Review

Build Healthier: Post-COVID-19 Urban Requirements for Healthy and Sustainable Living

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Abstract: The COVID-19 pandemic has brought a renewed interest in urban environment and healthy living and the changes in urban environments which can make for a healthier living. Today, more than 50% of the global population lives in urban areas, and in Europe the number is 75%. We present a narrative review to explore considerations and necessary requirements to achieve health and well-being within strategies for healthy design and urban planning whilst rethinking urban spaces for a post-COVID-19 and carbon-neutral future. The achievement of health and well-being demands healthy design strategies, namely, (1) moving from the concept of infrastructure for processes to the infrastructure for healthy living—requirements for healthy places, cycling, walking, disintegrating the role of polluting traffic from the urban environments, social vulnerability and equality; (2) physical space that will achieve standards of ‘liveable communities’—open, green space requirements and standards for any built environment; (3) mainstreaming ‘in-the-walking distance’ cities and neighbourhoods for healthy physical activities for daily living; (4) exploring any of the new concepts that connect the nexus of urban spaces and public health and improving of the population’s well-being. Public health needs to be prioritised systematically in planning of built environments, energy generations, sustainable food production, and nutrition.

Keywords: COVID-19; urban health; environmental health; healthy urban planning strategies

1. Introduction

The prediction of the United Nations (UN) is that the urbanisation process of the world will continue to be promoted in the future and that by 2050, the urban population of the world will exceed 6.6 billion, while the urbanisation rate will reach 68%. Urban centres are places of human prosperity and wealth but also of inequity and health detrimental environments, lacking green spaces and sufficiently good air quality. Furthermore, urban cities easily become epicentres of global pandemics mainly due to overcrowding, as well as poor housing and urban sanitation [1].

According to the latest WHO data available (from February 2022), the ongoing pandemic of COVID-19 has exceeded 6 million deaths from 400 million cases in the world. This pandemic is a strong warning that urbanisation has altered the ways of living, working and interacting for individuals and communities. There is an urgent need to create resilient systems—at all levels, from global to local—in order to prevent the spread of infectious diseases now and in the future [2]. In addition, for many, this pandemic has dramatically reduced their quality of life. It emphasises the significance of the planning and design towards pandemic-resilient cities and the acceleration of new urban planning developments [3].
In the 19th century, living conditions in many cities were poor, mainly due to the influx of people to cities in search of work. To meet the growing demand for living spaces, such spaces were built rapidly and in low quality, which in turn led to ill health [4]. Thus, throughout history, health crises and epidemics introduced urban planning as a public health response [5]. Nowadays, various urban concepts and models are being implemented in many cities, such as car-free centres or neighbourhoods; Superblocks; neighbourhoods with low-speed traffic; walkable and cyclable cities aimed at all amenities being within 15-min reach, i.e., the so-called ‘15 Minutes City’; or a mixture of these. The COVID-19 pandemic accelerated many of these initiatives even though many of those plannings started well before the current pandemic. These models have been introduced to discourage the use of cars and promote healthy and active transportation, such as walking and cycling, consequently leading to an increase in physical activity, better air quality, and reduction of noise, all resulting in promoting and improving human health. Streets dominated by car use, parking lots, parking spaces, and car lanes are how a majority of streets are planned. There are fewer considerations to green islands, green pedestrian streets and other green infrastructure. In the first wave of the COVID-19 pandemic, when most cities introduced full lockdowns, it was clear that spaces for people were missing. Cities have accelerated urban transformations of the space for active transportation, such as the introduction of more cycling lanes in their networks, transforming ‘car’ streets to mixed use streets, etc. [6].

Furthermore, it should be emphasised that measures taken to prevent the spread of COVID-19 have caused a number of mental health issues, such as depression, stress, anger, anxiety, etc. Alongside numerous health benefits, evidence is showing that both physical and visual exposure to nature and to public green spaces is associated with better mental health and overall better psychological well-being [7–9]. Moreover, literature data suggest that exposure to nature may help individuals improve their resilience, such as the ability to cope with stressful life events and difficulties [10–12].

The aim of this narrative review was to summarise concepts and ideas, backed by available data on public health interventions in urban spaces, urban planning, and infrastructure change in times of the COVID-19 pandemic. Another aim is to gather evidence to foster multisectoral public policy dialogues among health, infrastructure, energy, and environment policymakers in order to move to more protective urban planning that is both protective of health and the environment.

This paper is a review to explore the considerations and necessary requirements to achieve health and well-being within healthy design strategies and urban planning, rethinking of urban spaces for a post-COVID-19, carbon-neutral future; with a special focus on the needs during the COVID-19 pandemic. Our review also provides insights into the gaps in the research related to monitoring COVID-19 and urban, built environments and health.

2. Methods

We performed a search using the meta-database PubMed and grey literature on 25 November 2021 with the aim for writing a narrative review paper. We searched all the papers running the following keywords ("covid*" OR "coronavirus") AND ("urban planning" OR "urban design" OR "urban studies") AND (health).

The following three selection criteria were used to identify the eligibility of the retrieved studies for inclusion in the current review:
1. Exploring COVID-19 or pandemic.
2. Exploring one of the following aspects of urban planning:
   a. Moving from the concept of infrastructure for processes to the infrastructure for healthy living (requirements for healthy places, cycling, walking, disintegrating the role of polluting traffic from the urban environments);
   b. Physical space (open, green space requirements and standards for any built environment) that achieve ‘liveable communities’ standards;
c. Mainstreaming ‘in-the-walking distance’ cities and neighbourhoods (cities that are organised for healthy physical activities for daily living, 15 Minute Cities, etc.);

d. Exploring any new concepts, such as One Health or the New European Bauhaus concept;

e. Integrating spaces for culture and tradition (enhancing social integration, preventing of mental health issues associated with isolation and lack of social contact, etc.).

3. Written in English.

We included empirical studies, as well as opinions, viewpoints, and letters and concept papers in our search review. We included, as expert knowledge, five global reports from WHO, UNDP, and European Observation Network for Territorial Development and Cohesion (ESPON) as grey literature in this review.

In this review, we followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria to guide our screening [13]. The screening process and the number of studies included are displayed in Figure 1.

![Figure 1. PRISMA Flow Diagram.](image)

As a first step, we screened the title and abstracts to exclude studies that clearly did not cover the search criteria. In the second step, we dived into abstracts to examine the links between the search criteria and to remove those articles that failed to meet them. In all steps of the review, we had three reviewers reviewing all articles and agreeing on exclusion decisions.

Qualitative evidence synthesis using PICO elements [14] was not possible for this review of the papers due to large heterogeneity. Because of such heterogeneity of the papers, we summarized the findings or ideas from the papers based on five predefined categories. We also used the keywords of the papers to develop the categorization. This is reflected in the arc diagram and the subcategories, in addition to five predefined categories.

Our final review database contained 78 eligible full-text articles and grey literature reports, appropriate for the development of a narrative review paper.
3. Results

A total of 78 papers or pieces of grey literature were examined (full list of the papers is in the Appendix A, Table A1). They were largely heterogeneous and covered broad considerations regarding urban environments in times of COVID-19. Therefore, we pulled together the main topics and the gaps in the research that could facilitate policymaking for protecting public health in times of the spread of infectious diseases, such as COVID-19. We summarized the best evidence and ideas available to date on urban healthy spaces transformation.

Of the total number of papers, 7 were reviews (including rapid-reviews and narrative meta-reviews), 47 papers were empirical studies (including modelling and case studies), and 19 papers were conceptual works or viewpoints. The geographical scope was as follows: two from Africa, two from Brazil, one from Canada, twelve from China, one from Columbia, and thirteen from EU countries (four from Italy, three from Spain, and one each from all the following: Belgium, Finland, Greece, Germany, Portugal, and Romania). Furthermore, there was one study from Iran, one from Mexico, and twelve from the USA. Five global reports from WHO, UNDP, and European Observation Network for Territorial Development and Cohesion (ESPON) are also discussed in this paper.

The papers covered different topics of urban environment and health. In Figure 2, we present the topics and number of papers that were described in relation to COVID-19.

Figure 2. Tree map of papers exploring the topic of COVID-19 and dimensions of urban planning and health.

We grouped the papers screened in this review into five main categories, with eight topical subcategories emerging, as follows:

1. Moving from the concept of infrastructure for processes to the infrastructure for healthy living:
   a. Air pollution studies;
b. Infrastructure for the public good and public health;
c. Mobility patterns;
d. Injustices and inequities.

2. Physical space that achieve ‘liveable communities’ standards:
   a. Urban green spaces;
   b. Sound;
   c. Mental health;
   d. COVID-19 rates and urban spaces.

3. Mainstreaming ‘in-the-walking distance’ cities and neighbourhoods.
4. Exploring any new concepts.
5. Integrating spaces for culture and tradition.

Here we present the main findings per category and subcategory.

3.1. Moving from the Concept of Infrastructure for Processes to the Infrastructure for Healthy Living

The important conceptual move was from the concept of infrastructure for processes to the infrastructure for healthy living and the requirements for healthy places, cycling, walking, disintegrating the role of polluting traffic from the urban environments, social vulnerability, and equality. Studies examining the relationship between infrastructure use and infrastructure change during the COVID-19 were most numerous, numbering 34 studies. They varied in focus. Most could be grouped into the following subcategories: (1) air pollution; (2) infrastructure for the public good and public health; (3) mobility patterns; and (4) injustices and inequities.

3.1.1. Air Pollution

Changes in the use of the infrastructure in several regions and countries were due to partial and full lockdowns to control outbreaks and flatten the epidemic curve. Lockdown measures were primarily imposed to save public health but had one important co-benefit—they improved air quality in many areas. Some studies reported an improved air quality during the period of COVID-19 measures and lockdowns. We have identified four studies that reported air pollutants reductions for one or more of the following pollutants: PM$_{2.5}$, PM$_{10}$, CO, and NO$_2$. In 2020, most likely due to lockdown, NO$_2$ concentration dropped considerably compared to the same period in 2019. Bar et al. observed a drop of 18–40% in Europe and the USA [15]. Another study from São Paulo, Brazil, observed larger reductions in concentrations of NO, NO$_2$, and CO (up to −77.3%, −54.3%, and −64.8%, respectively) compared to the five-year monthly mean [16]. In the city of Turin, Ravina et al. used traffic flow monitoring for their dispersion model. The model showed pollution concentration from road traffic sources (those are cars, busses, light-duty and heavy-duty vehicles, and motorcycles) being reduced for PM$_{2.5}$ by at least 70% and for Benzo(a)pyrene (BaP) up to 88.1% [17]. Fan et al. found that in China there were 16% and 20% reductions in PM$_{2.5}$ and PM$_{10}$ concentrations, respectively. While significant PM pollution mitigation was observed in the central, east, and south regions of China [18].

3.1.2. Infrastructure for the Public Good and Public Health

The urban planning challenge of bottlenecks in public transportation networks is a well-known one. In times of a public health pandemic crisis, this problem is becoming more important, not only for the normal functioning of transportation but absolutely as an issue that needs to be solved in record time. Requirements to have a minimum distance between passengers and the regular ventilation of the public transport places are important to be addressed. We identified studies that search for new solutions that reduce the passenger load on central traffic nodes, such as an introduction of the navigation algorithm in public transport networks, the main aim of which is the reduction of the spread of infectious diseases [19]. Researchers applied this approach to public transportation in Munich. They simulated the results of infection cases on the real city’s urban traffic flow.
One of the examined factors in the study was time spent in traffic. The results showed that with an increase of 26 min of travelling time, there were safety benefits of avoiding COVID-19 infection. In Brazil, data from 30 cities uncovered a large percentage, 35%, of medical waste being improperly treated. Several cities reported the improper disposal of facemasks that could present an added risk for COVID-19 transmission. Researchers showed that there was a total termination of recycling programs. This not only has hindered natural resources from being saved but also economically impacted the total unsold recyclable materials, with that same waste being disposed of in landfills—leading to a double loss: economic and environmental [20].

In India, the population living in slums is estimated to be up to 121 million people, who are chronically exposed to poor residential environments and face the acute effects of a pandemic. Patel argues that preventive measures, such as social distancing, frequent handwashing, and lockdown, are hard, if not impossible, to achieve in the slum context, where overpopulation, scarce access to water and proper sanitation, and dependence on daily wages for nourishment and livelihood are daily struggles [21]. Similarly, in other regions of the Global South, such as Colombia, authors discussed that preventive measures in epidemics are impossible privileges for many living in urban centres. Those measures make structural inequities more prominent, exacerbating racial, gender, and class differences [22].

One study of 106 cities brought valuable insights into the impact of new bicycle infrastructure on cycling traffic. Data showed that within 4 months of the introduction of pop-up bike lanes, there have been 11.5 km of lanes built, on average, per city. This policy has increased cycling considerably, by between 11 and 48%. In monetary expression this could be translated into health benefits per year, reaching between USD 1 and USD 7 billion if those cycling habits are maintained by citizens [23].

A Greek study suggests that, during the pandemic, several individual health aspects decreased, as well as overall health, happiness, and general satisfaction regarding several aspects, i.e., life, relationships, leisure, income, and vacations. At the same time, anxiety and back pain increased. Authors concluded that better health and well-being outcomes during corona times were related to lower neighbourhood population density, living further from the city centre but in the proximity to large parks and to local facilities, and living in a larger dwelling [24].

3.1.3. Mobility Patterns

A study examining travel behaviour changes in Somerville, USA, showed that amenity clusters shape daily urban mobility patterns. Authors showed that there was a reduction in trips to amenities during the pandemic. This was partially due to policy introduced by the city authorities and to a further extent by residents. Resident-driven change of mobility patterns to amenities was due to a reduced number of trips and higher destination selectivity [25].

One study showed mobility patterns in low- and middle-income country (LMIC) settings but before COVID-19. This could however inform the measures needed in pandemic times. Researchers found that in Kenya, trips by citizens were mostly shorter and remained within the county. The most important factors that explained mobility patterns were socioeconomic variables, such as urbanicity, poverty, female education, and accessibility to major urban centres [26]. In those countries where the needs of the health sector are concentrated on the improvement of the health infrastructure and human resources, urban health has different perspectives on COVID-19 preparedness and response [1].

Different authors offered viewpoints of city-level information that could define urban intelligence for supporting the response to disease outbreaks [27] or offered detailed models of the design of urban landscape elements, such as urban public seating and providing healthier urban public options [28].
Similarly, several authors pointed out that physical and nonphysical aspects have importance in resilience to epidemic outbreaks. These include urban aspects, such as access, infrastructure, urban growth, urban facilities, land use, and natural environments; sociocultural aspects and economic factors, such as preventing home value increase, especially among low-income homes; and political aspects, including good governance factors [29–33]. Nieuwenhuijsen elaborated on a few new urban concepts or models that were developed either before or during the pandemic and have been so far introduced in various places. Those concepts include co-called Superblocks; neighbourhoods that are primarily redesigned as low traffic, with city amenities within 15 min reach, i.e., the ‘15 Minute City’; car-free cities; or a mixture of these and can be explored in detail elsewhere [3].

The elderly population is increasing worldwide. The period of 2020–2030 is the UN Decade of Healthy Ageing, with a special focus on fostering healthy ageing and improving the lives of older people and their families and communities. There were attempts to draw up a methodology in ordinary working scenarios during the pandemic to measure the quality of life through an indicative measure of urban accessibility to healthcare services [34].

3.1.4. Injustices and Inequities

Injustices and inequalities are deeply rooted in our societies and are reflected in the infectious disease rates as well. Socioeconomic factors, such as age, gender, education, income, employment status, and type of occupation, have an impact on the risk of contracting COVID-19. López-Gay et al. showed that the neighbourhoods in Barcelona that registered a higher number of COVID-19 cases had greater population density with a mainly older population, a high presence of nursing homes, individuals working in health occupations, and a high proportion of individuals who left their residential area during the lockdown. Protective factors for contracting COVID-19 were a higher percentage of residents with post-secondary education and populations born in countries with a high Human Development Index. It showed that the current pandemic is likely to reinforce inequalities and injustice on multiple levels: health, social, and urban environmental [35].

One of the inequities highlighted during COVID-19 pandemics is access to public transportation. Tiako and Strokes documented the changes made by bike-share companies, including benefits to various groups of essential workers, such as Black and Latinx individuals, who are underpaid and use public transport for commuting to work. Researchers noted that cycling may be an attractive alternative for commuting with less risk of COVID-19 infection than public transit transportation [36].

Several studies that took place as natural experimental studies during COVID-19 showed that Urban Green Spaces (UGS) play an important role in the regulation of physical activity as places of socialisation, relaxation, and connectedness to nature for the public during epidemic crises.

A study from Wuhan showed a noticeable difference in the spatial distribution between the elderly and young and middle-aged people. The spatial distribution of patients who were 60 years old and above had a strong clustering characteristic around large public open spaces in Wuhan, such as parks and wetlands. Various urban facilities and public spaces revealed influential properties for older patients, whereas middle and young-aged adults were more influenced by travelling and the locations of business services [37].

A study in Hong Kong, a high-density city, showed that urban greenery mitigated the reduction in physical activity during the COVID-19 pandemic, in particular, people living in greener areas experienced a minor decrease in leisure-time physical activity levels than those who lived in less green areas [38].

Racial vulnerability, especially in the USA, has a legacy of historical issues in urban planning. This is emphasised also in the study on four cities in the USA—Anchorage, Atlanta, Phoenix, and Portland—characterised by diverse racial and ethnic group populations with the impact on people of colour creating an unequal impact from COVID-19, also regarding noticeably fewer green open areas for physical activity [39].
Ezell et al. discussed the unequal ecological effects of COVID-19 and other crises, such as the Flint water crisis or the 1995 Chicago (IL, USA) heatwave that disproportionately affected communities of colour [40]. The researchers argued that crisis mitigation protocols face several non-material factors, such as structural racism and health efficacy, and confidence in one’s capability to practice a healthy lifestyle and health literacy.

Similarly, a study from the USA in Los Angeles County looked at the predictive model of vulnerability indicators for COVID-19 infection. The study offered four indicators—pre-existing health conditions, social vulnerability, obstacles to health care access, and built environment risk—that were linked with a higher risk of COVID-19 infections and mortality [41].

In April 2020 Seattle, Washington, and Vancouver, British Columbia, implemented so-called “Stay Healthy Streets” and “Slow Streets” street reallocation programs with the aim of reducing COVID-19 spread and promoting time outdoors. It seems these programs had an impact on the communities as both cities have spoken about making those changes permanent [42].

3.2. Physical Space That Will Achieve ‘Livable Communities’ Standards

Open green space requirements and standards for any built-up environments might help catalyse toward ‘liveable communities’ standards.

There were 28 studies examining the relationship between urban green spaces and health, specifically mental health, during the COVID-19 pandemic. We subcategorized them into (1) those studies looking specifically at urban green spaces; (2) studies examining noise; and (3) several studies focusing on mental health outcomes, and we also grouped studies that concentrated on COVID-19 rates and urban spaces.

3.2.1. Urban Green Spaces

Green spaces have an impact on people’s health and well-being through leisure time, sporting, socialising, or enjoying peaceful relaxation moments in those areas [43].

A qualitative study of the use of UGSs in Mexico City during the COVID-19 pandemic suggested that UGS helped in the reduction of stress and isolation caused by the pandemic, thus enhancing users’ physical and mental well-being [44].

Contact with nature has many health benefits: enhanced mental health; increased physical activity and, thus, an impact on conditions such as diabetes; improved BMI, stress reduction; and many more. One study in this review evaluated the effects of different colours of flowers and health effects. The results suggested that 3 min of the observation of yellow or red flowers might have instant strong positive influences on individuals’ well-being. Yellow flowers were most able to improve the individuals’ feelings of relaxation in comparison to red and white flowers [45]. Another study looked at the impacts of public gardening on the daily life of inhabitants and confirmed the positive role of public gardening activities to promote mental health and provided a practical strategy for the community to respond appropriately to public health disasters [46]. A Flemish study demonstrated the importance of green spaces especially surrounding schools’ environments, as green spaces were associated with better attention in adolescents. The study placed importance on the preservation and growth of available green space for children and adolescents who are growing up in a rapidly urbanizing environment [47].

3.2.2. Sound

The COVID-19 crisis was an opportunity to hear different sounds in cities, less noise and more diversity of basic human activities, excluding intensive transport. There were attempts to investigate the association between perceived sound causes and the perception of the soundscape, a constructive and often undervalued contribution. Research confirmed that acoustic complexity, acoustic richness, and eventfulness increased significantly over time, while the number of technological sounds decreased. Soundscape investigation provides essential clues to understanding the awareness and design of the multimodal
environment—how individuals are physically, psychologically, physiologically, and socially affected by sound and how other living beings are also affected. Researchers, architects and sound designers could be a part of the debate with urbanists, policymakers, politicians, and the general public in looking for solutions to the growing challenges to urban living environments in the future [48].

3.2.3. Mental Health

In China, during the lockdown, an increased number of mental health problems among adolescents were observed, ranging from 5.9% to 10.7%. Educational institutions worldwide were closed or changed to online education during the pandemic, leading to a great disturbance in students’ education and outdoor events. One study addressed the importance of students’ intention of visiting UGSs after the easing of the COVID-19 lockdown as an important component of mental health [49]. The COVID-19 crisis created quasi-experimental circumstances to evaluate whether retracted contact with nature and perceived nature deprivation impacted physical and emotional wellbeing. Perceived nature deprivation is greatly associated with nature contact, time spent in nature, access to public nature during the pandemic, job position, household structure, lockdown duration, and sociodemographic variables. Individuals with perceived nature deprivation under COVID-19 suffered from reduced well-being. The potential of local contact with nature to support an individual’s well-being and reduce emotional suffering and social isolation is significant in guiding public health policies [50]. Urban design interventions were also identified as an important contributor to the restoration of community confidence, choice, and safety [51].

During the COVID-19 crisis the majority of outdoor recreation sites were visited more or as frequently as prior to the pandemic. The spatial analysis showed that the most frequently visited recreational places were close to forests, semi-natural and housing areas, and places relatively near to respondents’ homes [52].

Results of the study performed in Bucharest pointed out that the peak period of the pandemic and the first lockdowns strongly influenced the daily recreation and relaxation activities that people performed in the parks. Considerations should be given to defining the movement of visitors and their observations of the endowments, landscaping, and management of urban parks [53].

Recent quarantined people showed mood fluctuations, depressive and anxiety symptoms, insomnia, and various stress symptoms. Severe depression, alcohol abuse, self-medication, and continuing avoidance behaviours have been documented as long-term effects. Along with social isolation and financial loss, quarantine increased suicidal ideation and behaviour among at-risk populations. Additionally, a strong link between poor housing and depressive symptoms was confirmed, with a specific reference to living in small apartments with a low-quality view and limited space indoors. Worsening working performance related to remote work increased the depressive symptoms’ risk of four-fold. The built environment is a crucial determinant of health, the quality of which depends on the accessibility of resources, site location planning, and green spaces, so housing project strategies should focus on larger and more comfortable living spaces in front of green areas [54].

From a public health perspective, green spaces are important. They can affect air quality by particle deposition, dispersion, and modification. Vegetation and green spaces showed reducing effects on pollutants concentrations, specifically particulate matter (PM). Guidance on green space utilisation for air quality control remains rare, however, as does its practical application [55].

Factors related to sociodemographics, housing, and lockdown were linked to changes in the exposure to nature during the pandemic lockdown. Changes in exposure to nature and mental health outcomes during the COVID-19 lockdown were strongly linked. Maintaining or increasing exposure to private and public natural spaces and nature observations were associated with improved mental health outcomes during the pandemic general lockdowns in Portugal and Spain. Policymakers should facilitate and create safe opportunities
for exposure to natural environments during the pandemic, especially for the people with low or no exposure to private green greenery [56].

All ‘green infrastructure’ (GI) resources (including parks, gardens, etc.) remained open and were shifted as ‘essential infrastructure’ supporting well-being. Still, the quality, functionality and position of GI in urban areas showed inequality in distribution. Frequently, societies with greater ethnic diversity, lower incomes, and larger health inequalities suffered from unsatisfactory access. GI is important in decision making to address inequality. There are GI factors essential for well-being: financing, equitability of access, and GI distribution in urban areas [57].

Many children and youths were more bored and worried in comparison with the pre-pandemic period. Simultaneously, many of them self-reported that they felt calmer and more relaxed. A latent class analysis showed that almost half of children and youth had fluctuations in their emotional state that may contribute to their lower subjective well-being (SWB). Potentially adjustable factors, such as access to friends, indoor and outdoor places to play and exercise, and healthy movement behaviours during the pandemic were associated with a lower chance of reporting low SWB. It is thus vital to enhance urban planning and design practices when making healthier and more resilient communities [58].

Financial problems were related to reduced time and fewer visits to green and blue places and the lesser diversity of those spaces visited. People expressing financial problems also expressed feelings that visiting green and blue places was less useful for maintaining social connections. Strategies in urban planning focusing on the availability and equal access to green and blue spaces might improve health benefits of strategies [59].

The maps showed that retail and recreation, grocery, pharmacy, parks, transit stations, and workplaces mostly have important and positive correlations—a reduction in visits to these sites was associated with a reduced number of new confirmed cases [60]. Investigations during the COVID-19 crisis can help architects prepare for their novel role in post-pandemic planning and forthcoming challenges [61].

3.2.4. COVID-19 Rates and Urban Spaces

Many studies examined COVID-19 rates, hospitalisations, mortality, and other outcomes and the link to the urban, built environment. More evidence in the past two years is showing links between the design of the urban environment and its implications on infectious diseases (such as COVID-19) and related well-being and public health.

One study aimed at providing data on how can measuring global multi-scale place connectivity with geotagged social media information could potentially be used to model the spread of infectious diseases. Study findings suggest that the multi-scale Place Connectivity Index (PCI), computed from old Twitter data, is a good indicator in forecasting the spatial spread of COVID-19 during the initial stage, outperforming the current Facebook SCI and SafeGraph-derived person-day movement data of the USA [62]. In their research, Wali and Frank showed that more mixed land use and better pedestrian-oriented street connectivity are linked with lower COVID-19 hospitalization rates. Moreover, higher participation in active travel was related to lower COVID-19 hospitalization and death [63]. Similarly, Li et al. showed the statistically significant impacts of commercial vitality and transportation organization on the number of confirmed cases [64]. In Iran, researchers explained an explicit relationship between urbanization processes and the COVID-19 outbreak, namely the entire population, urban inhabitants, fuel and energy consumption, overall intra-changed travels, and number of confirmed cases [65].

A review by Wang et al. confirmed that COVID-19 infection risk was positively related to the density of commercial services, roads, schools, and public transit availability, whereas it was negatively linked to the accessibility of green spaces [66]. Another association found by Wu et al. was that public rental housing and living in neighbourhoods with lower educated residents led to extended time to diagnosis in the first wave of infections (but not the second wave) [67]. A Malaysian study looked at the influences of population density on the spread and outcomes of COVID-19 infections. They suggested that reducing
trans-district travel and crowding risks at workplaces may reduce the speed of COVID-19 spread [68].

On the other hand, a couple of studies advocated for public transport operations as a priority, with special considerations for vulnerable populations, such as the elderly [69]. One study showed that the density and public transport exacerbating virus transmission are unfounded. The researchers argued that halting or limiting public transport operations might be necessary, rather than embracing, advocating for, and expanding [70].

An ESPON study [71] found that the degree of urbanisation and both governance quality and public health policies were tangible elements that explained the local differences observed in the geography of the COVID-19 outbreak.

3.3. Mainstreaming ‘In Walking Distance’ Cities and Neighbourhoods

Introducing ‘in walking distance’ cities and neighbourhoods gained global importance and attention in the COVID-19 pandemic. Globally, many cities moved towards the agendas of cities that are organized for healthy physical activities for daily living, ‘15 Minute Cities’, etc. Studies examining walking behaviour and walking needs were diverse in design and focus. One study designed as an empirical literature review exploring how to improve walking habits in relation to the hierarchy of walking needs within the present situation with COVID-19. The study recognized several key aspects of walking habits in the context of the pandemic: the relationship between walking behaviour and density or overcrowding; the role of crowded places in increasing stress during walking, which in turn contributes to mental illnesses; and the role of walking surroundings in decreasing the overload of stress produced by all the circumstances imposed by the pandemic [72].

Another study investigated how human behaviour, insights, and attitudes toward UGS may have altered due to restrictions imposed by the COVID-19 outbreak, compared to the period before the restrictions. An international study evaluated residents’ satisfaction with UGS in their neighbourhood and generated useful recommendations for improvement. Results of the study showed that urban citizens need available UGS, primarily for workout, relaxing, and enjoying nature. This study also highlighted the importance of the various services that different forms of UGS offer in the city and of reconsidering urban policy and planning to respond to new circumstances that arose from the COVID-19 outbreak [73]. Furthermore, one study empirically examined the hypothesised pathway between the upstream built setting, chronic illness, and downstream COVID-19 mortality accounting for the thorough effect of chronic illness. This study employed a comprehensive range of urban environmental features and evaluated how chronic illness mediates the association between built and natural environments and mortality caused by COVID-19. The results showed that creating surroundings fit for walking together in a green pace is related to a decreased risk of chronic illness and COVID-19 infection and mortality [74].

3.4. Exploring New Concepts

Papers exploring new concepts, such as One Health or the New European Bauhaus concept were scarce. They differed from our initial idea of new concepts (New Bauhaus and One Health) but considered concepts that link to global policy processes or the Concept of Age-friendly Smart Ecologies (CASE)’ framework. Capolongo et al. integrated the Urban Health strategic objectives and focused on the possible instant and medium-long term responses to the present environmental, social, and economic aspects of the period of social distancing. The strategies and the issues discussed in this paper were based on a social and infrastructural rethinking of the city and in line with the needs of welfare and public health and social and environmental justice as essential and unavoidable values recommended by the United Nations SDGs for 2030. This commentary provided The Decalogue of Public Health opportunities that can serve as a useful basis for designers, public health experts, policy makers and local health agencies, in promoting activities and procedures designed to change our cities into healthier living environments [75]. Recognizing the absence of scientific evidence for COVID-19 policymaking, another study investigated
and compared 418 policy measures taken in 2020 in New Zealand, Australia, Canada, the UK, Japan, and the US. The authors highlighted the importance of further promotion of international collaboration and the development of more publicly acceptable robust policy recommendations based on collective knowledge [76].

A narrative meta-review focused on Europe described several cutting-edge COVID-19 related urban models that may have a positive impact on citizens’ health. The review focused on urban development models, such as the low traffic neighbourhood, Superblocks, the ‘15 Minute City’, car-free cities, or a combination of these. What these concepts have in common is the reduction in noise, air pollution, and heat island effects, as well as an increase in green space and physical activity [3]. The opinion paper by Allam and Jones is a call for action for planning and architectural institutions to take into account pandemics in their disaster management approaches and to improve the design of relevant protocols together with health discipline organizations [77].

One paper explored how digital technology and design hacking can be used for understanding a smart age-friendly ecosystem in a post-pandemic world. By investigating a series of case studies and creating real-life scenarios from the perspective of COVID-19, the authors proposed the ‘Concept of Age-friendly Smart Ecologies (CASE)’ framework. Furthermore, it provided an understanding of numerous contemporary multi-disciplinary research, bringing various actors together [78].

Another paper demonstrated how the exposome concept and the urban exposome study context could perform together under an interdisciplinary methodological umbrella for the improvement of public health actions that may bring more effective non-pharmacological interventions (NPI) for infectious diseases management in urban settings. In addition, the authors also showed that the applications of the exposome approach in urban places could ease the assessment of health inequalities and improve the recognition of vulnerable groups, as enclosed by many environmental, urban design, and planning co-exposures [79]. Likewise, an essay by Triguero-Mas et al. proposed a novel approach that builds on diverse research areas joining social, health, and environmental sciences: the just ecofeminist healthy cities approach. The proposal is a response to the need to involve care work and emphasize intersectional social and environmental inequalities in the healthy city movement that the effects of the COVID-19 pandemic have demonstrated [80].

The paper designed as a data descriptor using a multiscale dynamic human mobility flow dataset in the USA throughout the COVID-19 pandemic. The authors concluded that a high spatiotemporal resolution human mobility flow dataset at different geographic scales over time may support monitoring epidemic spreading dynamics, help in advising public health policy, and expand our knowledge of human behaviour changes during public health disasters [81]. Similarly, Li et al. developed a scalable online platform for analysing, extracting, and sharing multi-source multi-scale human mobility flows. The created platform can support human mobility monitoring and research during disasters and benefit scientists and the general public in understanding human mobility flow [82].

UNDP concluded that large agglomerations are the hotspots for pandemics, but also other crises and shocks, because of their high population concentrations and interconnectivity. COVID-19 has strengthened the need to develop a comprehensive approach to risk management and resilience-building in cities, while online platforms have been recognized as supporting systems for governments to attend training and peer-to-peer learning events, creating barriers of geography, language, and distance, time and cost less important [83].

WHO plays a key role in promoting healthy transportation and healthy mobility but also highlights ways present WHO guidance on COVID-19 can be applied in the transport sector and in urban settings [84,85]. It also published a sourcebook for city managers, planners, and health professionals integrating health into urban planning. Here they focus on demonstrating how a joined approach to health can have an impact on decisions in various sectors, such as transport, housing, energy, water, and sanitation [86].
3.5. Integrating Spaces for Culture and Tradition

Integrated spaces for culture and tradition enhanced using social integrations and by preventing mental health issues associated with isolation and a lack of social contact were not identified. There were no papers illustrating or examining the points of culture and tradition. Papers on enhancing social integrations and the prevention of mental health issues associated with isolation and a lack of social contact were grouped in the mental health subcategory and were related to the physical space rather than spaces for culture and tradition.

4. Discussion

COVID-19 not only had a major impact on public health and economies but also caused direct and indirect environmental effects. Some of the effects were health-protective, such as improved air quality, while many were detrimental to the environment, e.g., medical waste pollution, causing environmental deterioration.

4.1. Positive and Health Protective Effects

This review highlights the short-term effects on improved air quality. Improved air quality also had an impact on improved health. Therefore, changes in the use of road infrastructure had a two-fold influence on public health: (1) reducing the rates of the transmission of the virus and (2) positive health impacts due to improved air quality [15–18]. Nevertheless, this was a short-term observation and most of the air pollution returned as the countries eased their lockdowns. The observed change and immediate positive impact of various measures would hopefully motivate policy makers to maintain the pace of introducing concrete measures and action plans aimed at improving the air quality and, eventually, achieving healthy levels of air quality recommended by the latest WHO global air quality guidelines [87].

Another positive effect noticed is an increased transformation or built infrastructure for healthy mobility, such as cycling and walking, but also more attention to public transportation conditions and networks was one of the most common interventions to lower the risk of transmission of infectious disease, consequently promoting a reduction in the gaps between inequalities [19,23,29–33,35].

The adaptation of urban space to enable and support walking, cycling and the continuation of key activities with social distancing showed that innovative transport and urban land-use planning can reduce the demand for motorized travel and foster community cohesion and resilience [25,29–33,36].

Furthermore, a shift of perception towards the importance of public health benefits in urban planning and urban infrastructure is an indirect positive effect that has the potential for more rapid changes in urban planning [86].

With the outbreak of COVID-19, special attention towards the public health has become an urban environment concern. Built and natural environments, various public spaces like urban parks and forests, transportation hubs, and urban open public spaces, are not only significant factors influencing the spread of infectious diseases, such as COVID-19. Those same spaces have protective roles for health as well, particularly mental health.

4.2. Negative Effects

This review did not touch on the COVID-19 deaths and respiratory and other health issues related to the disease itself. We focus here on urban spaces and how the pandemic changed its use and outcomes related to urban health.

One of the most described negative effects in this review of the COVID-19 pandemic was mental health. A lack of green and blue spaces for leisure, socializing, and sports are important factors contributing to mental health issues across different populations [49,50,54]. The pandemic in urban environments placed more emphasis on the conditions in which many people in the Global South live, where preventive measures for the epidemics are impossible privileges for many. Higher infectious disease rates were observed in under-
privileged populations. This once again highlights the need to address inequalities that are deeply rooted in our societies [21,22].

Negative effects were visible in the termination of recycling programs, which led to a double loss: economic and environmental.

4.3. Solutions

Solutions in urban planning could reflect positive effects for public health. From this narrative review that could include: (1) quality of green spaces with biodiversity, trees and flowers integrated into the urban green spaces; (2) the amount of green infrastructure and its location addressing inequality and injustices; (3) the amount and quality of urban infrastructure that promotes healthy living and healthy mobility, such as an increased number and distance of cycling and walking infrastructure; (4) considerations for public transport networks and their quality for passengers; and (5) public spaces that promote healthy socializing and address social cohesion.

4.4. Points of Attention

Different authors offered viewpoints of city-level information that could define urban intelligence for supporting the response to disease outbreaks [27] or offered detailed models of the design of urban landscape elements, such as urban public seating, and providing healthier urban public options [52–55,57].

In those countries where the needs of the health sector are concentrated on the improvement of the health infrastructure and human resources, urban health has different perspectives on COVID-19 preparedness and response.

Even though sustainability rhetoric was often used to address acute issues in the response to COVID-19 in the urban environment, community and well-being interventions require a much more thoughtful and interdisciplinary approach. Cities for people require the optimization of public spaces for citizens and their activities promoting health and healthy living, such as active movement, active mobility, green spaces that enhance experiences, and mental health, etc.

There are growing calls for a green and inclusive recovery at all levels, from the pan-European to the local. In this new setting, urban planning is essentially a public health intervention for delivering the desired change.

A limitation of this review that needs to be mentioned is the inclusion of the literature only in the English language. This might introduce biases regarding the urban forms and their relationship with COVID-19 in other geographical areas. In addition, we did not include topics related to specific problems in relation to urban planning and living in urban environments, such as security, living standards or dichotomy of perceptions [88], food chains and food consumption [89], and others we are not aware of but should be explored in prospective studies.

More studies are needed that will quantify the benefits of transformation and integration of green spaces in urban environments and the magnitude of their effects on public health.

The present review of the evidence confirms the importance of connecting a wide range of stakeholders and professionals—urban planners, health professionals, communities, and policy makers—to find the best possible solutions for the quality of life of people in urban environments. Public health priorities need to be systematically included in various areas, such as the planning of built environments to include nature and green spaces, energy generators, sustainable food production, and nutrition.

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### Appendix A

**Table A1.** List of the papers reviewed.

| No | Title of the Paper                                                                 | DOI or Link                                               |
|----|--------------------------------------------------------------------------------------|-----------------------------------------------------------|
| 1  | COVID-19 pandemic: Solid waste and environmental impacts in Brazil                   | 10.1016/j.scitotenv.2020.142471                          |
| 2  | Preventing COVID-19 Amid Public Health and Urban Planning Failures in Slums of Indian Cities | 10.1002/wmh3.351                                          |
| 3  | Urban Intelligence for Pandemic Response: Viewpoint                                  | 10.2196/18873                                             |
| 4  | Resilient urban form to pandemics: Lessons from COVID-19                             | 10.34177/mjiri.34.71                                      |
| 5  | Pandemic stricken cities on lockdown. Where are our planning and design professionals [now, then and into the future]? | 10.1016/j.landusepol.2020.104805 |
| No  | Title of the Paper                                                                 | DOI or Link                          |
|-----|------------------------------------------------------------------------------------|--------------------------------------|
| 24  | Coronavirus disease 2019 and slums in the Global South: lessons from Medellin (Colombia) | 10.1177/1757975920962797              |
| 25  | COVID-19 and urban spaces: A new integrated CFD approach for public health opportunities | 10.1016/j.buildenv.2021.108131        |
| 26  | New urban models for more sustainable, liveable and healthier cities post covid19; reducing air pollution, noise and heat island effects and increasing green space and physical activity | 10.1016/j.envint.2021.106850        |
| 27  | Access to Nature in a Post COVID-19 World: Opportunities for Green Infrastructure Financing, Distribution and Equitability in Urban Planning | 10.3390/ijerph18041527               |
| 28  | Subjective well-being of Canadian children and youth during the COVID-19 pandemic: The role of the social and physical environment and healthy movement behaviours | 10.1016/j.pmedr.2021.101404          |
| 29  | Multiscale dynamic human mobility flow dataset in the U.S. during the COVID-19 epidemic | 10.1038/s41597-020-00734-5            |
| 30  | How can vegetation protect us from air pollution? A critical review on green spaces’ mitigation abilities for air-borne particles from a public health perspective—with implications for urban planning | 10.1016/j.scitotenv.2021.148605     |
| 31  | Vision of China’s future urban construction reform: In the perspective of comprehensive prevention and control for multi disasters | 10.1016/j.scs.2020.102511            |
| 32  | Time for ‘Green’ during COVID-19? Inequities in Green and Blue Space Access, Visitation and Felt Benefits | 10.3390/ijerph18052757               |
| 33  | Association Between Population Mobility Reductions and New COVID-19 Diagnoses in the United States Along the Urban-Rural Gradient, February–April, 2020 | 10.5888/pcd17.200241                  |
| 34  | Indoor Air Quality: Rethinking rules of building design strategies in post-pandemic architecture | 10.1016/j.envres.2020.110471        |
| 35  | Neighborhood-level COVID-19 hospitalizations and mortality relationships with built environment, active and sedentary travel | 10.1016/j.healthplace.2021.102659    |
| 36  | Sociodemographic determinants of intraurban variations in COVID-19 incidence: the case of Barcelona | https://pubmed.ncbi.nlm.nih.gov/34158409/       |
| 37  | The adaptive capacity of public space under COVID-19: Exploring urban design interventions through a sociotechnical systems approach | 10.1002/hfm.20906                  |
| 38  | Built environment and early infection of COVID-19 in urban districts: A case study of Huangzhou | 10.1016/j.scs.2020.102685            |
| 39  | Investigation of the urbanization contribution to the COVID-19 outbreak in Iran and the MECA countries | 10.1007/s10668-021-01423-y           |
| 40  | Review of Associations between Built Environment Characteristics and Severe Acute Respiratory Syndrome Coronavirus 2 Infection Risk | 10.3390/ijerph18147561               |
| 41  | Healthy cities after COVID-19 pandemic: the just ecofeminist healthy cities approach | 10.1136/jech-2021-216725             |
| 42  | Outdoor recreation and nature’s contribution to well-being in a pandemic situation—Case Turku, Finland | 10.1016/j.ufug.2021.127257          |
| 43  | Relationship between Built Environment and COVID-19 Dispersal Based on Age Stratification: A Case Study of Wuhan | 10.3390/ijerph18147563               |
| 44  | Urban greener cushions the decrease in leisure-time physical activity during the COVID-19 pandemic: A natural experimental study | 10.1016/j.ufug.2021.127136          |
| 45  | The blueprint of disaster: COVID-19, the Flint water crisis, and unequal ecological impacts | 10.1016/S2542-5196(21)00076-0        |
| No  | Title of the Paper                                                                 | DOI or Link                                      |
|-----|-----------------------------------------------------------------------------------|-------------------------------------------------|
| 46  | Treating two pandemics for the price of one: Chronic and infectious disease impacts of the built and natural environment | 10.1016/j.scs.2021.103089                        |
| 47  | Using Social Media Data to Evaluate Urban Parks Use during the COVID-19 Pandemic | 10.3390/ijerph182010860                          |
| 48  | Practical geospatial and sociodemographic predictors of human mobility            | 10.1038/s41598-021-94683-7                      |
| 49  | Association of time to diagnosis with socioeconomic position and geographical accessibility to healthcare among symptomatic COVID-19 patients: A retrospective study in Hong Kong | 10.1016/j.healthplace.2020.102465                |
| 50  | The Relationship between Nature Deprivation and Individual Wellbeing across Urban Gradients under COVID-19 | 10.3390/ijerph18041511                          |
| 51  | Soundscape in Times of Change: Case Study of a City Neighbourhood During the COVID-19 Lockdown | 10.3389/fpsyg.2021.570741                        |
| 52  | Provisional COVID-19 infrastructure induces large, rapid increases in cycling    | 10.1073/pnas.2024399118                         |
| 53  | Who is Biking for? Urban Bikeshare Networks’ Responses to the COVID-19 Pandemic, Disparities in Bikeshare Access, and a Way Forward | https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7995947/ |
| 54  | The COVID-19 Pandemic Situation in Malaysia: Lessons Learned from the Perspective of Population Density | 10.3390/ijerph18126566                          |
| 55  | ODT FLOW: Extracting, analyzing, and sharing multi-source multi-scale human mobility | 10.1371/journal.pone.0255259                    |
| 56  | How Can Flowers and Their Colors Promote Individuals’ Physiological and Psychological States during the COVID-19 Lockdown? | 10.3390/ijerph181910258                         |
| 57  | Exploring the nexus between social vulnerability, built environment, and the prevalence of COVID-19: A case study of Chicago | 10.1016/j.scs.2021.103261                        |
| 58  | Using GIS-based spatial analysis to determine urban greenspace accessibility for different racial groups in the backdrop of COVID-19: a case study of four US cities | 10.1007/s10708-021-10538-8                      |
| 59  | Snapshot of the Use of Urban Green Spaces in Mexico City during the COVID-19 Pandemic: A Qualitative Study | 10.3390/ijerph18084304                          |
| 60  | Elderly mobility during the COVID-19 pandemic: A qualitative exploration in Kunming, China | 10.1016/j.jtrangeo.2021.103176                   |
| 61  | COVID-19 Medical Vulnerability Indicators: A Predictive, Local Data Model for Equity in Public Health Decision Making | 10.3390/ijerph18094829                          |
| 62  | Measuring global multi-scale place connectivity using geotagged social media data | 10.1038/s41598-021-94300-7                       |
| 63  | Introducing a Navigation Algorithm for Reducing the Spread of Diseases in Public Transport Networks | 10.3233/SHTI210097                               |
| 64  | Traffic-induced atmospheric pollution during the COVID-19 lockdown: Dispersion modeling based on traffic flow monitoring in Turin, Italy | 10.1016/j.jclepro.2021.128425                   |
| 65  | Effects of transport-related COVID-19 policy measures: A case study of six developed countries | 10.1016/j.tranpol.2021.05.013                    |
| 66  | Participatory Action Research on the Impact of Community Gardening in the Context of the COVID-19 Pandemic: Investigating the Seeding Plan in Shanghai, China | 10.3390/ijerph18126243                          |
| 67  | The impact of COVID-19 on trips to urban amenities: Examining travel behavior changes in Somerville, MA | 10.1371/journal.pone.0252794                    |
| 68  | Students’ Intention of Visiting Urban Green Spaces after the COVID-19 Lockdown in China | 10.3390/ijerph18168601                          |
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