. Two other considerations confirm that these data refer exclusively to the hospital environment. On the one hand, just since March 24th, 2020, the HIH has started a specific survey on Covid-19 in Assisted Healthcare Residences, i.e., 4,629 nursing homes for the elderly in Italy. On the other hand, the data published by Istat on the 9th of April reported a different total amount of deaths.

Following the Strategy for Digital Growth 2014–2020, the National Resident Population Registry (NRPR)[3] service was launched in Italy, one of the most important platforms for developing innovative digital services. NRPR directly referred to the Interior Ministry. Currently, the NRPR includes 5,909 Italian municipalities (44,299,613 inhabitants), about three fourths of the whole country. Based on the data collected into this platform, Istat published death-trends in the first quarter of 2020.

These data are available on the Istat website. In the explanatory note of April 16th, it is specified that the available dataset refers to the total amount of deaths (i.e., not only due to Covid-19) from January 1st to April 4th, 2020, only for a part of the Italian municipalities (Istat, 2020, p. 1).[4]

In particular, data on deaths registered in the first quarter of 2020 are available for 1,689 Italian municipalities. In Lombardy, the data of 622 municipalities out of 1,503 are available. The population of these 1,689 municipalities represents 31.8% of the entire national population; among these, the 622 municipalities in Lombardy house 71.7% of the entire regional population.

On the ninth of April 2020, Istat offered the first official data on Italy's deaths at the local scale. The reference period is limited to the first quarter of 2020 and for some municipalities. These data are fundamental because they represent the first knowledge-base on the Covid-19 effects at the municipal scale. These data allow the dissemination of more precise information and a better understanding of the health crisis effects.

By performing statistical analysis, we examined the number of deaths in three weeks of March 2020 (from the eighth to the 28th). This period was selected because, in March 8th, 2020, the Prime Minister's decree came into force. The Law, oriented to the containment measures for the Covid-19 pandemic, imposed a lockdown for the whole country. The estimate of deaths shows various situations in Lombardy according to Covid-19 impact and environmental structure. It is interesting to analyse this discrepancy, not to condemn the Government and the Civil Protection, but to evaluate correctly the Covid-19 effects on the territory. From an urban planning perspective, knowledge of the pandemic effects helps figure out possible urban transformation scenarios.

We develop a direct comparison between two data sources, both official: one (by Istat) related to the total deaths recorded and the other (by HIH) related to the deaths with swab positive to Covid-19. The sudden and unexpected growth of the pandemic in Italy during March 2020 resulted in an initial underestimation of Covid-related deaths. Hence, we tried to assess this underestimation through the comparison of the two aforementioned official data sources.

Thanks to Istat database, we performed data analysis to estimate the number of deaths due to Covid-19. The outcome of the research brings to light the divergences from the average data of previous years on a municipal basis. Therefore, these are not absolute data related to deaths due to Covid-19. Nevertheless, the uncertainties on these estimates should be regarded as negligible for the reasons listed below.

3. Case study

Lombardy, the northern Italian region has an extensive area of about 23.800 km^2 and has about 10 million inhabitants. The region is characterized by wide landscapes including hillsides, mountains, flat landscapes, metropolitan areas and well-known touristic amenities. According to the Covid-19 effects, we could suppose different scenarios for urban planning.

Urban systems diverge in population density, social characteristics, built-up system's morphology, public spaces or their equipment accessibility, greenery, ecological landscapes, mobility, etc. These different urban systems must be appropriately re-planned for future emergencies. From a prevention perspective, it is important to know the pandemic effects to assess the territorial exposure and vulnerability and imagine possible transformative actions useful to increase their resilient capability (e.g. increasing hospitals, reducing traffic congestion, improving slow mobility, implementing public spaces, etc.).

The most interesting and original aspect of this research is the spatialization of the deaths for Covid-19 in Lombardy. This is one of the most attractive Italian regions from a business, economic, and financial perspective. Moreover, Lombardy has a great natural and landscape heritage that attracts many tourists every year to the ski, lake, and spa resorts. The capitals of the 11 Lombard provinces and the metropolitan city of Milan are the most densely populated places in the region, together with the northern Milan area and the western part of the Monza-Brianza province (Fig. 1).

However, data spatialization shows that these territories have not suffered the first pandemic direct effects. Bergamo and Brescia were strongly affected by Covid-19. In addition, the pandemic hit also marginal territories, less accessible by public transport systems, and affected by abandonment and contraction dynamics, such as the mountain or the flat area in western Pavia province and Cremona's plain.

[3] In Italian *Anagrafe della Popolazione Residente*.

[4] In January 2020, in Italy there were 7,904 municipalities.

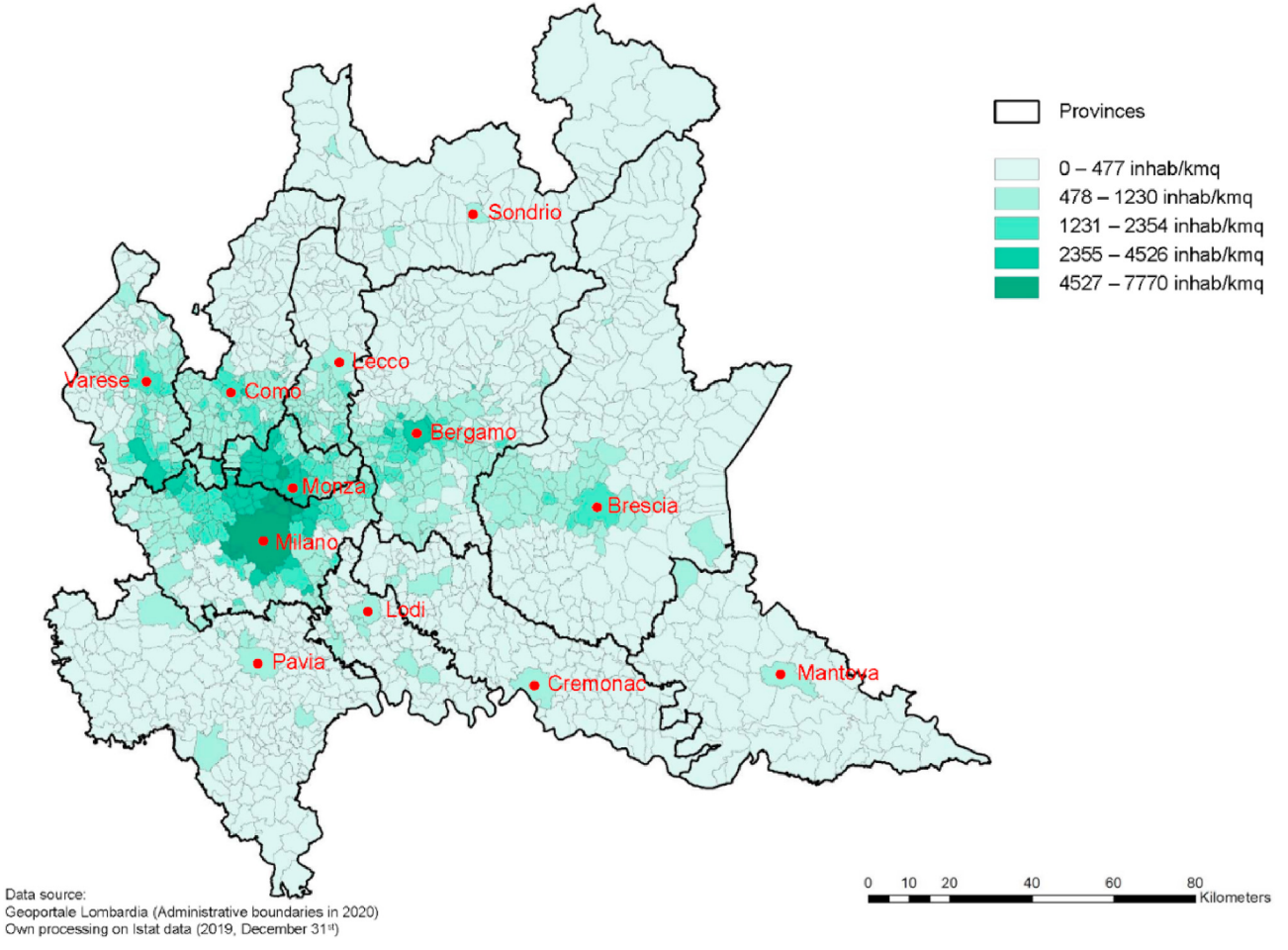


Fig. 1. The population density in Lombardy Region. Gradations of colour indicate the increase in inhabitants/square kilometres. In red dots, the Provincial Capitals. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

4. Results

4.1. National comparison

Considering the first quarter of the five-year period from 2015 to 2019 (Appendix, Table 1), there is a considerable constancy in the number of deaths recorded for each year based on the sample of 1,689 municipalities surveyed by Istat. In particular, the average number of deaths was 57,693, with an extremely low coefficient of variation equalling 4.82% (number of deaths varying between 52,966 and 59,974). Even limiting the analysis to the 622 municipalities of Lombardy, there is a remarkable constancy in the number of deaths annually recorded between 2015 and 2019. In particular, the average number of deaths was 20,164, with a coefficient of variation equalling 4.91%, very close to the one found at the national level.

Even limiting the investigated period from eight to 28th March, the constancy of deaths detected between 2015 and 2019 is confirmed (Appendix, Table 2). At the national level, the average number of deaths in the 1,689 sample municipalities was 12,045, with a coefficient of variation equalling 2.76%. Similarly, in the 622 Lombard municipalities, the average number of deaths was 4,204, with a coefficient of variation equalling 2.82%.

On the other hand, comparing the average number of deaths recorded monthly in the first quarter of the five-year period (2015–2019) to those observed in the same period of 2020, the effect of the virus clearly stands out (Appendix, Table 3). In particular, while in the period 2015–2019, the number of deaths registered in March was similar to the previous two months, a completely different situation was observed in March 2020, when the incisiveness of Covid-19 has been remarkably perceived. In fact, the number of deaths recorded in March 2020 in Italy (1,689 municipalities) and Lombardy (622 municipalities) correspond respectively to 207% and 288% of the previous years' average. These data diverge from those of the previous five years of 36.69 and 60.09 times the standard deviations. Such deviations from the average values are not statistically justifiable unless considering the presence of a new significant disturbance factor, such as Covid-19.

We assessed for each Italian region the ratio between the number of deaths in 2020 and the average number of deaths from 2015 to 2019, focusing on the three central weeks of March (Appendix, Table 4). The ratios are over 100% for all Italian regions, varying between 133% in Puglia and 338% in Lombardy. In the whole nation (1,689 municipalities), the number of deaths recorded in 2020 is 28,137, while in the previous five years an average value of 12,045 deaths was registered. The ratio between the deaths that occurred in 2020 and the average value of those related to the 2015–2019 period is 234%.

Even for the regions that are less affected by Covid-19, the number of deaths has greatly increased, up to values below the first percentile of the distribution curve assessed considering the previous five years' data. Thanks to this analysis, we may confirm that the whole of Italy, in the period from the eighth to the 28th of March 2020, had experienced 'excess deaths' concerning the expected values due to Covid-19 effects.

For each Italian region, first, the ratios of the total resident population to one of the surveyed municipalities have been computed, and then the data registered in the surveyed municipalities were multiplied times these ratios, to assess the total number of deaths.

We validated this approach on the period 2015–2019: in fact, the number of deaths assessed for each entire region by projecting the data of the surveyed municipalities do not differ from the respective official number of deaths registered by Istat. Performing this projection on 2020, the estimates of the 'excess deaths' are obtained as the difference between the estimate of deaths in 2020 and the average values of the previous five years (Appendix, Table 5).

According to the above-described procedure, in 2020 (from the eighth to the 28th of March), 70,590 deaths are estimated in Italy, while 36,769 deaths were expected considering the average of the previous five-year period. Therefore, 33,821 of them can be classified as 'excess deaths'. In Lombardy, 19,815 deaths are estimated, while 5,863 deaths were expected according to the average of the previous five-year period. Therefore, 13,952 of them can be classified as 'excess deaths'.

Computing the incidence of 'excess deaths' we confirm that Lombardy is the region most affected by the pandemic (0.144%), followed by Emilia Romagna (0.084%) and Marche (0.074%). Regions considered strongly affected by the pandemic, such as Veneto, are characterized by an incidence of 'excess deaths' similar to those recorded by most central-southern regions.

In the same period, the HIH reported 10,413 deaths in the whole Country due to Covid-19, among which 6,093 were in Lombardy. It follows that the 'excess deaths', determined by processing Istat data for the whole nation and Lombardy, amount respectively to 325% and 229% of the official data provided by the HIH. Therefore, it is very likely that the official data underestimate strongly the actual number of deaths at home (Appendix, Table 6).

Analysing the ratio between the 'excess deaths' and the official deaths, it emerges that the Italian regions, officially considered more affected by the pandemic (Lombardy, Emilia Romagna, Veneto, Piedmont and Marche), are those characterized by a lower overestimation (between 229% for Lombardy and 403% for Piedmont). On the other hand, the regions that were supposed to be very marginally affected by the pandemic are characterized by a considerable underestimation of 'excess deaths' (over 2000% for Sicily, Sardinia, Calabria, Basilicata, and Molise). While confirming the greater incidence of Covid-19 in the northern regions of Italy, this data suggest that no regions should be considered safe. These data had to alert the authorities in view of the second and third epidemiological wave.

In order to verify the validity of our estimates, we compared the actual annual average deaths in Italy (between 2015 and 2018, data for 2019 are not available by Istat yet) with the average annual deaths in Italy computed on the basis of our assessment procedure.

The average number of deaths recorded in the period from the eighth to the 28th of March of between 2015 and 2019, for the 1,689 surveyed municipalities, (12,045 deaths) was projected firstly on the entire national territory (36,769 deaths), and then over a period of one year (639,077 deaths). Official Istat data report 636,256 annual deaths in Italy (for the period between 2015 and 2018). This means that our estimates have an error lower than 1%. Hence, we consider our estimates sufficiently reliable to validate our thesis.

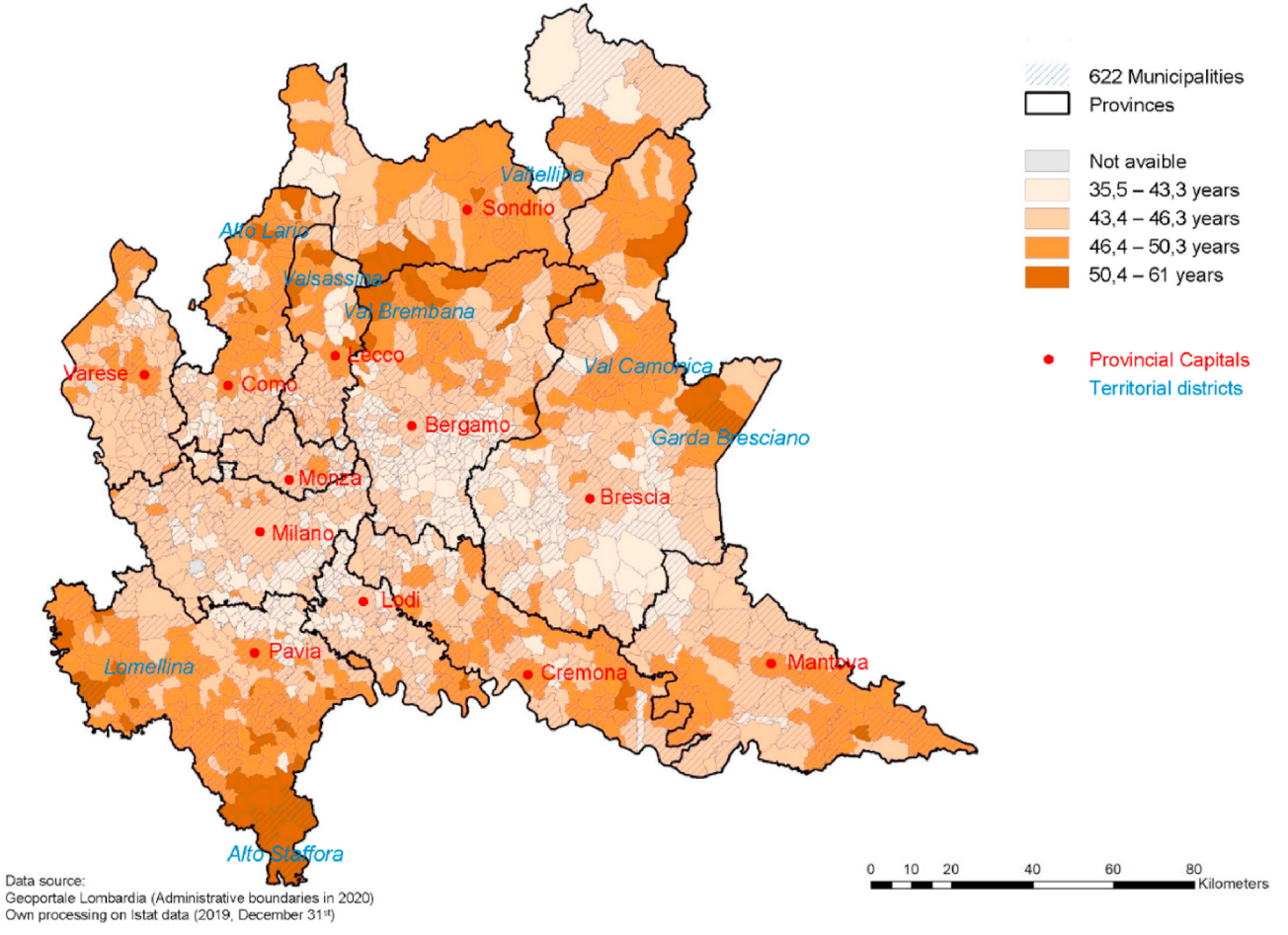


Fig. 2. Average age in the Lombard municipalities and identification of the analyzed municipalities.

4.2. Estimated deaths for Covid-19 in Italy by gender and age-groups

We have also performed an estimate of deaths subdividing population by age-groups. This analysis is very important for urban planning, economic, social, health, and education policies. The analysis of deaths in Lombardy from the 16th to the 30th of March 2020 (peak period of the official number of deaths due to Covid-19), distinguished by gender and age-group (Appendix, Table 7), confirms the trends highlighted by the Ministry of Health. In particular, males are more affected than females (respectively 435% and 335% of the average deaths registered in the period between 2015 and 2019). The increase of deaths is significant in the 35–39 age-group (324% of the average of the previous five years). Although the number of deaths belonging to the 35–39 age-group in Lombardy is only 11, the increase in percentage is relevant and surprising. On the other hand, significant increases in deaths are reported in older females, particularly in the 50–54 age-group.

The age-group that has experienced the greatest increase in deaths is 70–74 for males (555%) and 95–99 for females (395%). In terms of absolute numbers (Appendix, Table 8), it emerges that the greatest increase in deaths occurred for males in the 80–84 age-group (995 deaths more than the average 2015–2019) and for females in the 85–89 age-group (907 deaths more than the average 2015–19). These data are affected by the longer life expectancy of women.

Overall, the age-group that recorded the highest number of deaths is between 85 and 89 years old (1,773 deaths more than the average of the previous five years). The largest increasing ratio (466%) has been recorded in the 70–74 age-group. Surprisingly, the increasing ratio remains always larger than 175% in the 35–39 age-group.

4.3. Data geolocalization and demographic differences among lombard territories

We analyzed the municipalities based on the average age of the resident population to understand the demographic characteristics of the Lombard territories and offer knowledge to the post-pandemic urban planning scenarios (Fig. 2). The municipalities located in Bergamo and Brescia's plain have the lowest average age (between 35 and 43 years old). On the contrary, the municipalities in Alto Staffora districts and Western Lomellina (Pavia Prov.), Val Brembana (Bergamo Prov.) and Valtellina and Morbegno (Sondrio Prov.), upper Val Camonica and upper Garda Bresciano (Brescia Prov.), Alto Lario districts (Como Prov.), and Valsassina (Lecco Prov.) are those in which the highest average age is recorded (50–60 years old). This spatialization confirms that the municipalities with a low population density are also those with higher average age. Therefore, public transport is not easily accessible, they are dangerous places due to geomorphological conditions, and the population is among the oldest.

This information has subsequently been further analyzed, dividing the population into five age-groups. The first contains the population aged up to 34 years old, grouping young adults and young (up to 15 years old). Data released by HIH show that this is the less affected age-group by the virus. The other groups are 35–54; 55–69; 70–84; and over 85 years old.

The classification of all Lombard municipalities according to these age-groups is shown in Appendix n. 2. The following is what emerges.

As far as the age-group with a population up to 34 years old is concerned, the Bergamo and Brescia's plains have the highest percentage of young people and adults. This high percentage compared to the total number of residents is also recorded in the municipalities in South-East Milan/North-West Lodi areas and upper Valtellina area (red boxes in Appendix 2, Map 1).

The 35–54 age-group characterizes the North Pavia and Lodi's areas and the plains around Bergamo and Brescia (with over 32% of the entire resident population). In general, Lombardy's plain presents a percentage of adult residents higher than 28% of the total population (red rectangle in Appendix 2, Map 2 with the partial exclusion of the Cremona Prov.).

The 55–69 age-group distinguishes Valli Orobiche and Val Camonica (Sondrio, Bergamo and Brescia Prov.) and the southern side of Valtellina (Sondrio Prov.) with a percentage higher than 25% of the total resident population. Also, the municipalities in Oltrepò Mantovano districts, the southern part of Cremona Province, and Lomellina plain in Pavia Province present a high percentage of residents in this age-group (red boxes in Appendix 2,Map 3).

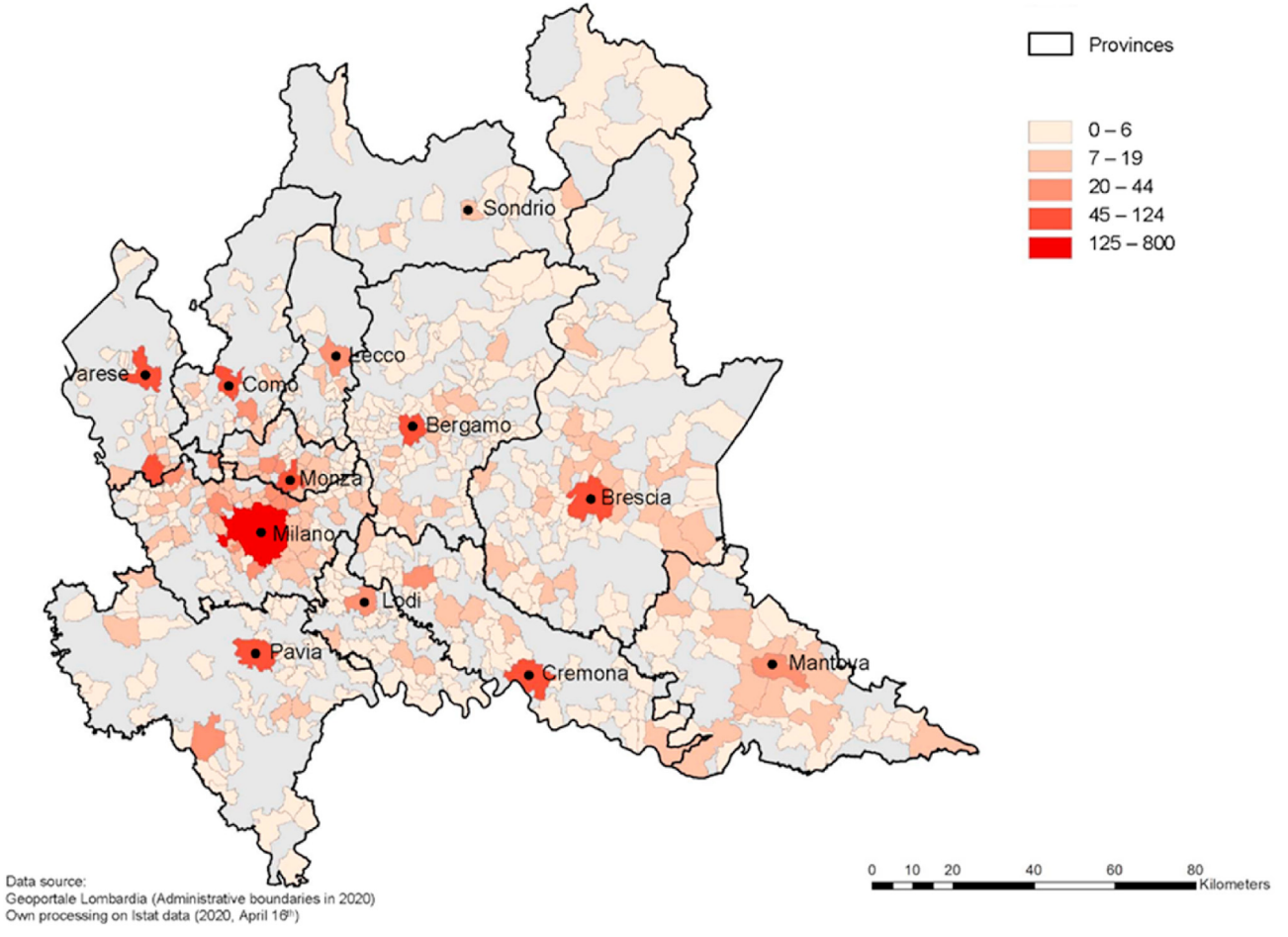
The elderly (70–84 years old) represent more than 15% of inhabitants in most Lombardy mountain territories. However, they are present with relevant percentages (from 13 to 15% of the total number of residents) in the provincial capitals and the most densely inhabited areas (red boxes in Appendix 2, Map 4). This population is hit Covid-19 because recording more than 450% of deaths, usually expected in March.

The older population group (over 85 years old) characterizes Lombardy's edges and the large urban centres. However, it counts between 5 and 14% of the whole population (red boxes in Appendix 2, Map 5). These are very different areas from the geomorphological, landscape, and economic perspectives. There are the Brescia Province's lacustrine territories that are mountainous and hilly territories with a Mediterranean microclimate. Local productions, such as Garda oil or citrus fruits, and holidays-home phenomenon characterize lacustrine territories. Besides, there are the agricultural territories of lower Cremona Province and Oltrepò Mantovano district. They are flat plains characterized by the Po River and by the distance from highways and railways networks. The economy is based on cereal production.

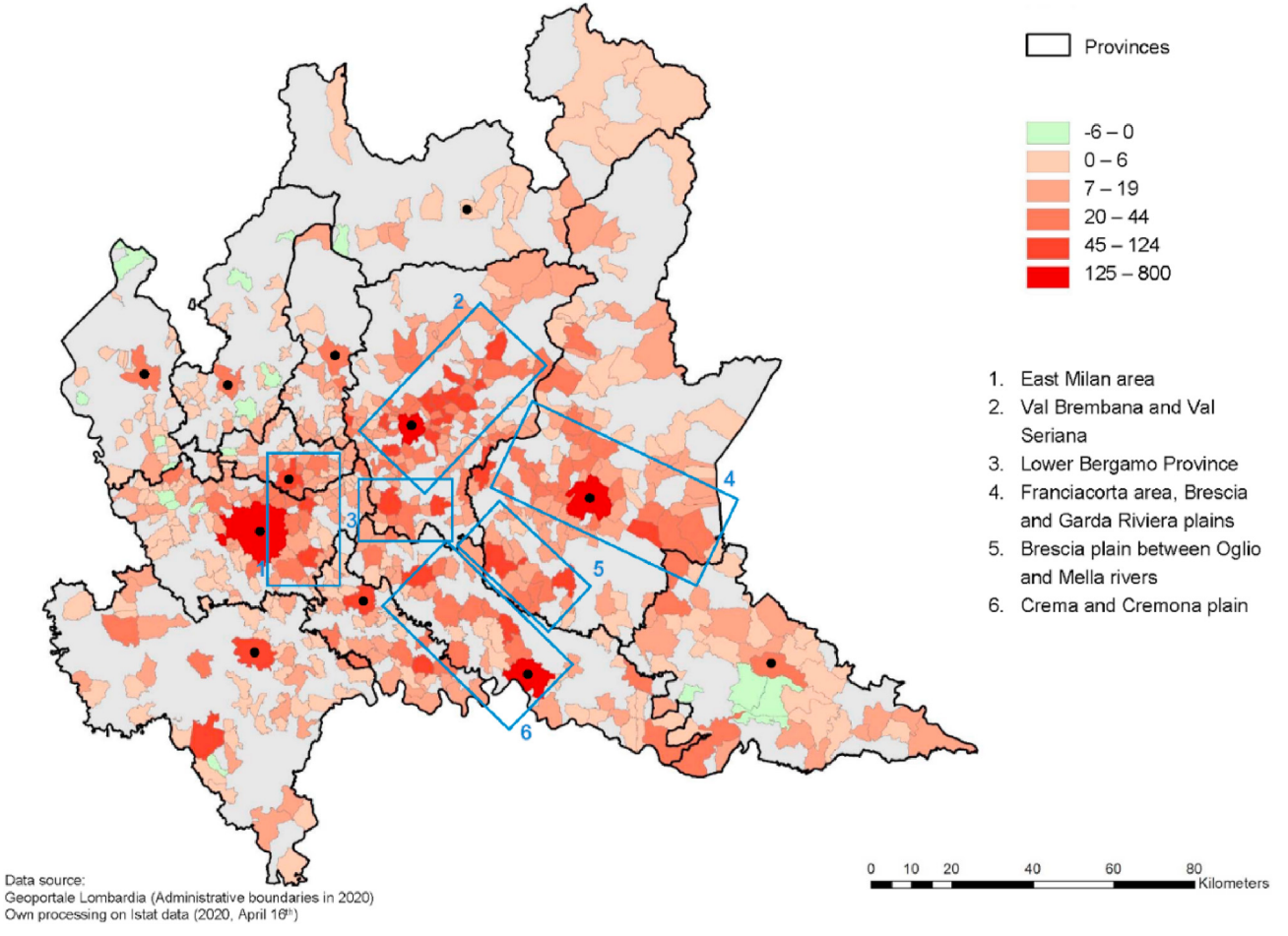
4.4. The spatialization of death-data for Covid-19 in lombardy

Using data provided by Istat for 622 municipalities, we estimated the balance of deaths for Covid-19 in March 2020 and analyzed the different areas where it occurred. In other words, the research shows which Lombard territories, concerning age-groups, were most affected by the first pandemic wave.

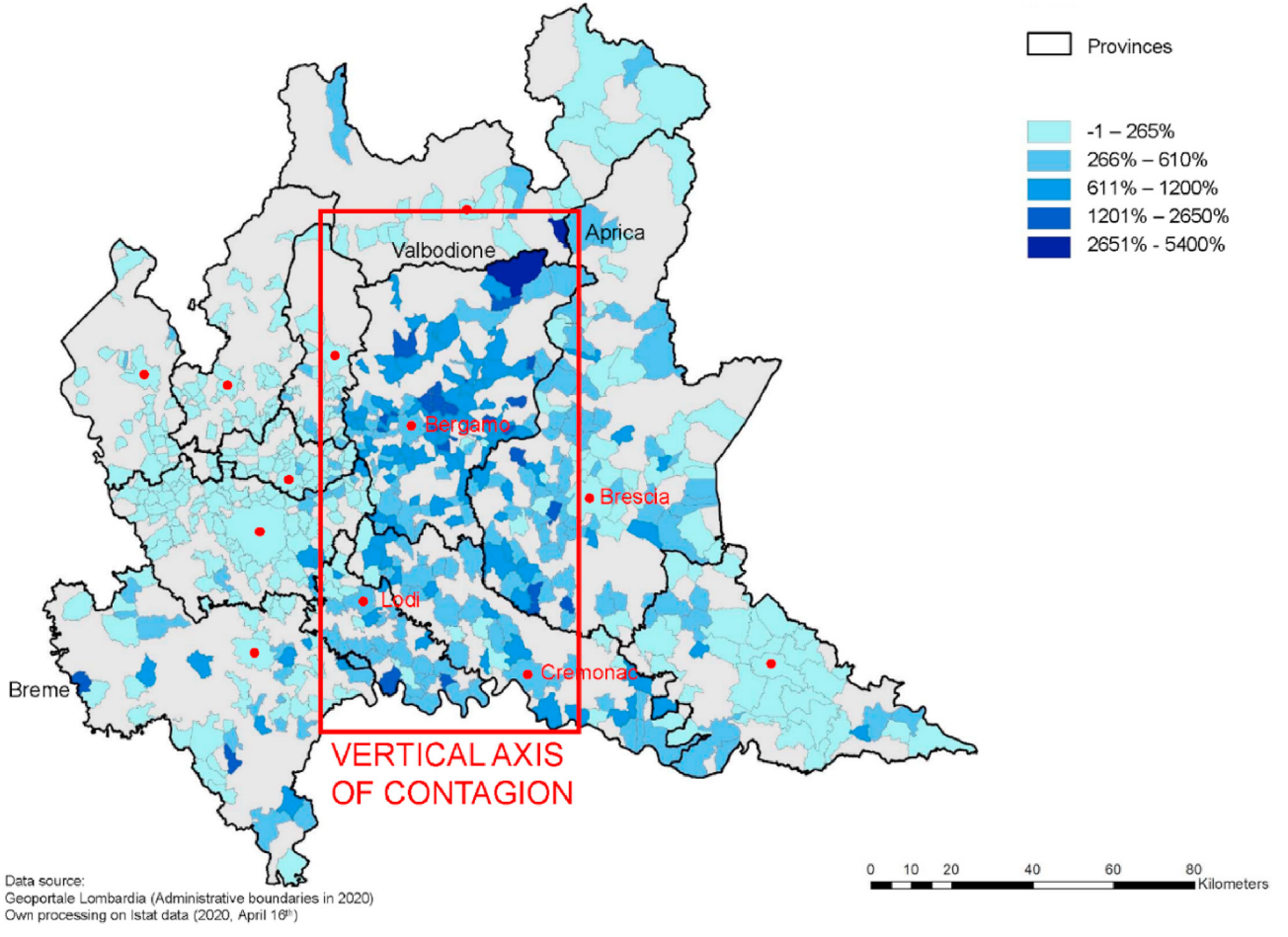
We designed eight thematic maps according to Istat data (based on 622 municipalities). The first three maps consider the total



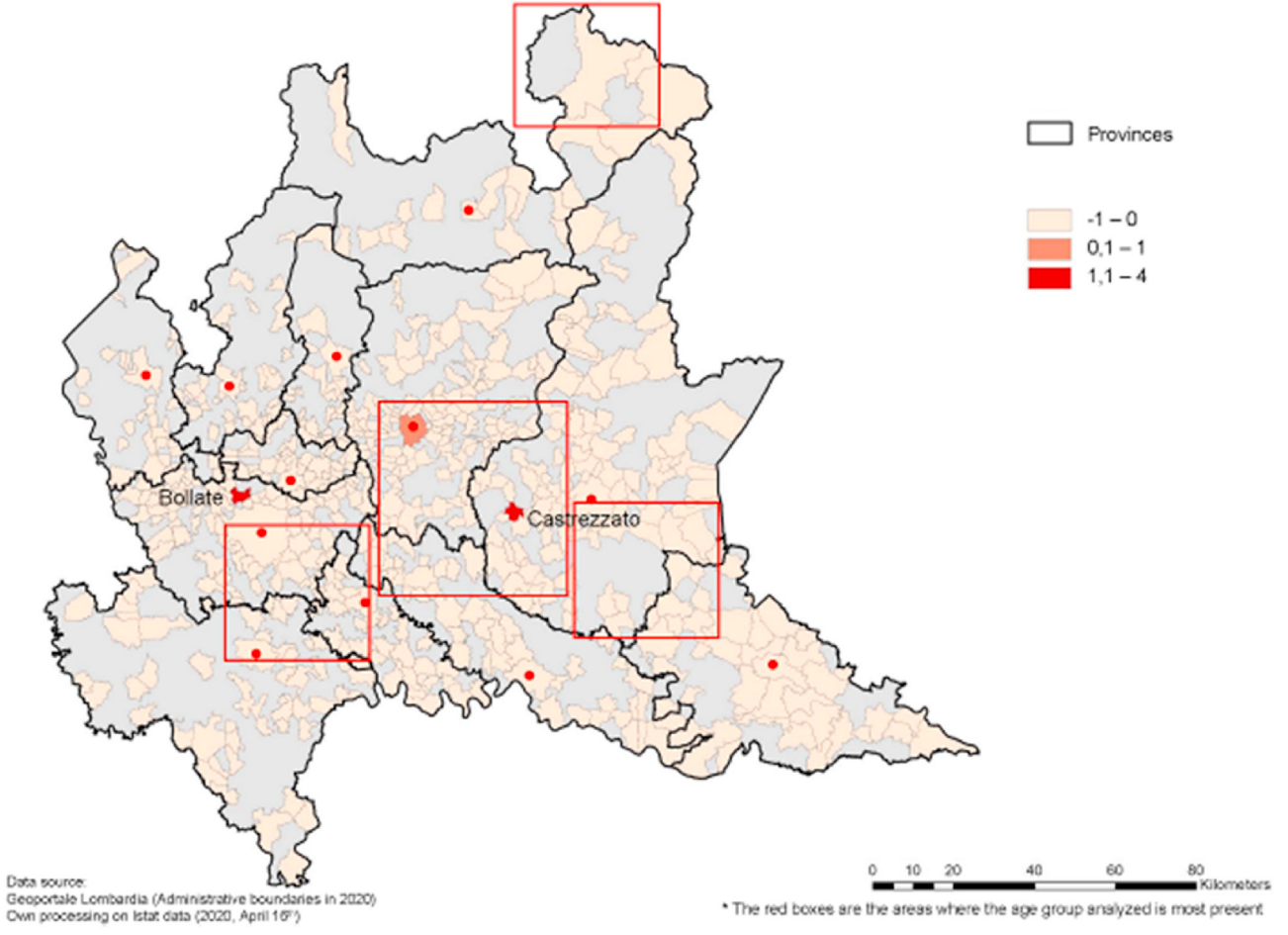
Map 3. Municipalities subdivision by the average deaths in three weeks (March 8th-28th) of the five-year period 2015–2019.



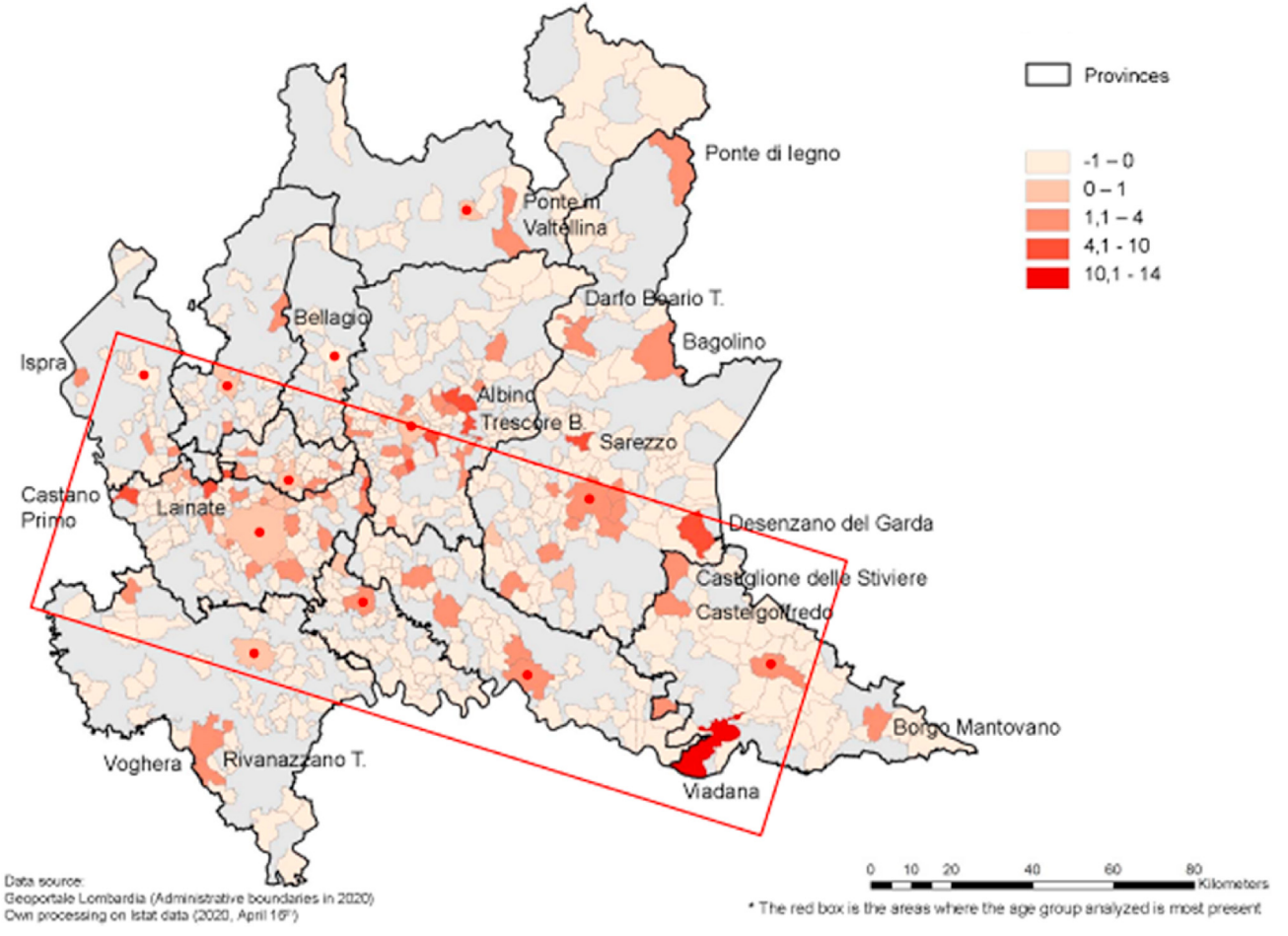
Map 4. Municipalities subdivision by the number of 'excess deaths' in 2020 compared to the average recorded in 2015–19.



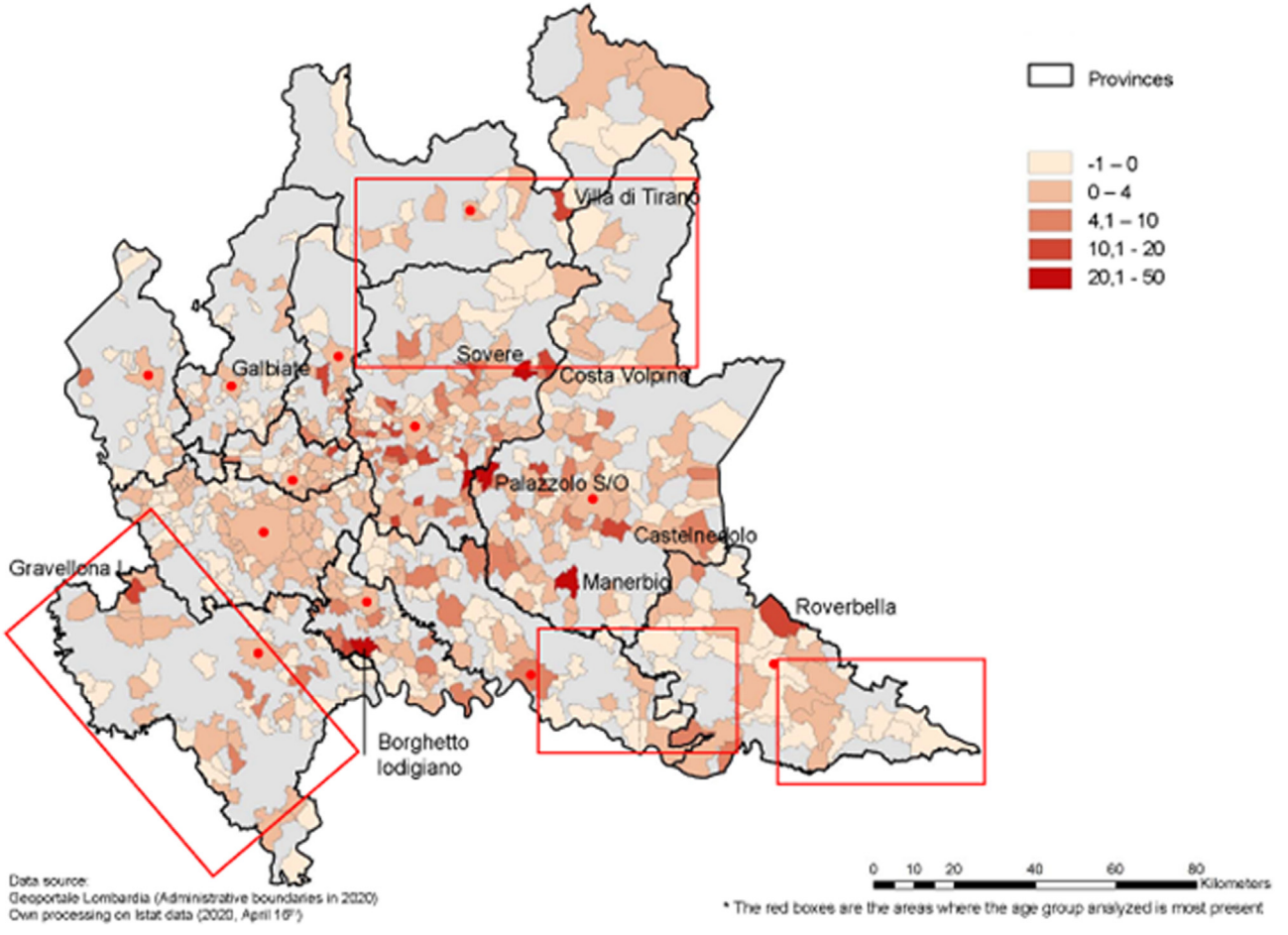
Map 5. Municipalities subdivision by the incidence of "excess deaths" in 2020 compared to the same period in 2015–2019 (weeks between the eighth and 28th of March).



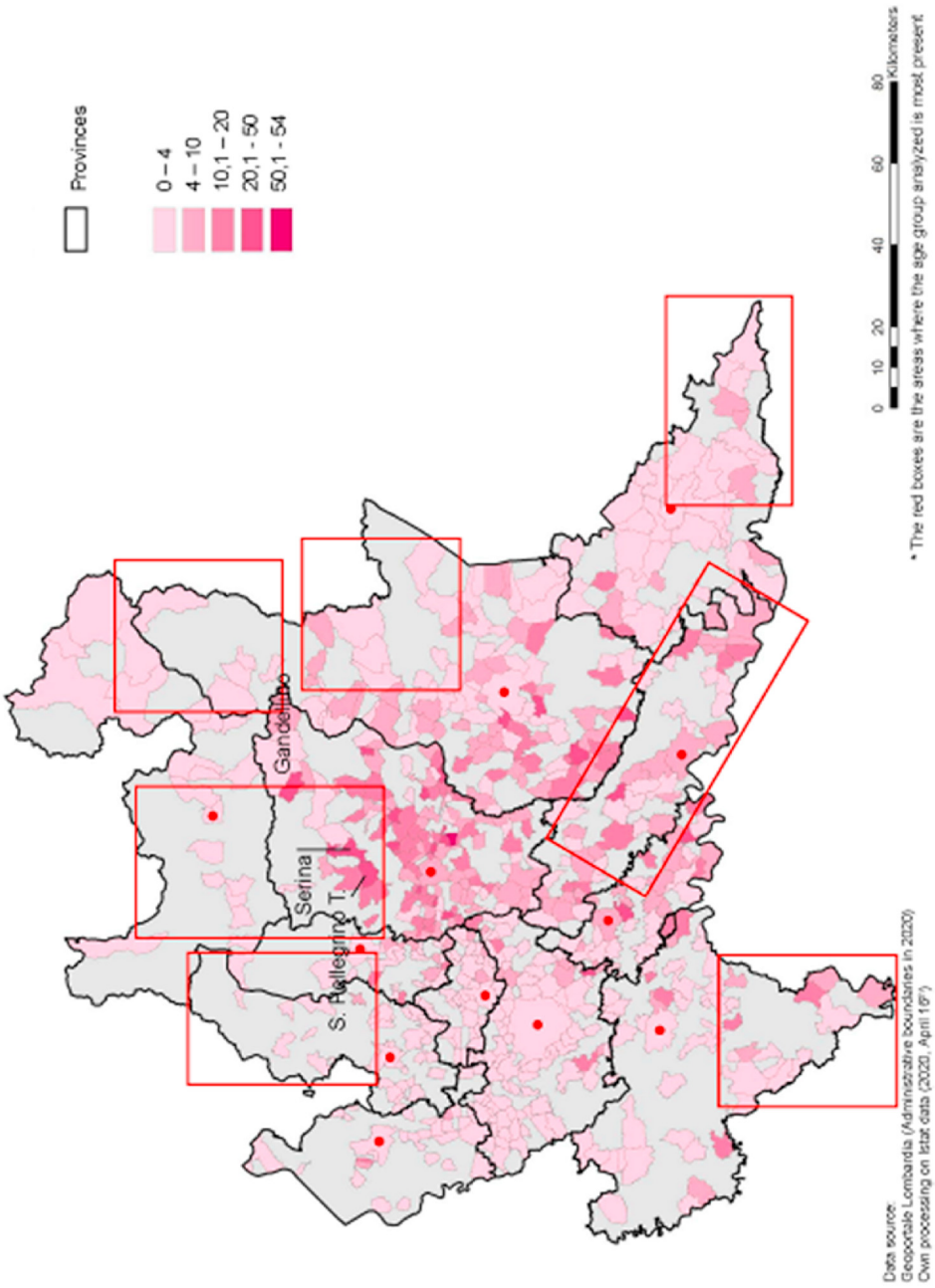
Map 6. Municipalities subdivision by the incidence of 'excess deaths' in the 0–34 age group.



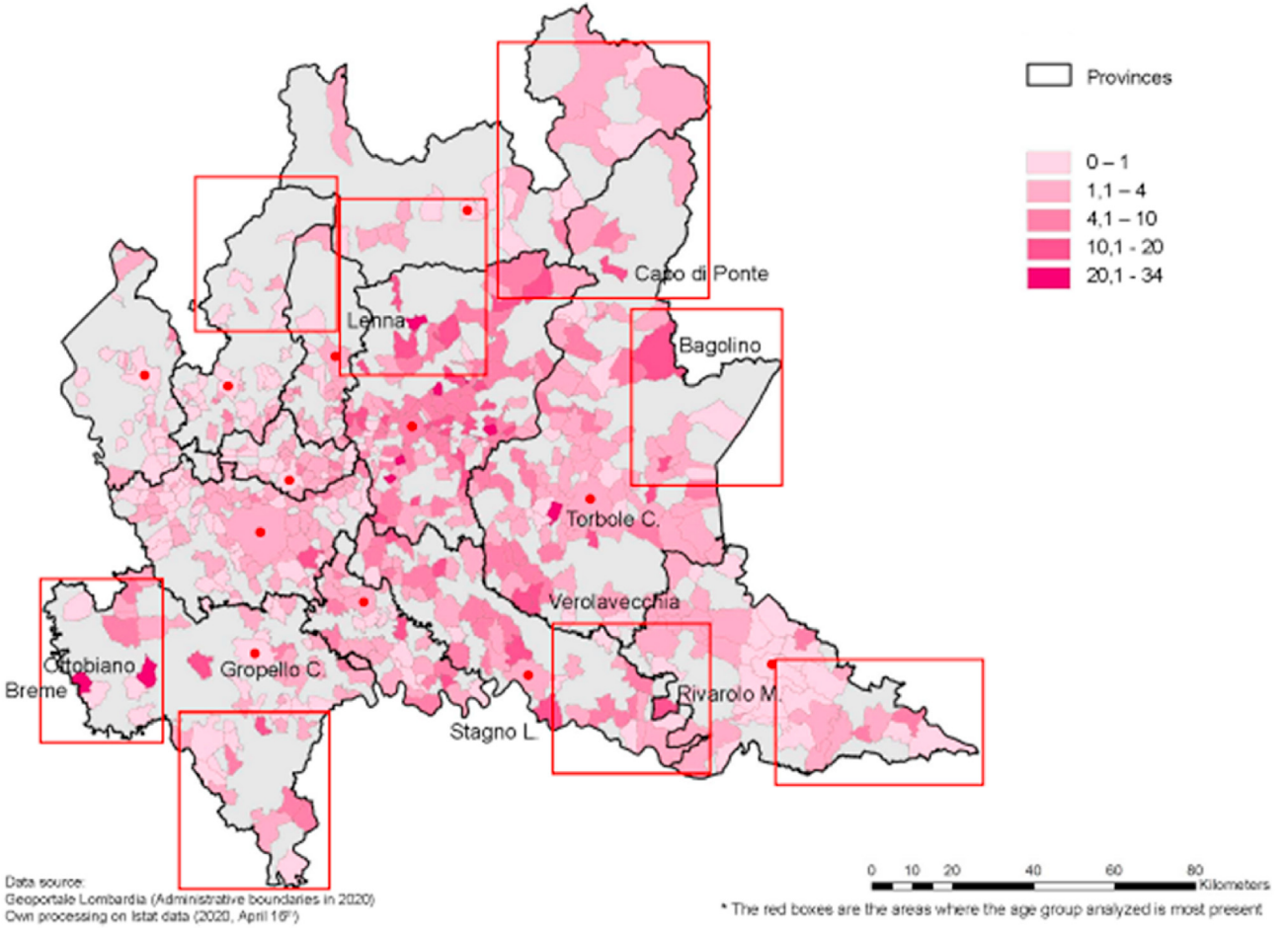
Map 7. Municipalities subdivision by the incidence of 'excess deaths' in class 35-54 years-old.



Map 8. Municipalities subdivision by the incidence of 'excess deaths' in class 55–69 years old.



Map 9. Municipalities subdivision by the incidence of 'excess deaths' in class 70–84 years old.



Map 10. Municipalities subdivision by the incidence of 'excess deaths' in class over 85 years old.

number of deaths between the eighth and the 28th of March, while the other five maps investigate deaths according to age-groups. Moreover, the first three maps highlight the comparison between the average deaths in the period between 2015 and 2019 and the deaths in 2020.

From the eighth to the 28th of March between 2015 and 2019, data show that the highest number of deaths (more than 125 deaths per day) was concentrated in the provincial capitals and their surroundings. That is in the denser and urbanized areas of Lombardy. Fig. 3 is in line with the population density recorded in these areas.

Analysing the difference of daily deaths that occurred between 2020 and the average of the previous five years (i.e., the so-called 'excess deaths' by Covid-19), it is noted that the balance is positive for most of the 622 municipalities analyzed (Fig. 4). Only a few municipalities in Como, Varese, and Mantova provinces have a negative balance. The peaks (with a number of deaths greater than 125) are found in the provincial capitals (characterized by a greater number of inhabitants) and between Val Brembana and Val Seriana districts. Then, in the East-West axis (along the A4 highway) that intercept the Franciacorta area, Brescia and the Garda Riviera plains, and the plain between Crema and Cremona. Others are in the East Milanese area and between the municipalities of Bergamo and Brescia's lowlands, where the municipalities of Caravaggio, Treviglio (lower Bergamo Prov.), and Orzinuovi (Brescia Prov.) stand out. This is a highly urbanized territory (the data on soil consumption and soil sealing are alarming in this area) and very productive; from the Bergamo valleys with dairy and fruit products and manufactured to Brescia's hills featured by the famous and certified cultivation of Franciacorta wine.

The map in Fig. 5 highlights the most interesting data of the research, i.e., how much the 'excess deaths' in 2020, compared to the average of the previous five years, have affected the population (in percentage). The greatest increase characterizes Bergamo, Lodi, and Cremona Provinces, and the Western part of the Brescia Province. The map shows a 'vertical axis of contagion' running from the Lodi area's southern edges until reaching the city of Bergamo and its entire province. Most remarkably, is the multiplicative factor where some municipalities have seen a 26 times higher increase of deaths compared to the average daily deaths, such as Valbondione, Aprica and Breme. Also Torrazza Coste (Pavia Prov.), Senna Lodigiana (Lodi Prov.), Verolavecchia, Corte Franca and Torbole Casaglia (Brescia Prov.), San Giovanni Bianco and Nembro, Alzano Lombardo, Selvino, Pradalunga (Bergamo Prov.) stand out.

The research has also further investigated the number of 'excess deaths' and their incidence on the average of the previous five years concerning the population's age-group. In particular, we analyzed the incidence of the normalized amount of 'excess deaths' compared to the average of the previous five years. The analysis for each of the five age-groups shows that the number of deaths increase is wide-ranging.

Although the effect of the virus is low in young people (0–34 years old), Bollate (Milano Prov.) and Castrezzato (Brescia Prov.), the two municipalities in red in Fig. 6, show an increase of deaths even four times higher than the previous five years.

Compared to the area in which the age-group survey is more robust (red rectangle in Fig. 7), the deaths in the 35–54 age-group have happened by hitting in a scattered way, a leopard spot, without a real territorial concentration. The 34–54 age-group was hit mainly in the surroundings of provincial capitals (Fig. 7). However, Viadana (14 deaths) stands out in the Mantova Province because it is a municipality with 20,000 inhabitants; Sarezzo and Desenzano del Garda, respectively of about 13,000 and 29,000 inhabitants, stand out in Brescia Province; Albino and Trescore Balneario, respectively of about 18,000 and 9,800 inhabitants, in the Bergamo Province. There are other municipalities, very different in location and number of inhabitants, in the provinces' most marginal areas or where this age-group is less robust. They are particularly small municipalities with less than 2,500 inhabitants, such as Ponte in Valtellina (Sondrio Prov.) and Ponte di Legno (Brescia Prov.). In this area, a loss of even just four inhabitants in this age-group could jeopardize these realities' survival. Others are municipalities with a population between 4,000 and 5,000 inhabitants such as Bagolino and Piancogno (Brescia Prov.), Rivanazzano Terme (Pavia Prov.), Ispra (Varese Prov.), Bellagio (Como Prov.); and larger ones with a population of more than 15,000 inhabitants such as Darfo Boario Terme (Brescia Prov.), Castiglione delle Stiviere and Borgo Mantovano (Mantova Prov.), and Voghera (Pavia Prov.). For this second group, the loss of population in this age-group could be irrelevant in the long term for re-programming urban planning strategies.

The 55–69 age-group was hit (with several deaths more than 10 times the average) especially in the municipalities along the A4 highway (in the south of Bergamo and close to Brescia) (Fig. 8). The peak is Palazzolo sull'Oglio in Brescia Province. Also, the municipalities of Roverbella (Mantova Prov.), Manerbio and Castelnedolo (Brescia Prov.), Borghetto Lodigiano (Lodi Prov.), Gravellona Lomellina (Pavia Prov.), Galbiate (Lecco Prov.), Villa di Tirano (Sondrio Prov.), Sovere and Costa Volpino (Bergamo Prov.) stand out.

Compared to the greater population concentration in this area (red rectangles), it is remarkable that the deaths have affected many municipalities. Still, above all, they are homogeneously distributed throughout the whole region. Probably, this age-group still has a lot of mobility due to working factors and family-care, so the whole 55–69 age-group was affected.

The 70–84 age-group was affected mainly in the municipalities of Bergamo, Brescia, Cremona, and Lodi provinces, in line with the general effect of the virus in Lombardy (Fig. 9). The thickening of cases in this age-group around the city of Bergamo is particularly evident. More specifically, the Orobic side of Val Brembana (San Pellegrino Terme, Serina, and Gandellino) counts numerous deaths in one of the most characteristic age-groups of this territory. The same is registered for the Cremona Province. Alto Staffora, Oltrepò Mantovano, and Val Camonica are less affected, even if strongly characterized by this population group. The most marginal territories of Lombardy, which are undergoing processes of contraction and depopulation for different reasons, have not seen the loss of their typical population age-group.

The age-group over 85 years old was strongly hit in different areas of Lombardy, regardless the fact that in those areas the populations was constituted mainly by elder people or not. This age-group was strongly hit in the whole Bergamo province (Lenna particularly), Cremona, and Brescia provinces (Fig. 10). The Lomellina with Breme, Gropello Cairoli, and Ottobiano also stand out, but there is also Bagolino (in the upper Val Sabbia) already affected in the 35–54 age-group.

5. Discussion

Focusing on the period from the eighth to the 28th of March, the comparison between the average number of deaths between 2015 and 2019 and the data of 2020 leads to interesting considerations. Our research confirms that the number of deaths is much higher than the average recorded in Italy and Lombardy in recent years. The pandemic reconfigures the demographic pyramid in the coming years. Accordingly, we have to rethink urban policies and planning strategies such as the public services provision, the transport infrastructures priority, the size of public spaces and houses, and economic activities, etc. In particular, planning should consider new demographic pyramid distinguishing strategies and policies according to current geographical needs.

Although we confirm that the most devastating impact occurred among the elderly, it should be noted that Covid-19 in Lombardy was probably the first cause of death for adults over 35 years old. This is important especially for marginalized areas where young people are decreasing for a long time. This has a clear impact on the future economic, social, and urban planning since the Covid-19 is affecting the elderly and young and hitting different territorial areas.

The entire region has been strongly hit by the pandemic, reporting a significantly higher number of deaths comparing to official deaths, because national authorities recorded only hospitals' deaths. Analysing the total number of deaths in the first quarter of 2020 and comparing it to the average of the previous five years, deaths' spatial distribution is in line with the official data but exhibits much higher values. In fact, we notice an increase from the average of the previous five years of more than 300% at the national level.

However, the most interesting aspect concerns the spatialization of the data and the subdivision by age-groups. Concerning the first point, in Lombardy, the North-South contagion axis is confirmed, following the Adda, Serio, and Oglio Rivers.

Concerning the demographic aspect, interesting data regarding the phenomenon location become known. The age-group over 85 years old was the most affected one in terms of amount of deaths, while in percentage terms the 70–84 years old class was the most hit one. These population classes characterize Lombardy's most marginal territories, particularly the mountains, towards the Alps and the Apennines.

The valleys have been affected by Covid-19, with percentages varying between 15 and 30% of the total resident population (70–84 age-group) and between 6 and 14% for the age-group over 85 years old. However, when we analyzed where the increase in deaths compared to the previous five-year period was more intense, we noted that the most affected municipalities are those in the lowland areas, where these population classes are less present.

This leads us to state that the very dense and urbanized Milanese metropolitan region (which extends from Milan to the east, as far as Garda Lake) is under pressure from a health management perspective. This is in line with what has happened in other urban areas, from India to Brazil, where public space and public transport have been the virus's main transmission vector (Abrahão et al., 2020; Paul et al., 2020). In the surroundings of the provincial capitals and the region's lowland area, the hospitals should increase their capability to manage medical and hospital personnel and ensure greater capacity in intensive care. In fact, most people hospitalized belong to the older population group that the statistics show to be the most vulnerable.

The second wave of contagion, which is taking place in autumn 2020, confirms this need. The Lombardy plain's built-up system is characterized by high-urbanized soils and scarcity of natural spaces from a planning perspective. These two factors affect people's rarefaction and, therefore, the possibility of maintaining the physical distance necessary to limit contagions. Open-air spaces are fundamental for reducing mental illnesses, psychological stress and promoting a good and healthy lifestyle based on sport activity, walking, and physical movement (Fisher, 2020). Natural spaces in densely urban areas can help people to reduce the virus influence by limiting physical proximity and psychological stress. At the same time, other studies have shown that living in urban areas (rich in infrastructure and hospitals) rather than rural areas significantly reduces anxiety among people (Singh et al., 2020). People feel much safer in urban areas than in rural ones because hospitals are much more quickly reachable. That is why urban planning must focus on improving urban resilience in terms of increasing open-air spaces in dense areas useful to push a behavioural change in people's life-styles. On the other hand, even the less dense territories (for example the mountains) have recorded numerous deaths. This leads us to believe that if the authorities had allowed the use of natural spaces, typical of these areas, instead of forcing the population to stay at home, the contagions would probably have been limited. At the same time, we suggest improving the resilience in terms of increasing accessibility to hospitals and healthcare centres.

About the mountain and valley territories (the most peripheral of the region), the analysis shows the incidence of the number of deaths in the 35–54 age-group. These deaths characterized municipalities such as Ponte di Legno, Bagolino, Darfo Boario Terme, Piancogno in the Brescia Province, Ponte in Valtellina in the Sondrio Province, Castiglione delle Stiviere and Borgo Mantovano in the Mantova Province, Voghera and Rivanazzano Terme in the Pavia Province, Ispra in the Varese Province and Bellagio in the Como province. These are municipalities where tourist, skiing, hiking, and spa activities are present. The deaths in the 35–54 age group are not so many in absolute values, but compared to previous years the percentage rises considerably. In this environment, the high incidence of deaths for this age-group involves a set of reflections on the accessibility of these areas.

In the future, the lack of young working-age population could make the maintenance of settlement assets, public spaces, tourist and accommodation activities critical, leading to a contraction of income sources for smaller communities, as well as a drastic recession in terms of care and ordinary maintenance of the territory and landscape. The numerous reflections already advanced on the fate of 'historical villages' both in Italian inland areas and in developed regions such as Lombardy, make worse by events such as the pandemic. This implies the need to carefully monitor the emergency phases that will develop in the future months and years. These territories will lose additional working-resources and direct control of these territories certainly means precluding these realities from resisting the globalizing phenomena and keeping their identity alive through the constant presence of local inhabitants who invest in the preservation and local production.

6. Conclusions

The research suggests that an urban health-oriented study approach should be adopted where urban strategies and design actions are aimed at continuously improving people's health status. The aim is to ensure a complete state of physical, mental, and social well-being of people and not only to avoid the onset of disease (WHO, 1986). Health is no longer a restricted health theme, even a priority strongly influenced by how people live and, consequently, urban and building planning and programming strategies.

Urbanism might consider the research results in two ways. On the one hand, recognizing the usefulness of the 'urban health' approach, especially in compact and dense cities, by reducing/mitigating the urban features that influence the spread of contagious diseases (e.g. lack of open-air spaces, housing overcrowding, and shortage of public transport capacity). On the other hand, investigating specific territorial weaknesses (mainly mobility and accessibility issues), which affect the response to emergencies and accessibility to essential services in dispersed/marginalized cities (e.g. distance from hospitals, isolation/lack of fast connection infrastructures).

The second aspect refers to the effects of disease on population assessing the actual accessibility to health services (e.g. first aid, intensive care, primary medical care, and medical presence/preparation), travel time to reach hospitals or emergency response time. Considering that in mountain areas, youngers died much more than in the past period, they maybe suffered the distance from hospitals and the scarcity of local health-care. Another contribution could develop this analysis in the future because accessibility and hospital services knowledge must be added to the data available today. This investigation is fundamental for the community's preparedness and the assessment of its exposure.

The paper investigates the relationship between deaths and the demographic pyramid in Lombardy. The research did not aim to find direct cause-effect relations between these two variables because many others might be considered (e.g. presence of other diseases, lifestyles, economic availability for specialist care, etc.). Our research highlighted that Covid-19 is certainly an accelerator of territorial fragility, i.e., inhabitants' loss. Considering marginal areas, the decrease of youngers exacerbates historical centres' abandonment, the depopulation of residents in touristic areas, and premature aging of communities. In environments with already critical demographic phenomena, Covid-19 has undoubtedly increased their fragility.

It is important information for urbanism because it could support site-specific recovery/regeneration strategies based on developing economic support mechanisms, growing welfare of family-care, and promoting school policies. On the contrary, in metropolitan areas, affected by other forms of fragility (overcrowding of immigrants, isolation of the elderly, polluting production activities, lack of urban green areas, etc.), urbanism can be oriented towards reducing soil sealing, renewal living spaces, relocating businesses at risk, stimulating a sustainable and smart development, improving slow-mobility and reducing traffic. Generally, urbanism might lead to a behavioural change (healthier lifestyles) and contribute to achieving a healthy city. Indeed, the Ministry of Health data shows that in addition to the seniority factor, other diseases than Covid-19 affect deaths and, in particular high blood pressure, diabetes mellitus type 2, and ischemic heart disease.[5] Diseases that can be prevented through increased physical activity and improved nutrition. To do this, people need open-air spaces spread in the urban environment. They can play sports, walk and live in the urban environment without increasing people's crowding in public spaces.

Finally, we emphasize some limits and opportunities of the research. Our study could be extended spatially to the other Italian regions and temporally to the following months in 2020. It would be better to understand whether the peculiarities detected in Lombardy could be extended to other geographical areas and whether the initial gap between official data of HIH and Istat has been reduced over time. Another limitation of our study is that the comparison between HIH and Istat data is based on projections since the availability of Istat data was limited to the municipalities equipped with a digital recording system of deaths. Therefore, the assessments reported in our study could be subjected to slight adjustments when the data of all municipalities will be available. Last, our evaluation of the actual amount of deaths related to Covid-19 needs to be validated over the years, considering the anomalies of the total deaths recording in 2020 (and in particular in March and April) concerning the following years.

Nevertheless, all the claims are based on the processing of official data reported by Istat. The result of the processing and projections are shown in the annex tables. Possible development of this research could be an extension to all the Italian regions of all the figures currently related to Lombardy. Another opportunity to improve the research is to study a list of case studies in Lombardy, analyse their pandemic-proof planning tool, and compare urban planning strategies, rules, and measures.

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Declaration of competing interest

All authors declare no support from any organization for the submitted work, no competing interests with regards to the submitted work.

[5] Website of Ministry of Health Covid-19 - Anziani e persone fragili (salute.gov.it).

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Appendix 1. List of tables

Table. 1
Deaths variability in Italy and Lombardy during the first quarter of the five-year period 2015–2019

	Period under investigation > Jan 1st – March 31st						
Deaths	2015	2016	2017	2018	2019	A 15-19	Δ 15-19
Italy*	59,480	52,966	59,974	58,118	57,925	57,693	4.82%
Lombardy**	20,623	18,430	20,916	20,449	20,403	20,164	4.91%

* 1,689 municipalities, ** 622 municipalities, A = Average 2015–2019, Δ = Coefficient of variation.

Table. 2
Deaths variability in Italy and Lombardy between March, 8th-28th of the five-year period 2015–2019

	Period under investigation > March 8th – March 28th						
Deaths	2015	2016	2017	2018	2019	A 15-19	Δ 15-19
Italy*	12,495	11,686	11,750	12,176	12,117	12,045	2.76%
Lombardy**	4,296	4,067	4,084	4,265	4,309	4,204	2.82%

* 1,689 municipalities, ** 622 municipalities, A = Average 2015–2019, Δ = Coefficient of variation.

Table. 3
Incidence of Covid-19 on the first quarter of 2015–2020. Deaths in Italy and Lombardy and comparison between the average of the five-year period 2015–2019 and the year 2020

	(A) Average deaths 15-19	Standard deviation	Δ 15-19	Deaths 2020	Δ deaths 2020 – A 15-19	% deaths 2020 compared to A 15-19
	JANUARY					
Italy*	21,524	2,225	10.34%	19,292	−2232	90%
Lombardy**	7,549	822	10.89%	6,683	−866	89%
	FEBRUARY					
Italy*	18,180	1,060	5.83%	17,934	−246	99%
Lombardy**	6,344	380	5.99%	6,283	−61	99%
	MARCH					
Italy*	17,989	525	2.92%	37,240	19,251	207%
Lombardy**	6,272	196	3.13%	18,066	11,794	288%

* 1,689 municipalities, ** 622 municipalities, Δ = Coefficient of variation.

Table. 4
Regional comparison between deaths in 2015–2019 and 2020 (8th-28th March) based on data provided by Istat

	Municipalities present in RPR		
Italian Regions	Average deaths in 2015-2019	Deaths in 2020	Ratio between deaths 2020 and average deaths 2015-2019
Piedmont	1,200	2,263	189%
Valle d'Aosta	35	68	194%
**Lombardy ** **	**4,204**	**14,209**	**338%**
Trentino Alto Adige	120	251	210%
Veneto	1,123	1,711	152%
Friuli Venezia Giulia	73	125	171%
Liguria	874	1,448	166%
Emilia Romagna	1,783	3,992	224%
Toscana	841	1,214	144%
Umbria	137	193	140%
Marche	339	722	213%
Lazio	107	159	149%
Abruzzo	107	176	164%
Molise	16	32	195%
Campania	131	199	151%
Puglia	424	565	133%
Basilicata	33	45	138%
Calabria	62	100	160%
Sicily	229	326	142%
Sardinia	205	339	166%
Italy *	**12,045**	**28,137**	**234%**

* 1,689 municipalities, ** 622 municipalities

Table. 5
Regional comparison between estimates of deaths in 2015-2019 and 2020 (8th-28th March). The estimates are derived as a projection of the data provided by Istat

		Estimates of deaths			
Italian Regions	Ratio between population of 622 municipalities and Italian Municipalities	Average deaths in 2015-2019	Deaths in 2020	'Excess deaths' 2020	Ratio between 'excess deaths' 2020 and total population
Piedmont	38.8%	3,090	5,827	2,737	0.063%
Valle d'Aosta	39.2%	89	174	84	0.066%
Lombardy	**71.7%**	**5,863**	**19,815**	**13,952**	**0.144%**
Trentino Alto Adige	18.9%	631	1,325	694	0.067%
Veneto	40.8%	2,751	4,190	1,440	0.030%
Friuli Venezia Giulia	9.8%	746	1,277	531	0.044%
Liguria	68.8%	1,270	2,105	835	0.053%
Emilia Romagna	60.5%	2,946	6,596	3,650	0.084%
Toscana	31.8%	2,648	3,821	1,173	0.032%
Umbria	23.8%	577	811	234	0.026%
Marche	33.5%	1,012	2,154	1,141	0.074%
Lazio	3.2%	3,308	4,915	1,607	0.029%
Abruzzo	13.2%	812	1,334	521	0.040%
Molise	8.5%	192	375	183	0.058%
Campania	4.5%	2,936	4,446	1,510	0.026%
Puglia	18.6%	2,281	3,037	757	0.019%
Basilicata	8.5%	385	531	146	0.025%
Calabria	5.2%	1,209	1,937	728	0.037%
Sicily	7.3%	3,163	4,495	1,332	0.027%
Sardinia	23.8%	861	1,426	565	0.034%
Italy	**31.8 %**	**36,769**	**70,590**	**33,821**	**0.057%**

Table. 6
Comparison between 'excess deaths' 2020 and official deaths for Covid-19 provided by HIH (8th-28th March)

Italian Regions	'Excess deaths' 2020	Official deaths for Covid-19 (HIH data)	Ratio between 'excess deaths' and official deaths
Piedmont	2,737	679	403%
Valle d'Aosta	84	43	196%
Lombardy	**13,952**	**6,093**	**229%**
Trentino Alto Adige	694	193	359%
Veneto	1,440	374	385%
Friuli Venezia Giulia	531	97	548%
Liguria	835	371	225%
Emilia Romagna	3,650	1,387	263%
Toscana	1,173	215	545%
Umbria	234	31	753%
Marche	1,141	379	301%
Lazio	1,607	133	1,209%
Abruzzo	521	88	593%
Molise	183	9	2,029%
Campania	1,510	117	1,291%
Puglia	757	83	912%
Basilicata	146	4	3,659%
Calabria	728	25	2,913%
Sicily	1,332	65	2,049%
Sardinia	565	27	2,094%
Italy	**33,821**	**10,413**	**325%**

Table. 7
Deaths in Lombardy (16th-30th March) for 622 municipalities

	Age-group		Males					Females				
			A	B	C	D	E	A	B	C	D	E
Young	0	4	4.4	8	0.1%	3.,6	182%	2.6	0	0.0%	−2.6	0%
	5	9	1.0	0	0.0%	−1.0	0%	0.6	0	0.0%	−0.6	0%
	10	14	0.6	1	0.0%	0.4	167%	0.2	0	0.0%	−0.2	0%
	15	19	1.8	0	0.0%	−1.8	0%	0.2	1	0.0%	0.8	500%
	20	24	2.4	1	0.0%	−1.4	42%	0.8	0	0.0%	−0.8	0%
	25	29	2.8	1	0.0%	−1.8	36%	1.4	1	0.0%	−0.4	71%
	30	34	3.8	2	0.0%	−1.8	53%	4.0	3	0.1%	−1.0	75%
Adults	35	39	3.4	11	0.2%	7.6	324%	3.6	4	0.1%	0.4	111%

(*continued on next page*)

Table. 7 (*continued*)

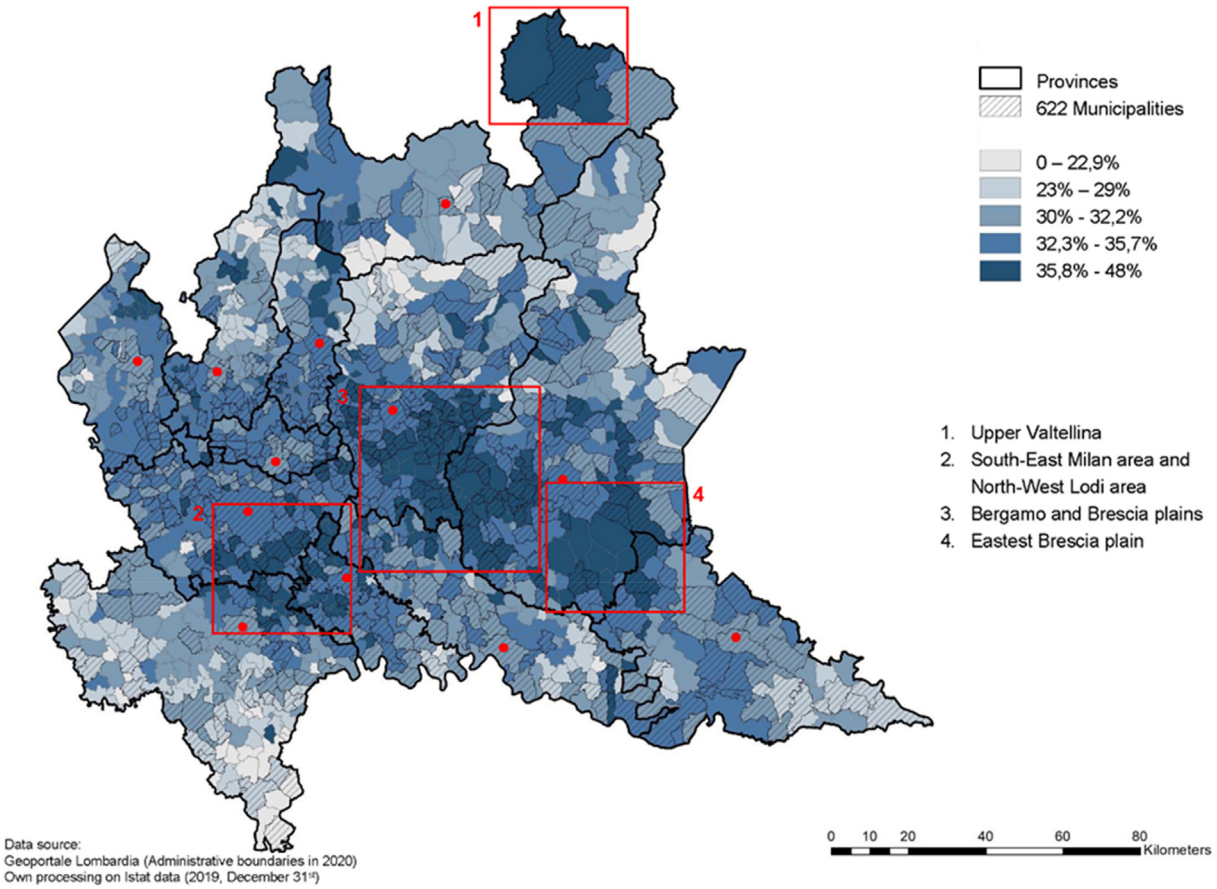
	Age-group		Males					Females				
			A	B	C	D	E	A	B	C	D	E
	40	44	9.4	17	0.3%	7.6	181%	6.0	10	0.2%	4.0	167%
	45	49	19.4	54	0.9%	34.6	278%	11.4	20	0.4%	8.6	175%
	50	54	31.4	80	1.3%	48.6	255%	19.8	44	0.8%	24.2	222%
	55	59	44.6	153	2.6%	108.4	343%	25.6	58	1.1%	32.4	227%
	60	64	68.0	253	4.2%	185.0	372%	37.0	74	1.4%	37.0	200%
	65	69	92.6	428	7.2%	335.4	462%	59.6	140	2.7%	80.4	235%
Elders	70	74	135.4	752	12.6%	616.6	555%	87.2	285	5.4%	197.8	327%
	75	79	216.2	1053	17.6%	836.8	487%	163.4	551	10.4%	387.6	337%
	80	84	274.0	1269	21.2%	995.0	463%	248.8	940	17.8%	691.2	378%
	85	89	259.0	1125	18.8%	866.0	434%	368.8	1276	24.2%	907.2	346%
	90	94	162.4	604	10.1%	441.6	372%	358.0	1206	22.9%	848.0	337%
	95	99	38.4	159	2.7%	120.6	414%	144.4	571	10,.8%	426.6	395%
	100	+	4.2	12	0.2%	7.8	286%	32.0	89	1.7%	57.0	278%
	All groups		**1,375.2**	**5983**	**100.0%**	**4,607.8**	**435%**	**1,575.4**	**5,273**	**100,0%**	**3,697.6**	**335%**

Column A = Deaths in 2015–2019.
Column B = Deaths in 2020.
Column C = % deaths on total deaths in 2015–2019.
Column D = 'excess deaths' in 2020.
Column E = % deaths in 2020 on average deaths in 2015–2019.

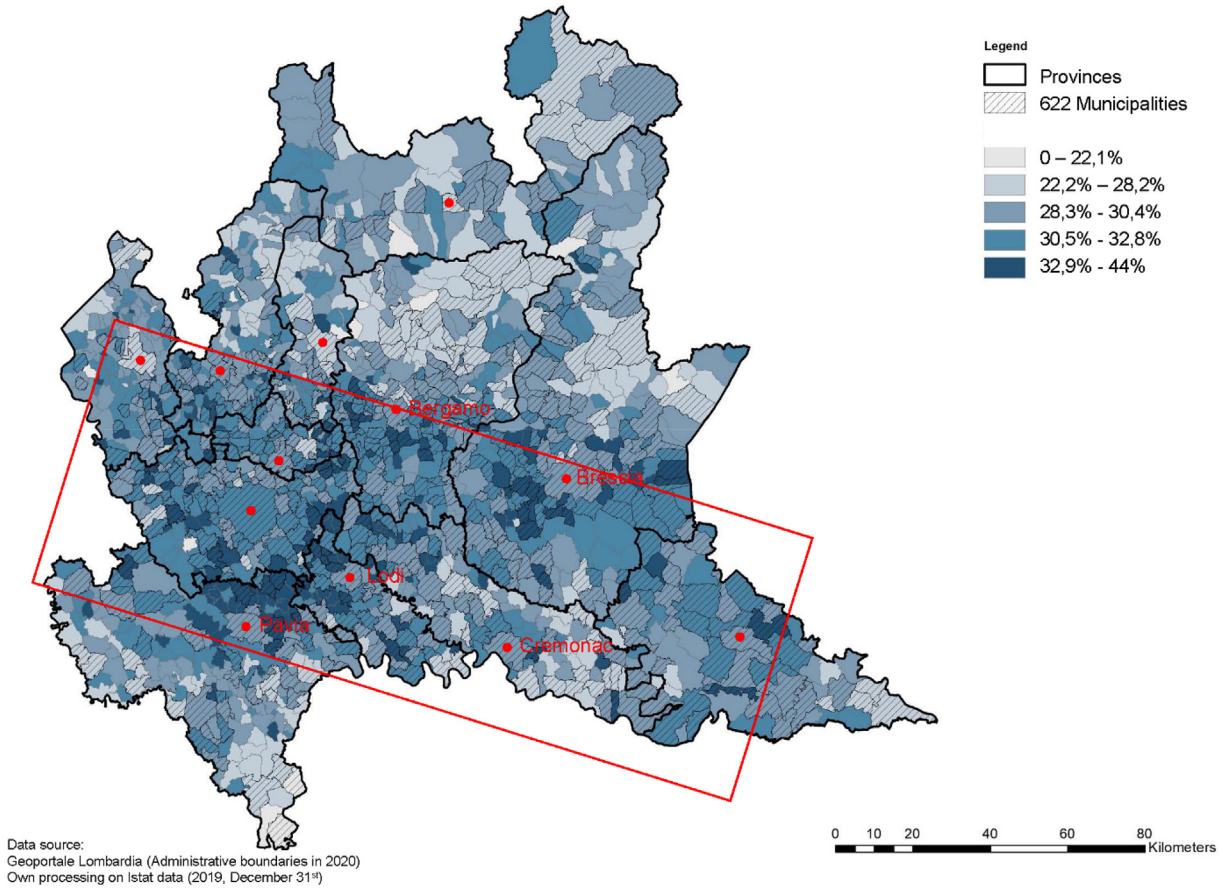
Table. 8
Deaths in Lombardy (16th-30th March) for 622 municipalities

	Age-groups		Total amount of deaths (males and females)				
			% deaths in 2020 on average deaths in 15–19	% deaths in 2020 on average deaths in 2015–2019	% deaths in 2020 on average deaths in 15–19	% deaths in 2020 on average deaths in 15–19	% deaths in 2020 on average deaths in 15–19
Young	0	4	7.0	8	0.1%	1.0	114%
	5	9	1.6	0	0.0%	−1.6	0%
	10	14	0.8	1	0.0%	0.2	125%
	15	19	2.0	1	0.0%	−1.0	50%
	20	24	3.2	1	0.0%	−2.2	31%
	25	29	4.2	2	0.0%	−2.2	48%
	30	34	7.8	5	0.0%	−2.8	64%
Adults	35	39	7.0	15	0.1%	8.0	214%
	40	44	15.4	27	0.2%	11.6	175%
	45	49	30.8	74	0,7%	43.2	240%
	50	54	51.2	124	1,1%	72.8	242%
	55	59	70.2	211	1,9%	140.8	301%
	60	64	105.0	327	2,9%	222.0	311%
	65	69	152.2	568	5,0%	415.8	373%
Elders	70	74	222.6	1037	9,2%	814.4	466%
	75	79	379.6	1604	14,3%	1224.4	423%
	80	84	522.8	2209	19.6%	1686.2	423%
	85	89	627.8	2401	21.3%	1773.2	382%
	90	94	520.4	1810	16.1%	1289.6	348%
	95	99	182.8	730	6.5%	547.2	399%
	100	+	36.2	101	0.9%	64.8	279%
	All groups		**2,950.6**	**11,256**	**100.0%**	**8,305.4**	**381%**

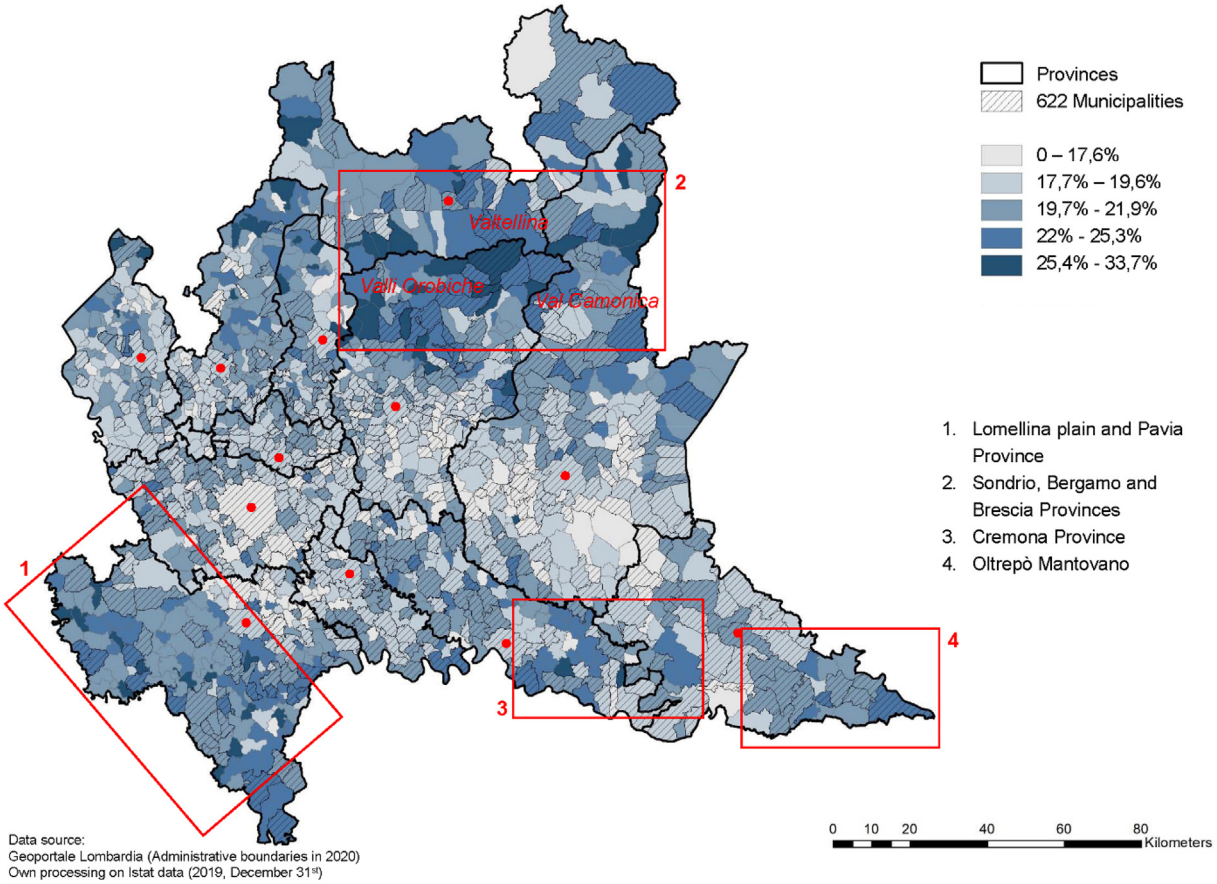
Appendix 2. List of Maps



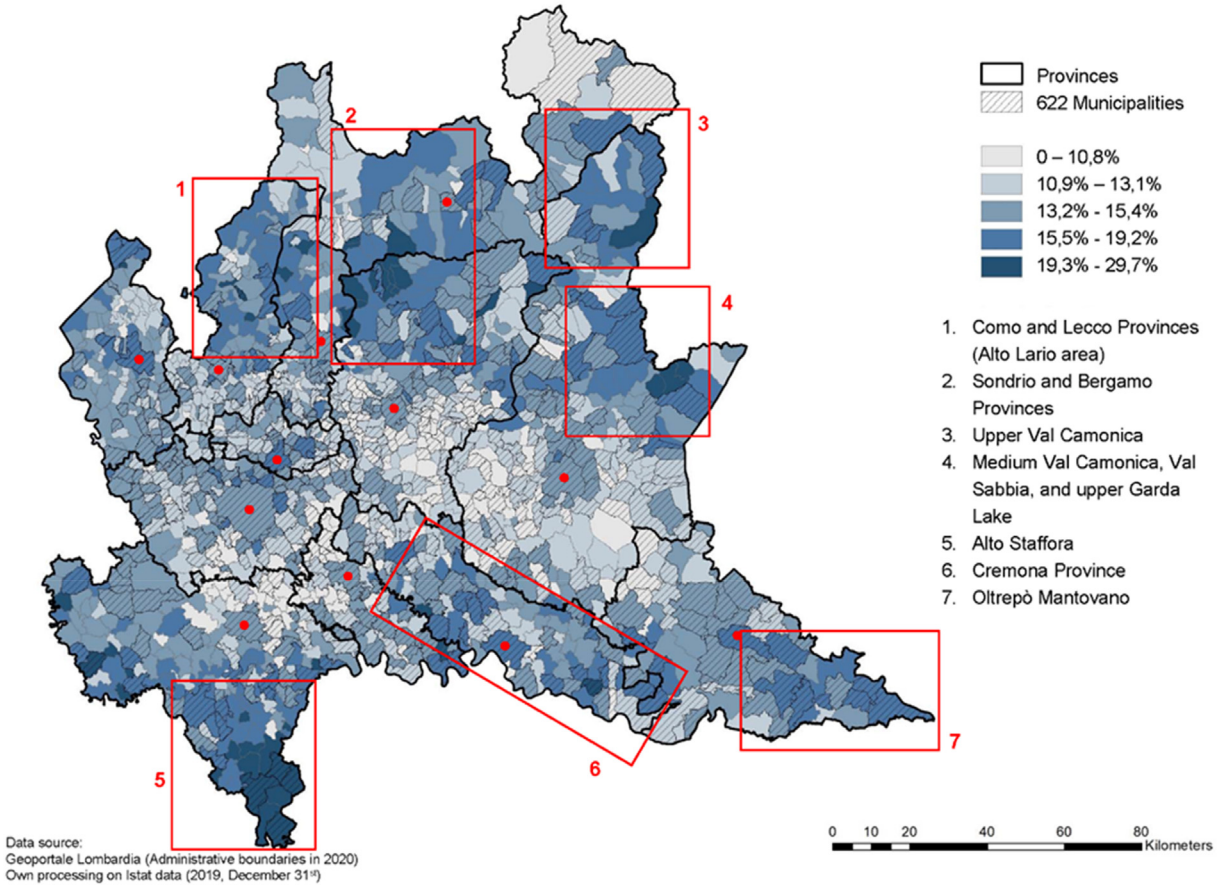
Map 1. Lombard municipalities subdivision by the percentage of the population in age-group 0-34 years-old on the total resident population.



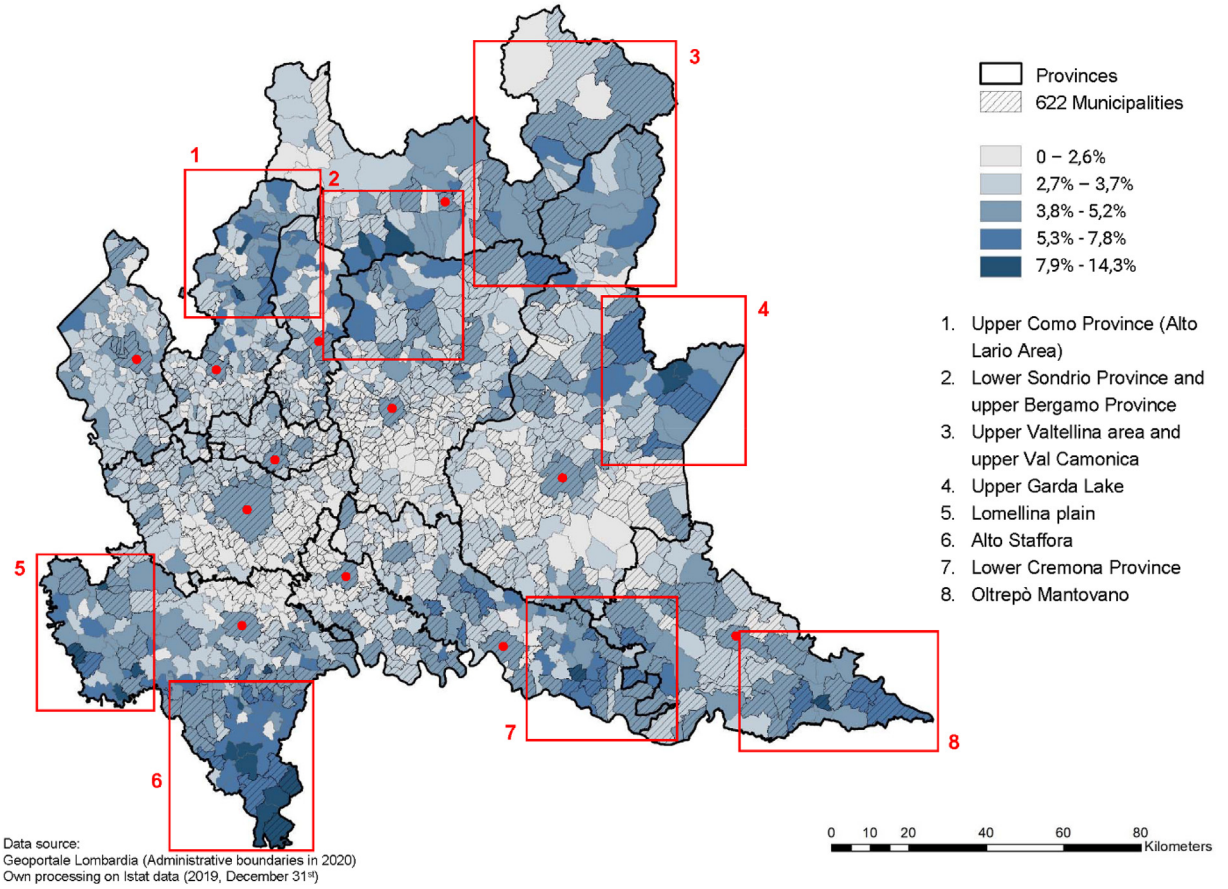
Map 2. Lombard municipalities subdivision by the percentage of the population in age-group 35-54 years-old on the total resident population.



Map 3. Lombard municipalities subdivision by the percentage of the population in age-group 55-69 years-old on the total resident population.



Map 4. Lombard municipalities subdivision by the percentage of the population in age-group 70-84 years-old on the total resident population.



Map 5. Lombard municipalities subdivision by the percentage of the population in age-group over 85 years-old on the total resident population.

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