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The cover image is a photo of the 1966 flood of the Arno in Florence (Italy).

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The Covid-19 pandemic from the elderly perspective in urban areas: An evaluation of urban green areas in ten European capitals

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Abstract
The global Covid-19 pandemic has reshaped lives and activities, especially in urban areas: national and regional authorities have had to react promptly to limit the spread of the coronavirus and avoid the collapse of healthy provision systems. Urban environments, as noted in several World Health Organization reports, are fertile ground for an epidemic's rapid transformation into a pandemic due to their high densities of people, activities, structures and networks. Cities around the world have thus rapidly reorganised to manage the coronavirus crisis. This paper focuses on the spread of the Covid-19 pandemic in European countries during the initial emergency phase and the importance of safe access to and uniform distribution of urban services. We focus on urban green areas as a means of achieving better quality of life, especially for vulnerable groups like the elderly. We selected 10 capital cities (Amsterdam, Brussels, Berlin, Copenhagen, Dublin, Lisbon, London, Madrid, Paris and Rome) to reflect the heterogeneous demographic, social and economic panoramas of European countries and cities. The outcomes of this study can support decision-makers in defining priority actions to reduce the negative impacts on the elderly in the coexistence phase of the pandemic and for future development.

Keywords
Covid-19; Urban areas; Elderly; Green areas.

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1. Introduction

The spread of the novel coronavirus (Covid-19) has raised new and challenging issues closely related to demographic changes and the development of age-friendly urban environments (Oiu et al., 2020; Peters, 2020). The global population is ageing at an unprecedented rate: according to the projections of the World Health Organization (WHO; 2020), people over the age of 60 will number more than two billion by 2050 – more than twice the elderly population recorded by the end of 2019. Although the elderly today are healthier than in previous generations thanks to improvements in welfare and healthcare services, ageing is still commonly associated with greater vulnerability to disease (ARUP, 2015) and the Covid-19 pandemic has shown that people over the age of 60 are most likely to develop severe cases of the virus (WHO, 2020). In Europe, many countries are already facing these issues. Due to these epidemiological concerns, policymakers have needed to strengthen healthcare provisions, which is the most pressing issue in the short term, but also improve the resilience of urban areas to limit economic and social problems in the medium and long term (EY, 2020; Venter et al., 2020). The WHO (2020) has stated that cities are where factors such as high population and activity densities, public transport networks and available structures can function as multipliers of pandemic effects (Desai, 2020; Samuelsson, 2020). At the same time, older adults are mostly located in urban areas, which must be adequately equipped to ensure an acceptable quality of life from the elderly perspective (ARUP, 2015).

This paper is part of a series of Covid-19 studies conducted to more deeply examine the pandemic outbreak and subsequent waves of contagion in European countries and the importance of safe access to essential urban services such as green areas to achieve better quality of life, especially for vulnerable groups like the elderly. Referring to population ageing data and reflecting urban areas through the lenses of accessible mobility and built and digital environments, this research addresses how cities are prepared to face demographic challenges, especially in light of the Covid-19 outbreak and subsequent coexistence phases. A comparison of the trends and patterns in 10 European capital cities serves as the basis for further investigation of the relationship among ageing, politics and planning to face new challenges related to public health and urban governance.

The next section examines the condition of the elderly in urban areas, provides an overview of quality of life in cities and towns, analyses changes in the demographic structure of European countries with a focus on the ageing phenomenon and investigates the role of green urban areas in improving the living conditions of the elderly. The third section evaluates the spread of Covid-19 in Europe, considering the restrictions and limits to activities and services resulting from policies preventing the further spread of Covid-19 and highlighting the challenges of the forthcoming coexistence phase that involve both ageing and green urban areas. The fourth section analyses 10 European case studies selected for this overview, while the final section focuses on the analysis and results of the case studies.

2. The challenge of quality of life in urban areas from the elderly perspective

Quality of life refers to "the overall level of well-being and fulfilment that people enjoy from a combination of their social, economic and community environment and their physical and material conditions" (Morais et al., 2013). Numerous surveys have been conducted to measure quality of life in European cities and analyse residents' satisfaction with various aspects of urban life (European Commission [EC], 2013, 2020; WHO, 2007). Each study has been developed using different dimensions and indicators according to the focus of the analysis and the territorial, cultural and social context of the research (Morais et al., 2013).

In these studies, the presence of adequate public amenities, health and welfare services, and parks and urban green areas represent suitable indicators of the potential quality of life in urban areas. This paper reviews

accessibility in urban green areas from the elderly perspective and in light of the challenges connected to the Covid-19 outbreak and coexistence phase that will drive urban planning practices in the next several years.

The global population of those aged 60 or older is expected to double in the coming decades, reaching two billion before 2050 (WHO, 2020), due to decreases in mortality and fertility rates and the improvement of public health services (ARUP, 2015; Wen et al., 2020). In Europe, as in numerous Western countries, ageing will be one of the most significant economic and social challenges in future years. The ageing of the population is a priority for cities and urban areas, which will need strategies to manage this phenomenon, since about 90% of the world's population is expected to live in urban areas by the end of the 21st century (Artmann et al., 2017). Indeed, the ageing of the global population alongside rapid urbanisation will mean that more and more people will grow old in towns and cities, which will have to adapt to new features and needs in order to improve their inhabitants' quality of life.

In an increasingly urban age, ensuring the fulfilment of elderly people's rights and needs is key to building inclusive, secure, healthy and prosperous communities with a high quality of life (ARUP, 2015). Therefore, the great challenge for urban areas is to achieve a high level of satisfaction amongst the elderly through taking action on several factors that can improve their living standards (EC, 2020; Sun et al., 2010). In other words, cities governments have an essential role in becoming more attractive places for the elderly to live.

In particular, the WHO has emphasised the role of urban green spaces in age-friendly cities, considering safety, accessibility, cleanliness, design and pedestrian-friendly walkways as determinants of cities' suitability for older people (WHO, 2007). Urban green areas have beneficial effects on quality of life for the elderly: living within walking distance of green spaces can increase longevity, reduce health vulnerabilities, promote physical activity and otherwise contribute to elderly well-being, with a consequent positive impact on older people's quality of life (Artmann et al., 2017; Wen et al., 2020).

The following subsections highlight the main demographic trends and geographic distributions in European countries and their capital cities and the importance of green urban areas in defining elderly people's quality of life in anthropised environments.

2.1 The ageing phenomenon in Europe

In the last 60 years, Europe's demographic structure has gradually changed for several reasons. This change is attributable not only to longer life expectancy and improved well-being but also to lower birth rates and to immigration and emigration, which have caused fluctuations in the size of the working-age population in particular (EC, 2014). Combining these effects has modified the population pyramid shape, as shown in Fig. 1, foreshadowing significant social and economic consequences for all communities.

The proportion of the population aged 65 and above has significantly increased in recent years (Mestheneos, 2011; WHO, 2007, 2016).

Between the 20th and the 21st century, the percentage of older people increased in every European country (Mestheneos, 2011; WHO, 2016), albeit at a different pace in each state, and cities have demonstrated distinctive patterns. Whilst most cities have experienced population ageing, certain cities, such as Copenhagen, have become younger (ARUP, 2015).

Tab. 1 shows data concerning population ageing and its distribution within urban or rural areas provided by DataBank, an analysis and visualisation tool powered by the World Bank (2019). Regarding location, it is worth noting that on average about 74% of people live in cities and towns, ranging from 53.7% in Slovakia to 98% in Belgium (ARUP, 2015).

Hence, the greatest demand for services from the elderly is in urban areas, which also represent a potential turning point for more age-friendly policies and practices (WHO, 2007, 2016).

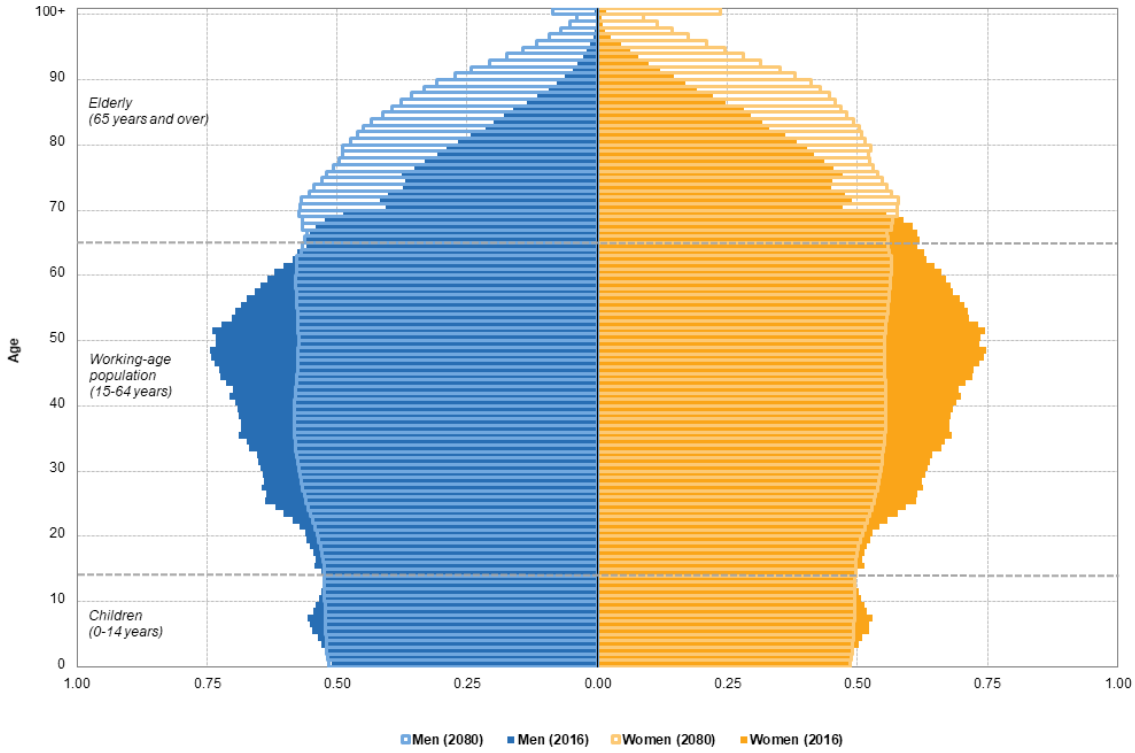


Fig.1. European population pyramid for 2016 and projections to 2080 (EUROSTAT, 2016)

The share of older adults is on average about 20%. By the end of the Decade of Healthy Ageing (2020–2030), defined by the WHO to promote improvement in life of elderly people, their families and communities, the share of people aged 65 and over will be 34% higher, increasing from 1 billion in 2019 to 1.4 billion in 2030 (WHO, 2017). By 2050, the global population of older people will have more than doubled, reaching 2.1 billion. There will be more than twice as many people over 65 years old than children under the age of five, outnumbering adolescents and young people aged 15–24 years (WHO, 2007). Data suggest that the European continent has already aged: by 2025, more than 20% of Europeans will be 65 or older, with a remarkably rapid increase in the number of people older than 80 years (EC, 2014; UN, 2018). As stated by EUROSTAT (2019), in the decades since 1962 – when the percentage of people over 60 reached the percentage of children under five – the share of people aged 65 and older has continued to increase while the natural growth rate has remained negative. Italy is an elderly country, with 23% of people aged 65 and older. According to recent studies, if Italy maintains its current fertility rates, it will need to raise the retirement age to 77 or admit 2.2 million immigrants annually to maintain its worker-to-retiree ratio (Lunenfeld & Stratton, 2013). This phenomenon will have several consequences for relevant sectors, including the overall demand system and the socioeconomic and tertiary systems (Alfano & Capasso, 2019). In particular, the ageing of the population will impact the organisation and management of many activities that characterise urban environments, such as leisure activities, healthcare, mobility and welfare services (Mobley et al., 2006; Somenahalli & Shipton, 2013), with consequences comparable to those of the Industrial Revolution (ARUP, 2015). Indeed, this issue will inevitably impact national and international labour markets and finances due to increased social spending for pensions and the decline of the workforce, which could be partially offset by lowering unemployment and childcare costs (Metz, 2000). Moreover, both the overall population and Europe's GDP will proportionally decrease compared to the rest of the world. As such, given the ageing population phenomenon, ensuring high quality of life for older people is key to building resilient, inclusive, secure, healthy and prosperous communities in the coming years (ARUP, 2015). The next subsection elucidates the relationship between quality of life and

urban green areas, highlighting the role of green spaces in the overall well-being of older people who live in cities and towns.

Countries	Total population	Urban population		Population over 65 years old	
	Inhabitants	Inhabitants	%	Inhabitants	%
Austria	8,877,067	5,194,416	58.5	1,693,354	19.1
Belgium	11,484,055	11,259,082	98.0	2,182,725	19.0
Bulgaria	6,975,761	5,256,027	75.3	1,482,556	21.3
Croatia	4,067,500	2,328,318	57.2	848,486	20.9
Cyprus	1,198,575	800,708	66.8	168,379	14.0
Czech Republic	10,669,709	7,887,156	73.9	2,112,682	19.8
Denmark	5,818,553	5,119,978	88.0	1,161,689	20.0
Estonia	1,326,590	916,024	69.1	265,209	20.0
Finland	5,520,314	4,716,888	85.4	1,222,233	22.1
France	67,059,887	54,123,364	80.7	13,674,430	20.4
Germany	83,132,799	64,324,835	77.4	17,925,919	21.6
Greece	10,716,322	8,507,474	79.4	2,351,319	21.9
Hungary	9,769,949	6,999,582	71.6	1,924,138	19.7
Ireland	4,941,444	3,133,123	63.4	702,813	14.2
Italy	60,297,396	42,651,966	70.7	13,875,719	23.0
Latvia	1,912,789	1,304,943	68.2	388,995	20.3
Lithuania	2,786,844	1,891,013	67.9	561,784	20.2
Luxembourg	619,896	565,488	91.2	8,849	14.3
Malta	502,653	475,902	94.7	104,638	20.8
Netherlands	17,332,850	15,924,729	91.9	3,398,161	19.6
Poland	37,970,874	22,796,574	60.0	6,879,144	18.1
Portugal	10,269,417	6,753,579	65.8	2,295,902	22.4
Romania	19,356,544	10,468,793	54.1	3,637,107	18.8
Slovakia	5,454,073	2,930,419	53.7	882,053	16.2
Slovenia	2,087,946	1,144,654	54.8	421,479	20.2
Spain	47,076,781	37,927,409	80.6	9,249,563	19.6
Sweden	10,285,453	9,021,165	87.7	2,077,514	20.2
United Kingdom	66,834,405	55,908,316	83.7	12,370,177	18.5

Tab.1 National, urban and over-65 population (The World Bank, 2020)

2.2 Quality of life and urban green areas

The scientific literature recognises that greenery-filled public areas provide comfortable and pleasant living environments for urban residents (Chiesura, 2004; EC, 2013, 2020; Sturm & Cohen, 2014; Gargiulo, 2016). Urban green areas can both directly and indirectly influence people's quality of life (Ugolini et al., 2020). Multidisciplinary research has concluded that the positive effects include, for example, the mitigation of the heat island phenomenon, improvement of air quality, reduction of the effects of climate change and encouragement of physical activity (Samuelsson et al., 2020; Sobral et al., 2020). Moreover, living near green areas is associated with lower risk of cardiovascular disease, obesity, diabetes, asthma hospitalisation, mental distress and mortality among adults and with lower risk of obesity and myopia in children (Ekkel & de Vries, 2017; Paquet et al., 2013; Sturm & Cohen, 2014). More significant quantities of urban green areas in a neighbourhood are also associated with better self-reported health and subjective well-being in adults and

improved birth outcomes and cognitive development in children (Sullivan et al., 2004). Urban green spaces, including parks and small green spaces, provide a wide range of ecosystem services, which can help people cope with many diseases and improve their quality of life and health status (Wolch, 2014). Specifically, stress harms psycho-physiological health, and leisure experiences in green environments such as parks improve these negative mood states (Orsega-Smith, 2004). Urban vegetation also impacts several issues related to urban physical environments: it can improve groundwater management (Puigdefábregas, 2005), protect slope stability (Pignatti et al., 2001), control soil erosion and water levels (Gedan et al., 2011), act as a noise barrier (Cook & Haverbeke, 1974), protect biodiversity (Kong et al., 2010), reduce air pollution (De Carvalho & Szlafsztein, 2019), improve microclimatic conditions, mitigate the heat island effect and reduce energy demand (Susca et al., 2011; Gargiulo, 2017; Papa, 2016). Furthermore, urban green areas offer economic benefits since their presence increases property values, as stated by international scientific researchers (Trojanek et al., 2018; Zhang et al., 2012). Hence, greenery represents an urban design resource that is both aesthetic and functional with regard to citizens' overall welfare (Ugolini et al., 2020).

These issues are closely related to the elderly's perceived quality of life in urban environments. Physical activities and social interactions are the most important benefits that gardens and parks provide for older people's quality of life (Artmann et al., 2017). Visiting green areas can improve health, increase longevity, lower stress, promote physical exercise (Artmann et al., 2017; Kabisch & Haase, 2013; WHO, 2007) and reduce the chances of suffering from pathologies common in the elderly population (Ekkel & de Vries, 2017; Sturm & Cohen, 2014). Moreover, green spaces enhance social interaction and active and passive recreation (enjoying the sun, chatting, relaxing, observing nature); provide recreational benefits; encourage meetings between individual people; and increase the elderly's perceptions of safety (Kabisch & Haase, 2013). According to Sun et al. (2011), older adults who have close contact with other people and take part in social and physical activities have a lower likelihood of developing problems related to mobility, pain, discomfort, anxiety and depression. Together, these aspects contribute to the overall well-being of older people in urban areas, enhancing their quality of life (Carpentieri, 2020; Wen et al., 2020; WHO, 2007). Greenery can thus significantly support the well-being of the elderly, which is under threat due to fundamental social changes that accompany ageing such as losing close relationships and independence (Artmann et al., 2017). As such, an appropriate design of urban green areas is crucial in satisfying older people's needs according to their age and health conditions.

However, taking into account the Covid-19 outbreak in our communities, there is a growing concern regarding the role of physical environmental factors in facilitating or modifying health behaviours. Currently, policymakers are facing this challenge in the context of a Covid-19 pandemic coexistence phase. Hence, the need to access and take advantage of secure green spaces could be particularly significant for the most vulnerable people, such as the elderly (Freeman & Eykelbosh, 2020).

The next section further investigates how Europe and its inhabitants – especially the oldest – have been deeply affected by the spread of Covid-19, proposing urban green area design as one way to afford the current coexistence phase.

3. The challenge of the Covid-19 pandemic in urban areas

In the first months of 2020, the entire world saw the spread of a novel coronavirus first detected in China at the end of 2019 that not only caused health emergencies but also raised social and economic issues not experienced in recent human history (Salama, 2020). This emergency did not spare Europe; indeed, since 13 March 2020, Europe has recorded more cases than China, such that the WHO considered European countries the new active epicentre of the pandemic. Relevant to the aim of our paper, among adults, the risk for developing severe Covid-19 symptoms increases with age, with older adults (over 65) at the highest risk

(Brooke & Jackson, 2020; Douglas et al., 2020; WHO, 2020). The data on infections and deaths indicate that the chance of becoming severely ill from Covid-19 increases with age, with eight out of 10 coronavirus-related deaths in Europe occurring among adults aged 65 years or older (Brooke & Jackson, 2020). Fig. 2 below focuses exclusively on the Italian context: the vertical axis indicates the number of deaths related to Covid-19, while the horizontal axis represents different age groups. This graph highlights that more than 95% of the people who have died were aged 60 or older. Other European countries present the same scenario.

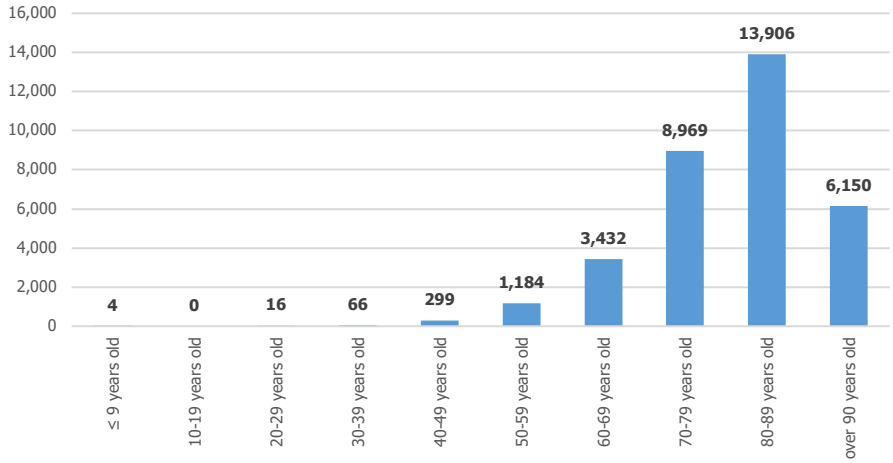


Fig.2 Covid-19 deaths in Italy as of 9 July 2020 by age (Italian Health Minister, 2020)

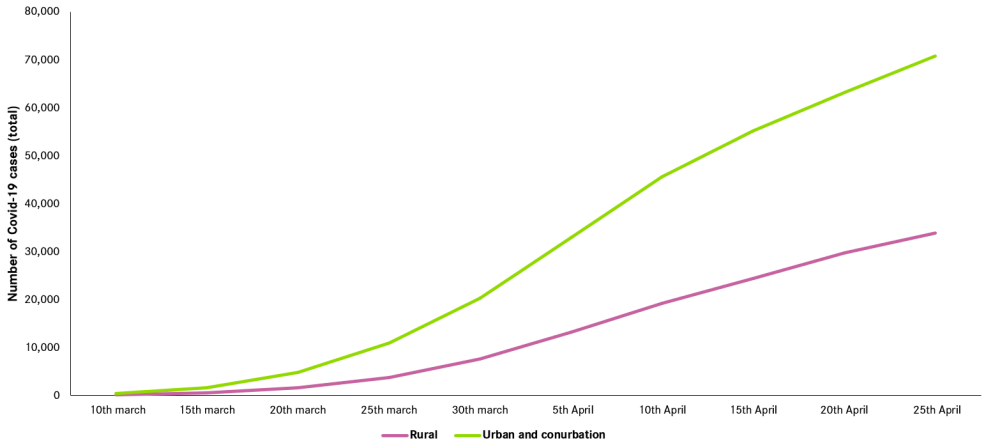


Fig.3 Growth in the number of Covid-19 cases in urban and rural areas in England (Public Health England, 2020)

While these data show that the elderly are particularly vulnerable to the spread of Covid-19 and consequent infections, Fig. 3 focuses on another significant issue related to the urban environment. Due to the high density of inhabitants and activities and the considerable number of opportunities for services and leisure, and consequent movements, the main features of the urban fabric multiply the effects of the pandemic's spread (Desai, 2020; Stier et al., 2020).

As for the UK, the number of cases registered in urban areas (green line) was more than twice the number recorded in rural environments (purple line) at the end of April 2020 (Office for National Statistics [ONS], 2020). Fig. 3 indicates that cities represent fertile ground for an epidemic's rapid transformation into a pandemic due to the presence of safe and efficient roads, railways, air and maritime networks, activities and opportunities, shopping and leisure centres and so on. To investigate the relationship between the Covid-19 pandemic and the main features of the urban fabric, we further analysed the pandemic's temporal evolution in European countries. We considered the number of certified cases at the end of June, the number of

infectious people until the peak day (i.e. the day with the highest number of new daily cases, which differs by country) and finally the speed of Covid-19's evolution (the ratio of the sum total cases until peak day and the number of days between the first detected case of Covid-19 and peak day per nation).

Country	Covid-19 cases through 30 June 2020	Peak day	Total cases until peak day	Covid-19 infection speed until peak day
		Date		Cases/day
Austria	17,766	27/03/20	7,399	411
Belgium	61,427	15/04/20	33,573	839
Bulgaria	4,831	10/07/20	6,672	53
Croatia	2,777	11/07/20	3,672	32
Cyprus	985	02/04/20	356	40
Czech Republic	11,954	27/03/20	2,395	160
Denmark	12,968	07/04/20	5,266	195
Estonia	1,989	26/03/20	538	45
Finland	7,248	29/03/20	2,301	105
France	164,801	31/03/20	52,128	1,682
Germany	194,259	28/03/20	48,582	1,799
Greece	3,302	22/04/20	2,401	63
Hungary	4,155	10/04/20	119	60
Ireland	25,473	16/04/20	13,176	399
Italy	240,578	21/03/20	53,578	1,848
Latvia	1,121	31/03/20	446	37
Lithuania	1,817	18/04/20	1,239	46
Luxembourg	4,299	25/03/20	274	34
Malta	670	07/04/20	293	10
Netherlands	5,027	10/04/20	23,097	745
Poland	34,393	08/06/20	2,716	316
Portugal	42,171	10/04/20	15,472	553
Romania	34,226	11/07/20	32,079	270
Slovakia	1,687	15/04/20	977	35
Slovenia	1600	27/03/20	632	45
Spain	249,271	26/03/20	75,486	3,019
Sweden	69,738	24/06/20	64,124	697
United Kingdom	312,654	12/04/20	84,279	2,161

Tab.2 Covid-19 spread data for European countries (National Governments, 2020)

Tab. 4 summarises the evolution of the pandemic in the European context and shows some significant differences, mostly related to restrictive policies and people's behaviours as well as the ordinary functionality of urban activities and structures. According to recent analyses (Fang et al., 2020; Qianying, 2020), it is worth noting that the measure of the infectious speed of Covid-19 could be useful in representing transmission dynamics. There are 11 countries among the 28 considered with a peak seed value higher than 350.

The relationship between the main features of the urban fabric and the spread of the pandemic, along with cities' demographic structures, has highlighted the vulnerability of the elderly living in urban areas and how urgently new solutions are needed to improve the lives of older people and their families. There is little evidence that older people are in better health today than in previous generations (WHO, 2015), which implies

more potential opportunities that could arise from increasing longevity. However, ageing is usually associated with poor health, social isolation and dependence on care such that individual ability to access the opportunities mentioned above depends on a person's intrinsic capacities (e.g. the combination of all of the individual's physical and mental capabilities), living environment (in the broadest sense, including physical, social and policy factors) and the interactions among them (EC, 2014; Somenahalli & Shipton, 2013). The Covid-19 outbreak has emphasised the vulnerability of this sociodemographic group, showing the limited ability of Western countries and cities to afford a world health emergency (Lithander et al., 2020). That said, old age itself is not an inherent vulnerability. It is the failure of policies, systems and society to respect and support the fulfilment of rights in older age that constructs older adults' vulnerability through their exclusion from processes and decision-making and their inequitable access to resources and services (ARUP, 2015; Freeman & Eykelbosh, 2020; Samuelsson et al., 2020). Neither are older people a homogenous group; rather, they are diverse in their lived experiences throughout life and older age as well as in their physical, social and economic resources. Still, as individuals, adult people enjoy a range of civil, political, economic, social and cultural rights that are often denied in older age due to patronising and paternalistic ageist discrimination and harmful stereotypes (WHO, 2016).

Cities play a key role in facing demographic changes since more people than ever before will grow old in urban environments (UN, 2018), where most human experiences and activities are concentrated. Hence, they have a fundamental role in defining how to respond to our ageing (or greying) society. In 2007, the world passed a significant milestone when, for the first time in history, 50% of the world's population was living in urban areas (Brenner & Schmid, 2014). People are growing old in housing, streets, communities, towns, cities and mega-cities that are failing to respond appropriately to ageing populations with specific policies that remove all forms of discrimination based on older age (WHO, 2016). Moreover, climate change-related events (e.g. heat waves) and emergencies pose an increased risk to densely populated urban areas, as shown by the Covid-19 pandemic (Sobral et al., 2020). Older people's vulnerabilities further emphasise the need for policies and systems that respect and protect rights in older age to build more resilient communities and urban environments (Douglas et al., 2020; EY, 2020). At the same time, many opportunities and intrinsic advantages arise from urbanisation, which is driving the growth of cities across the world in ways that respect, protect and fulfil older adults' rights, according to the principle of age-friendly settings (WHO, 2007, 2016). The built environment plays a significant role in the construction of social relationships and experiences and can be appropriate for communities and people throughout the course of their lives. Places to rest, access to green spaces, well-designed and safe streets and pavements, accessible pedestrian crossings, walkways and cycling paths can all play an essential role in supporting social interaction and improving health (Ugolini et al., 2020). Pedestrian-friendly, accessible cities and urban environments encourage social connections and physical activity over the course of a person's life, particularly in later life, and can play a crucial role in developing physical, mental and cognitive function (Ekkel & de Vries, 2017; Gong et al., 2016; Ruiz-Euler et al., 2020; WEF, 2020). Early in the pandemic, many cities moved to create more space for people to walk and ride bicycles, not only to increase clean air, social inclusion and public health but also to provide more efficient ways to move people and goods in congested urban areas. The availability, affordability and accessibility of public transportation can impact people's ability to move around a city, visit friends and family, and access services, particularly in older age (Ekkel & de Vries, 2017; Paquet et al., 2013). Providing accessible information, planning transportation routes with appropriate destinations and providing specialised services where required are all critical. All around the world, hundreds of initiatives have sprouted to put walking, cycling and other urban transport innovations at the heart of recovery efforts. They demonstrate the global shift towards supporting more high-quality walking and cycling infrastructure and highlighting active mobility's role in ensuring that cities are welcoming and attractive to people from all walks of life (WEF, 2020).

In this context, in light of the Covid-19 outbreak, green urban areas assume the essential role of promoting quality of life, increasing the longevity and physical and psychological well-being of older people in cities and towns. Recent events related to the Covid-19 pandemic have highlighted the impact that housing quality has on both physical and mental health, especially for the elderly and other vulnerable groups: strict quarantine measures, as well as social distancing, false information and rumours can cause panic and fear among urban residents, affecting mental health (EC, 2020; Kamara et al., 2017). Moreover, extreme lockdown measures have created additional problems for older people who live alone and have to deal with social confinement and isolation from their families (Briguglio et al., 2020). Since many urban inhabitants do not have the opportunity to live in a house with outdoor spaces, parks, gardens and other local green areas are vital to citizens' everyday health (de Kleyn et al., 2020). Several scientific studies have identified and evaluated the benefits of such spaces (Chiesura, 2004; Sturm & Cohen, 2014), including for the elderly (Artmann et al., 2017; Sun et al., 2010; Wen et al., 2020). During the Covid-19–related isolation, urban green areas have provided places of solace and respite and allowed for physical exercise and relaxation. Therefore, urban green areas are considered a critical factor in defining the quality of urbanised contexts, especially during the Covid-19 pandemic.

Despite these benefits, not everyone has easy and safe access to green spaces (White et al., 2019). Due to the Covid-19 pandemic, cities need more open and accessible spaces to ensure that people both respect social distancing and are able to spend time in safe and secure green areas (Metha, 2020; Samuelsson, 2020; WEF, 2020). The rapid changes in modern society necessitate the continual adaptation of urban green areas and other features of the urban fabric. In line with the aim of this paper, urban green areas must adapt to the behavioural changes observed during quarantine, e.g. an increase in people walking to small urban gardens nearby or tree-lined streets (Ugolini et al., 2020) and to the needs of older people, whose preferences depend on the size, aesthetic quality, accessibility and maximal travel distance of a green space (Wen et al., 2020).

In the next few years, further challenges will drive urban environments and service design. The spread of the novel coronavirus has highlighted significant vulnerabilities related to the high density of people and activities in cities, which may pose challenges for appropriate social distancing appropriate social distancing (Desai, 2020; Stier et al., 2020). The coronavirus pandemic has rapidly changed Europe and the whole world. As Covid-19 will impact our ways of living and working for a long time, and considering how green and digital transitions influence, sustain or accelerate demographic paths, future strategic national and local projects will be essential in preparing adequate policies to face the combination of these challenging issues. Cities must be designed such that access to amenities can be provided while maintaining safe social distance, facilitating public health and safeguarding elderly people. These issues are closely related to the elderly's perception of their quality of life in urban environments, especially in the coexistence phase: the improvement of well-being must go hand in hand with the construction of more resilient communities in light of a planetary-scale pandemic. This issue is also significant for policymakers in managing territorial government practices.

4. Ten capital cities as case studies

This study presents an overview of green area distribution and potential usability by the elderly in urban environments, focusing on 10 European cities as case studies: Amsterdam, Brussels, Berlin, Copenhagen, Dublin, Lisbon, London, Madrid, Paris and Rome. This sample of capital cities reflects European demographic, social and economic structures in terms of their major differences and their heterogeneous territorial and historical features (ARUP, 2015; Mestheneos, 2011).

Studies have linked the engagement of older people in certain areas to the presence of specific geography within a city: routes, green spaces, public transport networks, the layout of building blocks, and dimensions and densities of certain elements (Ekkel & de Vries, 2017). Our research focuses on urban green areas (i.e.

parks, public gardens and nearby forests) due to their many beneficial effects, as described in previous sections.

Studies have revealed that in many countries people aged 65 and over are less physically active and have less access to nature-based recreation compared to younger groups (Lee & Maheswaran, 2011). Compared to other social groups, elderly people have specific preferences for some aspects of urban green spaces; for instance, they tend to search for calm and shaded areas where relaxing activities can take place, such as low-intensity sports, dancing, observing animals and plants, feeding animals and spending time socialising (Loukaitou-Sideris et al., 2016). Elderly people's access to nature-based areas should account for a variety of special factors, both objective and subjective: the distribution of parks or green spaces, the distance between greenery and their residences, cultural aspects and aesthetic preferences, infrastructure and mental status (Kamphuis et al., 2009; Kemperman & Timmermans, 2014; Ward Thompson & Aspinall, 2011). On the other hand, they dislike green areas with an absence of visitors or in an environment perceived as unsafe and unguarded (La Rosa et al., 2018). Among these aspects, Kemperman and Timmermans (2006) found that distance from a park was a major constraint for older adults, along with the trip to and from the park, with distance and heavy traffic acting as deterrents to park use.

For the sample of cities, the elderly population distribution was analysed and the urban green areas were located. Next, the extension and local distribution of green areas and the percentage of elderly population were compared. The next subsection presents the results of these analyses.

4.1 Elderly population distribution in the ten case studies

When analysing the elderly population structure and distribution, the total population, population density and percentage of young, medium and old elderly people were considered for each city. The 10 case studies were grouped into the following three clusters based on their surface extension:

- Big cities (London and Rome) had surface areas greater than 1,200 km^2;
- Medium-sized cities (Berlin and Madrid) had surface areas of 890 and 600 km^2, respectively; and
- Small cities (Amsterdam, Brussels, Copenhagen, Dublin, Lisbon and Paris) had surface areas smaller than 220 km^2.

City	Year	Total population	City surface	Population density	65–69	70–79	Over 80
		inh.[1]	km^2	inh./km^2	%	%	%
Amsterdam	2020	872,757	219	3,985	4.2%	5.8%	2.7%
Berlin	2019	3,669,491	892	4,113	5.0%	8.7%	5.4%
Brussels	2020	185,103	32	5,676	3.4%	4.5%	3.1%
Copenhagen	2020	632,340	88	7,185	3.3%	5.0%	2.1%
Dublin	2016	1,173,179	318	3,689	4.0%	5.4%	3.2%
Lisbon	2019	509,515	100	5,095	6.5%	12.0%	9.8%
London	2019	8,961,989	1,572	5,701	6.2%	6.1%	6.3%
Madrid	2019	3,266,126	604	5,407	4.7%	8.1%	7.3%
Paris	2017	2,152,423	105	20,499	4.0%	7.6%	5.1%
Rome	2020	2,837,332	1,287	2,203	5.5%	9.7%	7.5%

Tab.2: Population characteristics for the 10 selected cities (data from EUROSTAT, 2019)

[1] Inhabitants

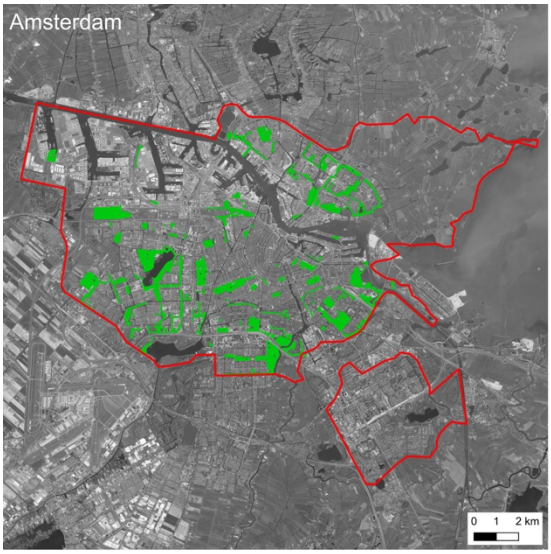
The cities with the highest percentages of elderly population are Lisbon, with 6.5% younger elderly (65-69), 12% medium elderly (70-74) and 9.8% older elderly (≥75), followed by London, with approximately 6.2% aged 65–69, 6.1% aged 70–79 and 6.3% over 80. Berlin and Rome have about 5% young elderly, around 9% medium elderly and 5.4% and 7.5% over 80, respectively. Amsterdam, Brussels, Copenhagen and Dublin have the lowest percentage of elderly residents (around 4% aged 65–69, 5% aged 70–79 and 3% aged 80 and older; EUROSTAT, 2019).

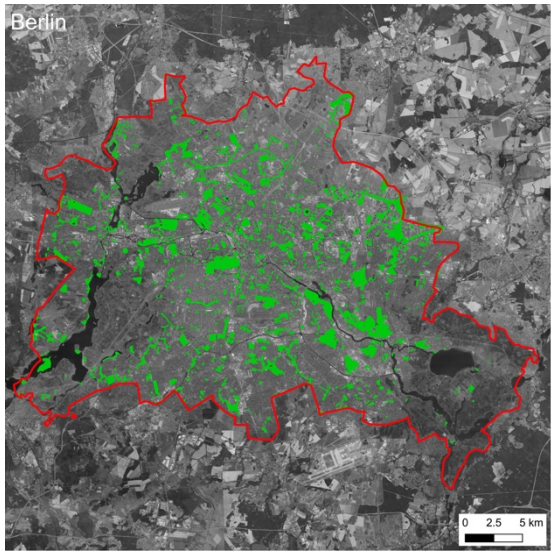
It is worth considering not only the elderly population in the selected case studies but also the distribution of population within cities, since urban structure influences how people live, move and gather (Gong et al., 2016). The population density index can explain the link between a city's population and dimensions. Paris and Copenhagen have very high population densities (20,499 and 7,185 inh./km^2, respectively) while Rome has the lowest (2,203 inh./km^2). Other cities' density values are about 5,000 inh./km^2.

In Lisbon and Madrid, the elderly population distribution is almost homogeneous, with a few variations: while there are higher concentrations in the centre of the city in Lisbon, the centres are slightly younger in Madrid. In Berlin, Brussels and Dublin, the suburbs are generally older than the city centres. In Dublin and Brussels, there is a ring around the centre, whilst in Dublin, older people are mostly located in the northern suburbs. Amsterdam and London have the highest percentages of elderly people in the suburbs but Paris also shows high concentrations in the centre and southwest (ARUP, 2015).

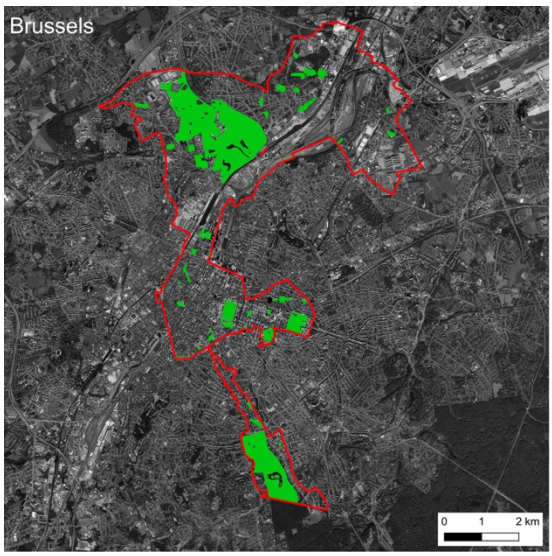
4.2 Urban green area distribution in the ten case studies

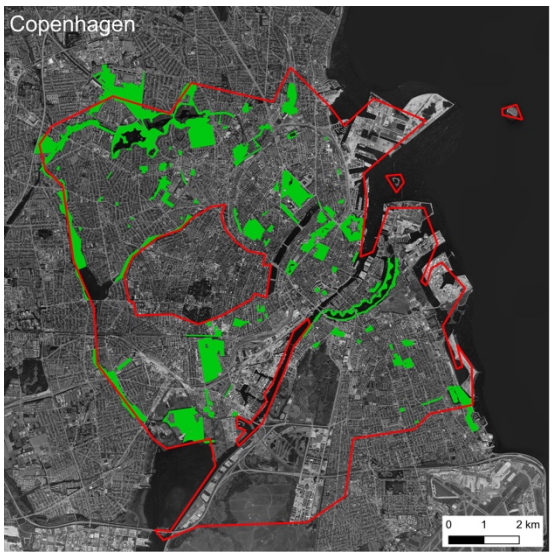
We propose a numerical and spatial evaluation of urban green areas in the 10 European cities. For this research, we used the latest available release (2018) of the Corine Land Cover (CLC) data. In the CLC database, we only selected the 'green urban areas' surfaces to evaluate the localisation and extension of these areas within the administrative boundaries of each city.[2] Based on the maps of each city (Fig. 4), it is possible to locate urban green areas and their extension. Comparing the urban green area spatial distribution between the two big cities in the sample highlights that a significant portion of Rome's urban green areas are located in the city centre, whereas in London these areas are uniformly distributed. The London scenario is an example of the adequate spatial distribution of green urban areas, considering the limited mobility capacity of older adults or other groups with similar mobility impairments.

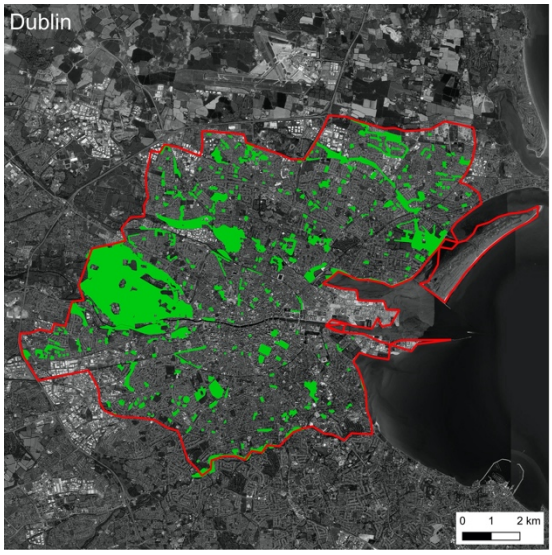


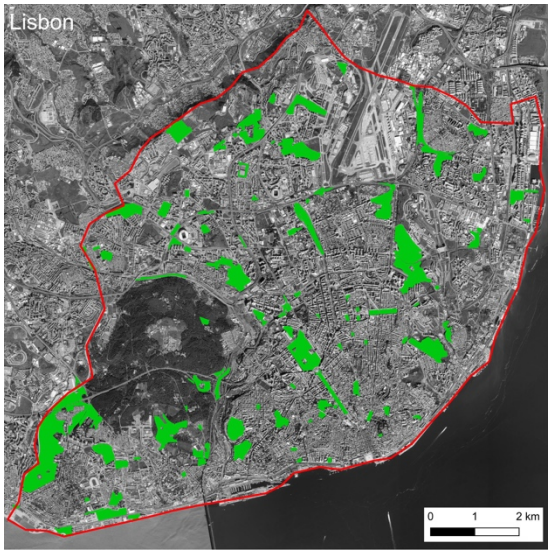


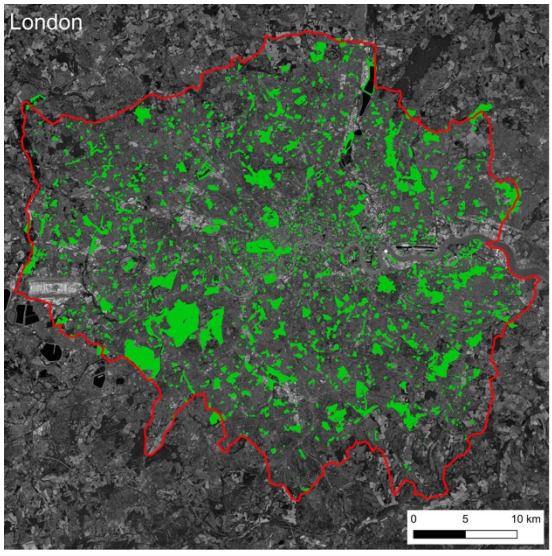
[2] CLC urban green area classifications are available at https://land.copernicus.eu/user-corner/technical-library/corine-land-cover-nomenclature-guidelines/html/index-clc-141.html.

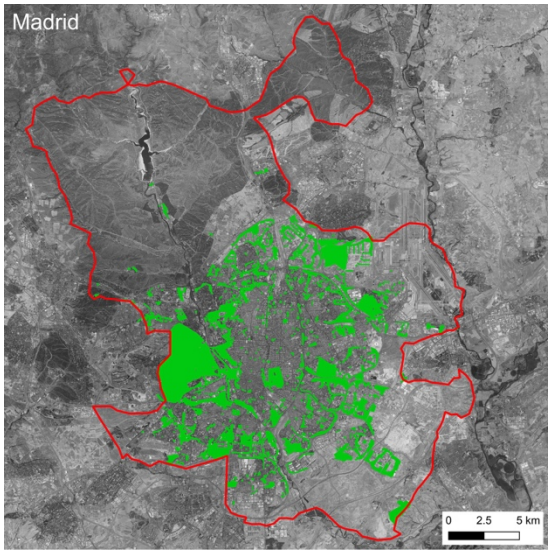

Brussels
0 1 2 km


Copenhagen
0 1 2 km


Dublin
0 1 2 km


Lisbon
0 1 2 km


London
0 5 10 km


Madrid
0 2.5 5 km

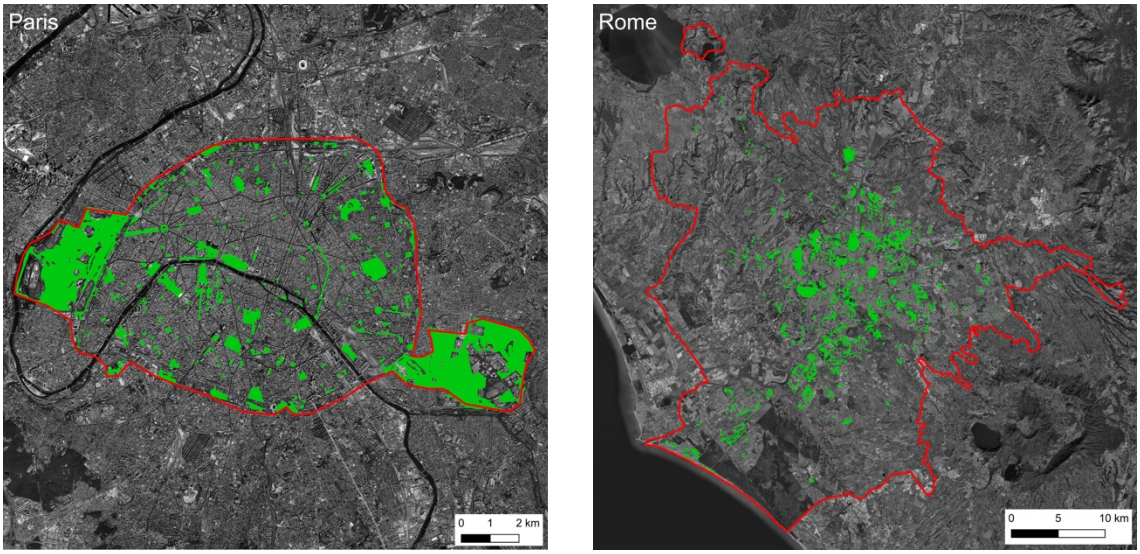


Fig.4 Urban green areas (green) in the 10 selected cities (Corine Land Cover, 2018)

City	Urban green areas	Percentage of urban green areas on city surface	Urban green area/inhabitants
	km^2	%	m^2/inh.
Amsterdam	10,770	5%	12.34
Berlin	69,846	8%	19.03
Brussels	5,083	16%	27.46
Copenhagen	8,550	10%	13.52
Dublin	15,229	13%	12.98
Lisbon	6,276	6%	12.32
London	153,302	10%	17.11
Madrid	58,073	10%	17.78
Paris	17,698	17%	8.22
Rome	35,494	3%	12.51

Tab.4 Urban green area surface in 10 selected cities (Corine Land Cover, 2018)

In the medium cities cluster, the distribution of green areas is mostly uniform. In Madrid, the most significant green spaces are outside the city centre, while in Berlin, the surface of the green spaces is relatively uniform for all municipalities.

In the small cities cluster, the dimensions and localisation of urban green areas varies significantly within the sample. Brussels, Dublin and Paris are characterised by some large green areas, while Amsterdam, Copenhagen and Lisbon show a medium extension of most urban green areas. The numerical data from the GIS analysis show that Paris has the greatest percentage of urban green space surface but the lowest square meters per inhabitant.

In general, if a green space is larger, it has better capacity and greater opportunity to attract people from more distant places (Wen et al., 2020). The EC's (2020) *Report on the quality of life in European cities, 2020* identified the satisfaction with green spaces rates for London, Copenhagen and Lisbon as 93%, 92% and 70%, respectively. Overall, people living in capital cities (74%) were less satisfied with the green spaces in their city than those living in non-capital cities (79%). Indeed, London has the greatest green area surface (more than 150,000 km^2) but the rate of urban area per inhabitant is only average (17.11%). The city with the highest rate of urban green areas is Brussels (27.46%). Brussels and Paris have the highest percentages of green

areas on the city surface (16% and 17%, respectively), followed by Dublin (13%) and London, Madrid and Copenhagen (10% each). The city with the lowest value for this indicator is Rome (3%).
Lisbon is particularly impressive as the city with the highest percentage of elderly people: although the percentage of green areas on the city surface is only 6%, citizens' satisfaction is very high (70%), perhaps due to the even distribution of green spaces throughout the city. While Paris has the highest rate of urban green area surface, it also has the greatest population density; accordingly, the green area surface per inhabitant is the lowest (8.2 m^2/inh.). The comparison of the spatial and numerical analyses demonstrates the importance of considering both of these factors in the urban planning process.

5. Discussion and conclusions

Demographic structure change is a complex issue that should be addressed by local and national authorities. High density of inhabitants and activities in a limited space represents one of the main challenges for urban areas, particularly in light of the Covid-19 pandemic. In developed countries, the ageing population will need to be supported with specific approaches and solutions. The novel coronavirus pandemic has raised some critical concerns related to safe and rapid access to urban services, activities and places, especially for those who have limited mobility. The Covid-19 health emergency has aggravated an unsatisfactory situation for the elderly and other weak population groups.
To address these issues, we conducted this preliminary study on the implications of Covid-19 for urban planning during the first phases of pandemic diffusion in Europe. The data on the spread of the pandemic evidences that urban areas are significantly affected by Covid-19. This overview for the European case studies showed that the practice of urban planning requires a combined audit that considers both the quantitative and spatial aspects of primary urban services. Our findings might benefit planners looking to make informed decisions on the distribution and the accessibility of urban services, like urban green areas, from the elderly perspective. With reference to the results of this study, new planning measures shall be implemented, taking into account the relation among green urban areas, elderly population and the spread of pandemic, both during the decision-making phase and the monitoring one. The issues proposed could be useful to the implementation of some urban planning Plan as the Services Plan, which aims at guaranteeing accessibility and availability to public services, or the Timings Plan, which has the objective to evaluate and coordinate the times of urban services, ensuring access for all citizens. These plans do not consider the number of services by itself, they take into account the distribution, the quality and the paths, too. Perhaps, in the light of this, one limitation of this study is related to the typology of data on urban green areas – specifically, our analysis suffers from the lack of availability of more recent and detailed data.
Our findings raised many topics which are worth pursuing further. The next steps of this research could be measuring the level of accessibility for each city in terms of older adults' distance from the nearest urban green area. Further analysis might be carried out, considering the distance of built-up/residential areas from urban green areas to better relate the percentage of the elderly, the size/distribution of the urban green areas and the quality/safety of the paths. Moreover, it could be interesting to apply the results of our study also to other urban services that affect elderly quality of life, or the level of well-being of other vulnerable groups, e.g. children and people with disabilities.

Authors Contribution

The authors conceived of the presented idea and developed the theory and performed the computations. For what concerns the manuscript, Carpentieri G. and Guida C. wrote paragraphs 1 and 5; Ottavia F. wrote paragraphs 3 and 4; Sabrina S. wrote paragraphs 2 and 3.

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