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NEW CHALLENGES FOR XXI CENTURY CITIES

Global warming, ageing of population, reduction of energy consumption, immigration flows, optimization of land use, technological innovation

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TeMA Journal was established with the primary objective of fostering and strengthening the integration between urban transformation studies and those focused on mobility governance, in all their aspects, with a view to environmental sustainability. The three issues of the 2024 volume of TeMA Journal propose articles that deal the effects of global warming, the ageing of population, the reduction of energy consumption from fossil fuels, the immigration flows from disadvantaged regions, the technological innovation and the optimization of land use.

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The cover image shows railway street in Hanoi, Vietnam (Source: TeMA Journal Editorial Staff).

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A scoping review of urban design and planning studies on the Covid-19 pandemic and elements of the built environment

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Abstract
Human life has faced fundamental challenges in many aspects due to the spread of the Coronavirus disease in the world, resulting in rethinking urban design and planning policies and theories to make cities more resilient and healthier. Numerous studies have been conducted in this field due to the pivotal role of the built environment in improving public health. The present study aims to assess the role of the influential components of the built environment in the outbreak of Covid-19 by conducting a systematic literature review. The studies were searched through the Scopus database and screened and reviewed based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Totally, 145 studies among 13,002 met the predetermined criteria. The results were expressed in 11 themes including mobility, density, soundscape, public spaces, green spaces, housing, land use, socio-economic qualities, environmental qualities, tourism, and smartness.

Keywords
Coronavirus; Built environment; Urban design; Urban planning; Healthy city.

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1. Introduction

The spread of infectious and contagious diseases can create great challenges and make societies face temporary or even long-term changes in all spheres of life (Pinheiro & Luís, 2020). A type of Coronavirus called SARS-CoV-2 spread globally at an alarming rate at the beginning of 2020, resulting in taking a wide range of measures around the world to prevent its transmission and reduce future morbidity and mortality from Coronavirus disease.

The restrictions and policies applied to cope with Covid-19 affected cities positively and negatively. A large number of principles related to the organization of social life, healthcare, public safety, and urban planning should be reviewed due to the significant and widespread risks of the Covid-19 pandemic (Jasiński, 2022).

Urban planning plays a significant role in the changes in the consequences related to infectious diseases since cities can aggravate the spread of the virus. To control and mitigate the challenges caused by the Covid-19 pandemic, future policies and strategies of urban planning and design should be introduced through the lens of public health (Majewska et al., 2022) since built environments can play a critical role in boosting the general health of citizens. Since the beginning of the pandemic, numerous studies have been conducted to investigate the impact of various environmental factors on the transmission of Covid-19. Due to the high number of papers and contracting results, a number of review articles have been also developed to consolidate the findings from these studies.

However, these studies focusing on the impact of Covid-19 on urban areas have typically only explored a few aspects of urban planning, or in more comprehensive analyses, have grouped findings in ways that do not fully encompass all the key elements influencing city quality.

For instance, Eltarabily & Elghezanwy (2020) overlooked aspects like soundscape, environmental considerations, and active transportation (walking and cycling). Taking the study by Sharifi & Khavarian-Garmsir (2020) as an example, which examined the impacts of Covid-19 on cities related to four major themes, namely, environmental quality, socio-economic impacts, management and governance, and transportation and urban design.

They integrated transportation and urban design and restricted the dimensions of urban design to density only. Another review article also focused on six factors including transport and land use, urban nature, public space, facilities and services, housing, and (ICT) (Mouratidis, 2021). Sharifi (2022) also examined a large number of articles on the pandemic's effects on cities and identified six main themes: air quality, climatic factors, human-made environmental influences, transportation, socio-economic disparities, and smart city initiatives. Similarly, Alidadi & Sharifi (2022) explored the pandemic's impact on various urban factors but omitted discussions on green spaces, public places, soundscape, tourism, and urban governance in their key findings. Roosta et al. (2023) conducted a comprehensive review of early urban studies conducted during the pandemic, highlighting a narrow focus on resilient urban landscape and design. Alizadeh et al. (2023) concentrated their research solely on the social repercussions of Covid-19, providing insights for resilience, management, planning, and urban design.

Hernández et al. (2023) explored various themes including social equality, health-oriented urban spaces, sustainable transportation, and economic aspects in their review article.

To address this gap, this study, unlike previous review articles, seeks to give a more holistic view of the role of all influential components of the built environment in the spread of Covid-19 in the context of urban planning and designing. To do so, the review explored 11 dimensions of urban design and planning, including mobility, density, soundscape, public spaces, green spaces, housing, land use, socio-economic qualities, environmental qualities, tourism, and smartness.

The findings of the study can be helpful in improving the quality of the cities and making them resilient when facing pandemic diseases such as Covid-19.

2. Methodology

2.1 Eligibility criteria

First, we selected studies developed in the context of urban design and planning, excluding articles conducted through the lens of other disciplines. Second, we removed studies at the architectural and building level, including ones that conducted at neighborhood level, city level, and above. Thirdly, as the study aimed to concentrate on urban design and planning studies exclusively, the expertise of the authors played a crucial role in article selection. We primarily chose articles authored by experts in the fields of urban design, planning, and landscape architecture. Furthermore, we specifically selected studies that provided recommendations for policy and practice within the realm of urban design and planning. Lastly, we limited our inclusion criteria to journal articles written in English.

2.2 Search strategy

We conducted a series of literature searches using the Scopus database throughout 2022 and early 2023. To find almost all possible urban design and planning studies about the Covid-19 Pandemic, several groups of keywords searched in the title and keyword in the database (see Table. 1). The keywords were selected based on the element of urban form (land use, density, layout, transportation infrastructure, building/housing type) which is categorized by (Dempsey et al., 2010). Two limiters set in all database searches contained: (1) written in English; and (2) published in peer-reviewed journals or conference proceedings as a full article.

Categories	Search string
Built Environment	TITLE(covid) AND TITLE(environmental AND design) OR TITLE(city AND planning) OR TITLE(urban AND design) OR TITLE(Urban AND planning) OR KEY(environmental AND design) OR KEY(city AND planning) OR KEY(urban AND design) OR KEY(Urban AND planning)
Urban Form	TITLE (covid) AND TITLE (urban AND sprawl) OR TITLE (urban AND density) OR TITLE (building AND density) OR TITLE(urban AND form) OR TITLE(compact AND city) OR TITLE(compact AND development) OR TITLE (urban AND morphology) OR TITLE (urban AND fabric) OR TITLE (smart AND growth) OR KEY (urban AND sprawl) OR KEY (urban AND density) OR KEY (building AND density) OR KEY(urban AND form) OR KEY(compact AND city) OR KEY(compact AND development) OR KEY(urban AND morphology) OR KEY(urban AND fabric) OR KEY(smart AND growth)
Urban Space	TITLE(covid) AND TITLE(public AND space) OR TITLE(Urban AND space) OR TITLE(public AND place) OR TITLE(collective AND space) OR TITLE(street) OR TITLE(square) OR TITLE(Underground AND Space) OR TITLE(city AND center) OR TITLE(Neighborhood) OR KEY(public AND space) OR KEY(Urban AND space) OR KEY(public AND place) OR KEY(collective AND space) OR KEY(street) OR KEY(square) OR KEY(Underground AND Space) OR KEY(city AND center) OR KEY(Neighborhood)
Landscape	TITLE(covid) AND TITLE(urban AND landscape) OR TITLE(streetscape) OR TITLE(facade) OR TITLE(soundscape) OR TITLE(smellscape) OR KEY(urban AND landscape) OR KEY(streetscape) OR KEY(facade) OR KEY(soundscape) OR KEY(smellscape)
Mobility	TITLE(covid) AND TITLE(mobility) OR TITLE(cycling) OR TITLE(public and transportation) OR TITLE(biking) OR TITLE(walking) OR TITLE(walkability) OR TITLE(commuting) OR KEY(mobility) OR KEY(cycling) OR KEY(public and transportation) OR KEY(biking) OR KEY(walking) OR KEY(walkability) OR KEY(commuting)
Land use	TITLE(covid) And TITLE(land AND use) OR TITLE(Residential) OR TITLE(housing) OR TITLE(Infrastructure) OR TITLE(Green AND space) OR TITLE(Blue AND space) OR TITLE(park) OR TITLE(Dwelling) OR TITLE(mix AND use) OR KEY(land AND use) OR KEY(Residential) OR KEY(housing) OR KEY(Infrastructure) OR KEY(Green AND space) OR KEY(Blue AND space) OR KEY(park) OR KEY(Dwelling) OR KEY(mix AND use)
Urban Quality	TITLE(covid) And TITLE(sustainable AND city) OR TITLE(sustainable AND development) OR TITLE(livability) OR TITLE(Air AND quality) OR TITLE(social AND interaction) OR TITLE(Urban AND Resilience) OR TITLE(smart AND city) OR TITLE(inclusiveness and city) OR TITLE(tourism) OR TITLE(creative AND city) OR TITLE(urban AND health) OR KEY(sustainable AND city) OR KEY(sustainable AND development) OR KEY(livability) OR KEY(Air AND quality) OR KEY(social AND interaction) OR KEY(Urban AND Resilience) OR KEY(smart AND city) OR KEY(inclusiveness) OR KEY(tourism) OR KEY(creative AND city) OR KEY(urban AND health) OR KEY(smart AND city)

Tab.1 Scopus database search string

2.3 Screening process

Figure 1 exhibits the article screening and identification process, following the Preferred Reporting Items specified in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline (Moher et al., 2009). 13002 records were identified for further eligibility screening (see Figure 1). 12755 records were excluded during the title, and abstract screening, and 247 articles were excluded at the stage of full-text assessment. Finally, 145 studies remained in this review. Five reviewers performed the selection process independently. Disagreements were resolved through consensus discussions between the reviewers.

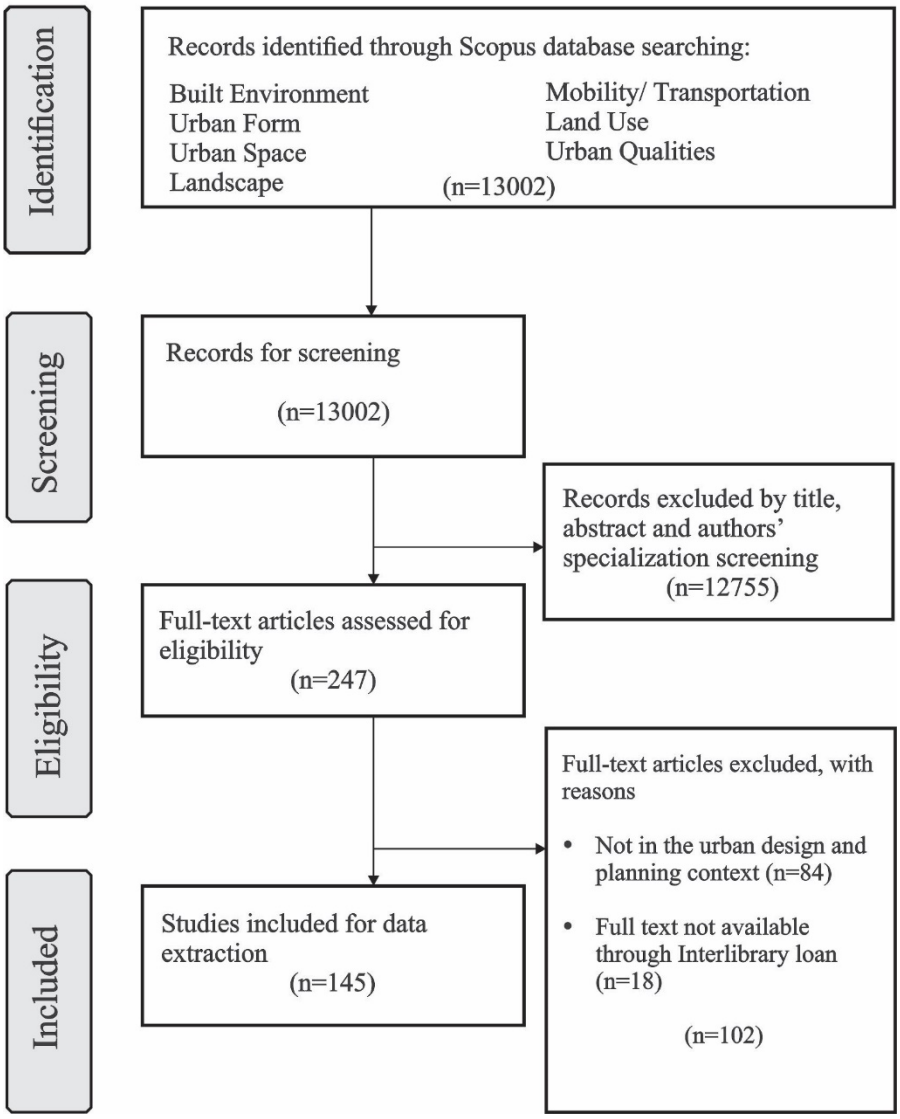

Fig.1 PRISMA flow diagram

2.4 Data extraction

Define Data Extraction Variables: Data from each selected study were extracted for five key dimensions: descriptive information, goals, methodology, findings, and limitations. Specific study characteristics extracted included first author, publication year, study area, study design, data source, data analysis methods, key conclusions, and limitations. *Develop Data Extraction Form:* Create a standardized form or template to systematically record the extracted data from each article. We developed a Microsoft Excel sheet and extracted information in detail. *Training and Calibration:* It is important to calibrate the reviewers to ensure that they are interpreting and extracting data in a consistent manner. We made several video calls and all necessary points were outlined by the first author about which parts of article they should read and how they should

extract data. *Data Extraction Process:* The papers were divided among all authors so that they independently conducted data extraction. The collected information was later synthesized to report the results presented in the next section. *Quality Control:* To ensure the accuracy and reliability of the extracted data, we double-checked a random sample of extracted data for consistency. *Data Synthesis:* Once all data has been extracted, they were synthesized and analyzed to identify patterns, trends, and themes across the selected articles.
To pinpoint the main themes, our initial approach involved organizing the articles into categories related to urban form elements such as density, transportation, layout, housing, and land use as outlined by Dempsey et al. (2010). Ultimately, we were able to pinpoint 11 distinct themes including mobility, density, soundscape, public spaces, green spaces, housing, land use, socio-economic qualities, environmental qualities, tourism, and smartness.

4. Results

4.1 Characteristics of reviewed studies

Tab.2 illustrates that over half of the articles utilized quantitative methods, while approximately 39% employed qualitative methods. Surveys (questionnaires and interviews) were conducted in only around 33% of the studies, whereas secondary data was utilized in about 60% of them. Upon categorizing the articles, it was revealed that the highest proportion focused on mobility and density, accounting for approximately 22% and 15%, respectively. Conversely, articles related to soundscape and smartness had the lowest representation, each comprising around 6%. Approximately 51% of the articles were cited between 0-10 times, while only 16.5% received more than 50 citations. China and the United States were the countries with the highest number of articles in this field, with approximately 15% and 12%, respectively. Notably, Sustainability and the International Journal of Environmental Research and Public Health were identified as the journals with the most published articles in this area.

Study characteristics	**No.**	**%**	**Study characteristics**	**No.**	**%**	**Study characteristics**	**No.**	**%**
Publication Year			**Themes**			**Citations**		
2020	33	22.7	Mobility	32	22.1	0-10	75	51.7
2021	98	67.5	Density	15	10.3	11-20	26	17.9
Early 2022	14	09.6	Soundscape	6	04.1	21-50	20	13.7
Study Design			Urban public spaces	7	04.8	+50	24	16.5
Quantitative method	76	52.4	Green spaces	22	15.2			
Qualitative method	57	39.3	Housing	15	10.3			
Mixed method	12	08.2	Land use and activity	13	08.9			
Outcome Data Sources			Socio-economic qualities	13	08.9			
Secondary data	86	59.3	Environmental qualities	8	05.5			
Questionnaire	36	24.8	Tourism	8	05.5			
Interview	12	08.2	Smartness	6	04.1			
Study areas								
North America	29	14.1	Czech Republic	1	00.5	Bangladesh	1	00.5
United States of America	25	12.2	Ireland	1	00.5	India	1	00.5
Canada	4	02.0	Israel	1	00.5	Palestine	1	00.5
South America	5	02.4	Norway	1	00.5	Philippine	1	00.5
Brazil	3	01.5	Scotland	1	00.5	Thailand	1	00.5
Colombia	2	01.0	Serbia	1	00.5	UAE	1	00.5
Europe	56	27.3	Switzerland	1	00.5	Vietnam	1	00.5
England	14	06.8	Turkey	1	00.5	*Australia*	8	03.9
Italy	11	05.4	*Asia*	71	34.6	Australia	6	02.9

Study characteristics	No.	%	Study characteristics	No.	%	Study characteristics	No.	%
Spain	5	02.4	China	31	15.1	New Zealand	2	01.0
Germany	4	02.0	Iran	10	04.9	*Africa*	5	02.4
Austria	3	01.5	Japan	5	02.4	Egypt	3	01.5
Poland	3	01.5	Singapore	5	02.4	Nigeria	1	00.5
Belgium	2	01.0	Indonesia	4	02.0	South Africa	1	00.5
Greece	2	01.0	South Korea	4	02.0	*Without case study*	28	15.1
Netherlands	2	01.0	Malaysia	3	01.5			
Sweden	2	01.0	Hong Kong	2	01.0			
Journals with the most published articles								
Sustainability	18	12.4	Sustainable Cities and Society	10	06.8	PLoS ONE	5	03.4
International Journal of Environmental Research and Public Health	13	08.9	Cities	9	06.2	Town Planning Review	5	03.4

Tab.2 Characteristics of the reviewed studies

4.2 Mobility and Covid-19

The results of studies in this field can be divided into three categories including the relationship between Covid-19 and public transportation, walking during the pandemic, and the association between the spread of Covid-19 and cycling.

The Covid-19 pandemic has significantly impacted mobility patterns due to the virus's transmission and the implementation of social distancing protocols (Ravagnan et al., 2022). Unlike other modes of transportation, public transportation suffered the most damage during the pandemic (Tully et al., 2021). Using public transport declined in a large number of countries during the first wave of the pandemic, leading to a decrease in people's willingness to travel by public transport even after removing the restrictions (Babalık, 2021; Basu & Ferreira, 2021; Bohman et al., 2021; Campisi et al., 2020; Guzman et al., 2021; Liu et al., 2020; Q. Liu et al., 2021; Monahan & Lamb, 2022; Mouratidis & Papagiannakis, 2021; Munawar et al., 2021; Tully et al., 2021). In addition, people, especially those who live in developing countries have switched from public transportation to private cars (Babalık, 2021; Tully et al., 2021) (Habib & Anik, 2021; Jasiński, 2022). Poor transport systems, fear of contracting Covid-19, and remote work are among the reasons for the decrease in traveling by public transportation during the pandemic. Therefore, a significant part of mandatory and optional travel has been replaced by telecommuting and other remote online activities (Basbas et al., 2021). For example, 60% of people in Australia tend to work remotely with the highest online shopping record (Basbas et al., 2021; Munawar et al., 2021). In addition, the pandemic represents social injustice and led to an increase in the incidence rate among low-income people due to their high dependence on public transportation (Dueñas et al., 2021; Lak et al., 2021; Monahan & Lamb, 2022).

A significant relationship is observed between the spread of Covid-19 and the number and duration of travel by public transportation. For example, Lak et al. (2021) indicated that public transportation infrastructures such as bus stations in Tehran affect the spread of Covid-19 significantly and a moderate association is reported between metro stations and the incidence rate in neighborhoods. In addition, AbouKorin et al. (2021) argued that the suspension of public transportation services was among the factors to reduce the spread of Covid-19 in Chinese cities, especially during the first week of the pandemic. However, Zhang et al. (2021) claimed that restricting the use of public transportation is not regarded as the only method to reduce the spread of the disease since only 48% of the transfer restrictions have been effective.

Based on the results, the rate of people using bicycle has increased in countries such as China, Sweden, the USA, Australia, and Iran, during the first and second waves of the pandemic, indicating the resilience of cycling

during the crisis (Buehler & Pucher, 2021; Chai et al., 2021; Heydari et al., 2021; Nurse & Dunning, 2020; Paydar & Fard, 2021; Shaer et al., 2021). The study by Fenu (2021) examines the urban policies of five cities (Barcelona, Bogota, Brussels, Milan, and Paris) and evaluates the measures taken during the initial lockdown from February 2020 to May 2020. Across all cities, there was an increase in the use of bicycles and improvements in bicycle infrastructure. The Covid-19 pandemic demonstrated that the bicycle is the safest and most effective mode of urban transportation. Further, Wali and Frank (2021) investigated the business trips and asserted that an adverse relationship is observed between active commuting including cycling and walking with the rate of death and hospitalization during the Covid-19 pandemic. The results indicate that the number of cyclists, the number of male/female users, the time duration of cycling, the type of bicycle (shared and electric), and the travel destination differ depending on the time and place during the pandemic. For example, using bicycle declined significantly during the early months of the pandemic in some regions such as China. A significant decrease has been observed in bicycle trips to metro stations, commercial plazas and squares, and religious places, as well (Chai et al., 2021; Shaer et al., 2021). However, factors such as shared and electric bicycles, as well as the smart bike system and smart mobile phone applications have led to an increase in the use of bicycles during the pandemic (Heydari et al., 2021; Kazemzadeh & Koglin, 2021; Paydar & Fard, 2021). Regarding gender, although the duration of cycling for both men and women has risen compared to the pre-pandemic era, men have cycled more than women (Campisi et al., 2020; Paydar & Fard, 2021). A large number of countries have seen the pandemic as an opportunity to improve cycling infrastructure by designing bicycle paths (Vancouver, Budapest, Rome, and Brussels) and converting roadways and parking lots into pedestrian streets and bicycle lanes (Paris, Melbourne, and Amsterdam) (Nurse & Dunning, 2020).

The results indicated that walking, especially during the first and second wave of the pandemic has declined with the imposition of restrictions and does not exhibit a significant relationship with a definite reduction in the mortality rate (Campisi et al., 2020; Enoch et al., 2022; Hunter et al., 2021; Shaer et al., 2021; Tully et al., 2021; Wali & Frank, 2021). For instance, Tully et al. (2021) declared that only 10% of Covid-19 outbreaks have been reported in parks, meaning that going to parks and public spaces, as well as reducing walking and cycling activities cannot affect the spread of the disease significantly. The studies attribute the amount and pattern of walking to various factors such as age, gender, time of virus outbreak, trip destination, economic and social conditions and built environment conditions. For example, Q. Liu et al. (2021) studied the movement of the elderly in the city of Kunming, China, during the first two months of the pandemic and indicated that the rate of elderly people who go walking for religious activities, and daily shopping, has not decreased, and such age group has not decreased the movement in the whole city.

In addition, the method of transportation in developing countries and poorer regions has been less affected by the pandemic and people have to move by any type of transportation (Dueñas et al., 2021; Lak et al., 2021). Hunter et al. (2021) and Guzman et al. (2021) believed that the pandemic significantly reduced the amount of walking among underprivileged citizens, who are at risk of contracting Covid-19 with far fewer options for moving around the city, while residents in high-income areas go walking in their leisure time and walk more compared to the pre-pandemic era. In addition, leisure and shopping trips have seen a rise, especially among men, while business, educational, and religious trips have decreased (Bohman et al., 2021; Shaer et al., 2021). Moreover, the patterns of walking have changed in order to maintain social distancing (Li & Xu, 2021).

To promote sustainable and resilient cities, some recommendations were outlined. The most significant of these include:

1) planning and designing 15-minute cities, 10-minute neighborhoods, and developing mixed-use neighborhoods to tackle spatial and social injustices (Basbas et al., 2021; Guzman et al., 2021; Kang et al., 2020);
2) using modern technologies to control the transmission of the virus in public spaces;

3) applying policies such as introducing parking charge and fines to reduce the use of private cars in order to encourage people to walk and bike (Basbas et al., 2021; Bohman et al., 2021; Rakhmatulloh et al., 2020);
4) applying movement restrictions based on the point of interest (POI) index and newly formed movement patterns (Li & Xu, 2021);
5) increasing access to parks and outdoor spaces with a focus on promoting active transportation infrastructure (Bohman et al., 2021);
6) efforts to improve non-motorized transportation should prioritize the development and planning of new public spaces and infrastructures for pedestrian mobility within the urban layout (Cirianni et al., 2022);
7) Streets can be reshaped in resilient infrastructure capable of responding to new forms of mobility and ever-changing mobility (Deponte et al., 2020);
8) policy-making and planning for justice to develop more flexible and sustainable urban systems.

A certain number of limitations were identified in this field:

- lack of generalizability of results to other cities and countries since movement in any city is related to the spread of the disease, online activities, urban form, spatial planning, social awareness about the future of cities, decision-making and policy-making systems in the city (Mouratidis & Papagiannakis, 2021);
- limitation in the time of conducting studies to the first and second waves of Covid-19 and the need for more extensive studies during the next waves (Campisi et al., 2020; Kazemzadeh & Koglin, 2021; Munawar et al., 2021; Shaer et al., 2021; Zhang et al., 2021);
- restriction in the use of accurate transportation data including spatial and temporal and the need for more detailed studies utilizing data from automatic passenger counting systems or smart cards (Heydari et al., 2021; Hunter et al., 2021; Li & Xu, 2021; Liu et al., 2020; Munawar et al., 2021; Nian et al., 2020);
- and limitation in interviewee groups, methods of interviewing, and conducting questionnaires, as well as the need for more detailed studies through face-to-face interviews instead of online ones (Zhang et al., 2021).

4.3 Density and Covid-19

The results of studies that have measured the relationship between density and the spread of the pandemic are somehow contradictory. A group of studies reported a negative/no relationship between density and Covid-19. Hamidi et al. (2020a; 2020b) indicated a significant and negative relationship was observed between density (population and occupation densities) and mortality rate in the USA. They claimed that connectivity affects the spread and mortality of Covid-19 more than density and that the mortality rate has been lower in high-density areas due to better access to health services and easier management. In addition, Khavarian-Garmsir et al. (2021) argued that residents in densely populated areas with better access to urban infrastructure and services can enjoy a safe environment by changing their lifestyles. Based on the results, the overcrowding of places is regarded as the driving force in the transmission of Covid-19, which can occur in both densely and sparsely populated areas. Further, Jasiński (2022) claimed that Covid-19 spreads mostly based on people's behavior at the community level. In fact, the existing inequalities in society such as the level of access to amenities and public health infrastructure is among the main reasons for the spread of Covid-19, and density alone cannot exacerbate the pandemic. Furthermore, Carozzi (2020) asserted that density affects the time of disease outbreak, not the incidence and mortality rate.

Unlike the above-mentioned results, Lak et al. (2021) found that building density among the elements of urban form affects the spread of Covid-19 in Tehran. In fact, higher building density means smaller housing size, which increases the probability of disease outbreaks due to the lack of social distancing. According to Choerunnisa et al. (2020), both building and population density affect the spread of Covid-19 directly, and the

possibility of such spread is higher in slums. Jo et al. (2021) believed that although urban density plays a significant role in the spread of Covid-19 in Korea, connectivity affects more than density and more attention should be paid to movement restrictions between cities. The study by Z. Liu et al. (2021) shows that there is a relationship between walk score and density and mortality rate. It does not mean that walking increases the rate of contagion but indicated that places with greater availability of urban amenities are potentially more contagious. In addition, Mouratidis (2022) focused on urban density through the lens of mental health and the perception of citizens and analyzed the negative impact of high-density areas on the mental health and the perception and satisfaction of citizens during the pandemic. High-density areas during the pandemic have led to a decrease in life satisfaction, happiness, and leisure satisfaction, especially due to the smallness of houses and traveling by public transportation among residents of densely populated areas.

Based on the relationship between urban density and Covid-19, some studies have presented various contradictory recommendations in this area for post-pandemic cities. The most significant of these include 1) developing compact cities with regard to its advantages in environmental, transportation, health, and economic dimensions (Hamidi et al., 2020a; Lima et al., 2021); 2) designing smaller-scale residential areas instead of large-scale urban units because shortage and inequality in basic services will be ended with the distribution of vital, diverse services and facilities (Jabareen & Eizenberg, 2021). However, McFarlane (2021) argued that revaluing density is a multi-scale and multi-sector challenge. The realization of which requires a wide range of changes involving those in housing policies, as well as infrastructure and resources, regulatory changes in urban development, participatory budgeting, and the creation of alliances between residents, activists, and governance structures, and the formation of integrated urban management between cities, regions, and central states. Finally, the study by Boujari et al. (2023) showed that Supporting or opposing urban development initiatives such as compact cities may be premature given the conflicting findings of existing studies, and further research is needed to resolve these uncertainties.

The most significant recommendations for future studies in this field include dealing with a wider sample of predictive variables and urban characteristics (Hamidi, Sabouri, et al., 2020; Lima et al., 2021), considering social, economic, ethnic, and racial indices (Lima et al., 2021), including indices related to health (Lima et al., 2021), focusing on the local scale and analyzing variables at different scales in order to assess inequalities in a single city (Hamidi et al., 2020; Khavarian-Garmsir et al., 2021; Lima et al., 2021), comparing densely populated cities around the world and evaluating the components in different social, cultural, and spatial contexts (Khavarian-Garmsir et al., 2021; Mouratidis & Yiannakou, 2022), applying longitudinal data to find causal relationships between variables (Lima et al., 2021; Mouratidis & Yiannakou, 2022), and considering the impact of control policies during the pandemic in the analysis model (Jo et al., 2021).

4.4 Soundscape and Covid-19

The results of studies showed a change in the level of noise and in the perceptions of soundscapes during the pandemic. Some studies conducted on the soundscape in cities represent the change in the noise level during the quarantine period. Hornberg et al. (2021) indicated that the average overall noise reduction during the pandemic in Germany was about 5.1 dB, while noise levels in each area fluctuated based on various factors such as human behavior, animals, vegetation, and the like. The weakest noise reduction was observed in "Main Street" (3.9 dB), and the strongest in "Urban Forest", "Green Space", and "Residential Area" (5.9 dB each). According to Basu et al. (2021), a significant decrease in the hourly average equivalent sound level and the minimum hourly sound level was seen in 12 stations during the quarantine period in Dublin. However, Lenzi et al. (2021) claimed that eventfulness, as well as acoustic complexity and richness, have increased significantly during the period, while the amount of technological sounds has decreased. Changes in the activities and behavior of people in open spaces, the gradual return of street life, and the use of personal transportation vehicles can be among the reasons for the clear increase in eventfulness and loudness. In

addition, Sakagami (2020) reported that the change in noise level in a small residential area in Japan was considered as small. The difference between the results of this study and previous ones may stem from the smallness of the studied area.

A number of studies have analyzed the change in the perception of urban soundscapes. For instance, Mitchell et al. (2021) asserted that natural sounds predominated over human sounds in all of the studied areas during quarantine in London and Venice in 2020, making those places previously dominated by traffic sound more pleasant. In addition, Aletta and Van Renterghem (2021) found that the participants who were more inclined to avoid public transport due to Covid-19 rated the soundscape related to the studied public space in the city of Antwerp as less lively. Plus, from the perception of participants who were more concerned about Covid-19, the acoustic environment was filled more with natural sounds and traffic noise coming from local roads. They also declared that environmental issues such as air quality and environmental noise play a more significant role, meaning that people may care more about the environmental quality of public space since the start of the pandemic. Further, Lenzi et al. (2021) argued that human activities in the interior are shared through open windows during the pandemic, and birdsong has emerged as a new element of the local urban soundscape, as well.

The results indicated that improving active transportation infrastructure such as walking and cycling can help reduce urban noise and increase public health (Basu et al., 2021; Hornberg et al., 2021). Some key limitations of reviewed studies and recommendations for future studies include: 1) considering demographic characteristics, personal attitudes, and changing environmental and contextual conditions of places when it comes to assessing soundscapes by people (Aletta & Van Renterghem, 2021; Mitchell et al., 2021); 2) recording sound in different places with diverse land use to achieve a comprehensive understanding of the urban sound environment (Hornberg et al., 2021); 3) utilizing longitudinal data to find the casual relationships between different variables (e.g., personal attitude influencing the soundscape, or vice versa) (Aletta & Van Renterghem, 2021); 4) comparing the amount of noise in different seasons (Hornberg et al., 2021).

4.5 Urban public spaces and Covid-19

The reviewed studies investigated the effects of Covid-19 on urban spaces and their role in critical situations. The results indicated that Covid-19 has made some changes in the method of using urban public spaces, resulting in altering the lifestyle of people in the world into two categories before and after the pandemic. Yong et al. (2021) believed that public spaces have been affected during the pandemic since the built environment in the pre-pandemic era was used without borders and clear zoning, as well as any control and supervision, while real and symbolic boundaries were applied after Covid-19 quite clearly for further surveillance, along with signs such as maintaining social distance and wearing a mask. Quarantine has created an opportunity for the emergence of virtual open spaces. Training classes and ceremonies are held virtually due to facilities such as the Internet and various multimedia applications (Shawket, 2020).

In addition, Shawket (2020) measured the popularity of public spaces such as "mediated by space" and "constrained by space" after the pandemic and claimed that the character of the first category (urban public spaces demarcated and controlled by natural urban forms) leaves a positive meaning such as a sense of belonging, happiness, and security for users after the pandemic, while the second one (where the physical environment hinders human activities) is regarded as a space in which users exhibit the least positive feelings towards the environment. According to some studies, Covid-19 can affect the social needs of the people, reduce the desire of pedestrians to commercial spaces, and decrease noise and air pollution in addition to its direct impact on public health (Askarizad et al., 2021; Honey-Rosés et al., 2020). Further, Bonomi Bezzo et al. (2021) reported that Covid-19 can affect the level of intimacy and sense of attachment to public places among children and adolescents significantly because people in such spaces have romantic or cultural experiences which lead to more social isolation of young people and their absence in urban public spaces when the

pandemic continues and other infectious diseases in the future. However, public spaces are still considered as a place for social interactions during the pandemic. For example, large green spaces in London, Vancouver, and New York were converted into emergency and field hospitals, indicating the main role of public spaces in making cities resilient (Honey-Rosés et al., 2020).

Some recommendations outlined for public spaces to control Covid-19 better include creating one-way circulation in the space, allocating checkpoints to maintain security and creating limited access nodes for managing public places better, closing secondary public places, limiting certain activities in public places (Cheshmehzangi, 2020), and using smart technologies to improve the quality of urban public spaces (da Fonseca & Kistmann, 2021).

4.6 Green spaces and Covid-19

The results can be divided into two categories including the role of green spaces in the citizens' health during the pandemic and the change in the quality of people's presence in such spaces after the outbreak of Covid-19. Some studies have investigated the effect of green spaces on public health during the pandemic. Access to green space in urban areas improves physical activity, healthy habits and behaviors, as well as the well-being of residents (Ahmadpoor & Shahab, 2021). The results indicated that the communities with less access to green spaces exhibit a higher incidence rate. Generally, inequality in accessibility to nature affects the citizens' health and social interactions negatively (Majewska et al., 2022; Spotswood et al., 2021; Sridhar, 2021). In addition, access to private gardens, shared spaces, parks within a 10-minute walk, or green buffers within 250 meters reduce the possibility of disease transmission in addition to improving the citizens' mental health due to the lower density of the audience and lack of need to travel and interact with others (Heckert & Bristowe, 2021; Pan et al., 2021; Poortinga et al., 2021; Robinson et al., 2021). Cheng et al. (2021) also asserted that citizens with more access to urban and small-scale parks such as pocket parks are regarded as happier (Cheng et al., 2021). Forest recreational services affect physical and mental health in addition to urban green spaces since they can reduce psychological pressures and relieve stress (Bamwesigye et al., 2021).

Some other studies have focused on the change in the quality of people's presence in green spaces during the pandemic. The study conducted on the presence of American students in urban parks indicates that the activity in urban open spaces and parks has decreased during the early stages of the disease outbreak, especially among racial minorities (Larson et al., 2022). However, most Chinese students tend to return to green spaces for social interactions and psychological recovery (Liu et al., 2021). Based on the results, the significance of green spaces in people's opinions has changed positively. For instance, most Polish and Chinese citizens have become increasingly interested in urban green spaces and believe that visiting such spaces during the Covid-19 pandemic has reduced their fear and stress levels (Luo et al., 2021; Noszczyk et al., 2022) although some ordinary people avoid visiting urban green spaces due to the fear of their parents and children getting infected (Luo et al., 2021). In addition, participation in passive activities in urban parks and local areas in Palestine has either decreased significantly or does not show any change compared to home gardens. There are two possible factors in this regard. In fact, the number of people allowed to move into such areas decreased during the quarantine, and the shops and recreational activities in the city parks were closed, resulting in eliminating a major opportunity for people to visit and relax in such spaces. Such results are incongruent with those elsewhere, which increase the use of urban parks as long as they remain open (Dawwas & Dyson, 2021). In addition, Li et al. (2021) found that green space quantity alone does not suffice to benefit. Rather, factors such as education level, income, gender, and place attachment affect people's perception of the health benefits of urban green spaces during the Covid-19 pandemic, as well Zhang & Schwartz (2020).

In order to increase the accessibility of residents to green spaces, the reviewed studies have proposed some recommendations, the most significant of which include: 1) designing pocket parks to increase access to green spaces for all of the urban population, especially when large-scale parks are closed due to the pandemic (Liu

& Wang, 2021); 2) changing the attitude towards parks as an essential part of urban infrastructure and reviewing the method of funding, designing, and managing urban green spaces (Dempsey & Dobson, 2021); 3) reusing and retrofitting abandoned urban spaces to create small green ones (Luo et al., 2021); 4) diversifying urban green spaces in terms of activities that can be done by users (Dempsey & Dobson, 2021); 5) increasing the construction of different types (vertical gardens, green roofs, etc.) of public green spaces in high-density areas with an elderly population to reduce commuting time for the elderly (Ahmadpoor & Shahab, 2021; Luo et al., 2021); 6) making workplaces greener to decrease stress and fatigue in built environments (Xie et al., 2020).

The reviewed studies have faced various limitations. For example, the population mainly includes young people in the studies where the data are collected through social networks (Cheng et al., 2021). The data taken from the interviewees' postal codes do not necessarily specify the location of their access to green spaces (Larson et al., 2022). The distinction between utilizing green spaces by local and non-local residents cannot be identified in the reviewed studies (Liu et al., 2021). The citizens' presence in urban green spaces during different months of the year depends on the weather, which should be included in future studies (Robinson et al. 2021).

4.7 Housing and Covid-19

Some studies investigated the quality of living in different types of housing and residential areas during Covid-19. For example, the residents of informal settlements and communal houses, especially in densely populated areas, have suffered from the most damage compared to other types of housing due to the weakness in meeting their basic needs (Corburn et al., 2020) since employment, housekeeping, and social, physical and mental health of citizens became dependent on the quality of housing during the Covid-19 pandemic (Horne et al., 2021). Raynor & Panza (2021) declared that 47% of Australian residents have faced financial difficulties, changed their homes, returned to their parents' houses, or lived in crowded environments. In addition, the Covid-19 pandemic has increased the feeling of fear and insecurity in gated communities in China. On the contrary, other studies revealed that people living in high-rise condominiums located in high-density planned residential complexes (unlike low-rise ones in low-density, unplanned, and organic neighborhoods) did not have any distress due to the feeling of security and highly controlled private entrances (Kang et al., 2021; L. Li et al., 2021).

A number of studies have focused on the significance of interior space parameters and their prioritization. Factors such as thermal and acoustic comfort of interior spaces, adaptability and flexibility of spaces to do a certain number of activities during the Coronavirus disease (Hizra & Dewi, 2021; Tajani et al., 2021), natural light, view and scenery, and the presence of open and semi-open spaces can increase the tolerance of the residents to cope with Covid-19 (D'alessandro et al., 2020; Zarrabi et al., 2021). In fact, such factors can affect mental health. In addition, Amerio et al. (2020) indicated that a strong relationship is observed between the low quality of housing and the symptoms of moderately severe depression in Milan so apartments without the aforementioned parameters have affected the mental health of people with such depression more than other people. Further, social isolation, living in crowded places, and living 24 hours a day in small apartments without a clear boundary between workplace and leisure time may lead to a decrease in productivity and threaten their health conditions (Cheshmehzangi, 2021).

A number of studies have reflected the relationship between Covid-19 and the housing market. For instance, Bentley and Baker (2020) argued that the housing system is considered an effective factor in the incidence rate of Covid-19 and economic vulnerability, which affects the quality of people's living places. According to the results, an increase in the value of local housing raises the incidence rate. In addition, Kang et al. (2020) identified the instability of housing costs as a major threat to the low-income class during the pandemic and

proposed that in order to ensure housing stability and prevent market stagnation in the short term, providing discounts on costs or taxes can help reduce the burden of housing costs.

Housing, as Keenan (2020) believed, can be effective in improving the resilience of cities. Thus, some recommendations are outlined for the architectural design of a healthy and sustainable housing in the post-pandemic era include: 1) making interior spaces more flexible to new needs; 2) making residential areas greener; 3) using ancient principles to achieve thermal comfort and improve indoor air quality; 4) managing water and sewage consumption; 5) paying attention to materials used in the interior space from public health point of view; 6) designing large windows to let more natural light in (D'alessandro et al., 2020; Zarrabi et al., 2021); 7) redesigning private and common spaces such as gardens and apartment terraces as an appropriate solution for improving social interactions; 8) creating economic and social values (Quaglio et al., 2021); 9) creating more public spaces in residential areas (Stoiljković, 2022); 10) government and social support can reduce the cost of living and the possibility of experiencing income shocks (Raynor & Panza, 2021).

4.8 Land use, activity and Covid-19

The results of the studies which have dealt with the relationship between Covid-19 and land use and activity are divided into two categories including the relationship between land use types with the incidence rate and analyzing the impact of the pandemic on the citizens' activities. Lak et al. (2021) claimed that a significant relationship is observed between land use and the spread of the pandemic. Land uses located in the eastern and central areas of Tehran city exhibit the highest correlation with the number of corona patients at the neighborhood level compared to other environmental factors such as physical environment and transportation infrastructure. Pharmacies, shopping malls, retail stores, as well as cheap and crowded chain stores in low-income neighborhoods have played a critical role in the transmission of the disease. In addition, Williams (2021) and Lak et al. (2021) reported that most of the confirmed cases of Covid-19 are concentrated in the central area of the city, which is regarded as the main place of commercial activities and economic activities. The concentration of service uses in city centers has made neighborhoods face serious risks of the disease. In addition, the lack of urban and health services in other parts of the city, especially the marginal ones, has led to more vulnerability in such areas and the lack of resilience against Covid-19 (Akter et al., 2021; Majewska et al., 2022; Mouratidis, 2021; Yang et al., 2020). However, Deas et al. (2021) asserted that an increase in the use of clinics and pharmacies has increased the level of medical services, which can spread the pandemic. Some studies in this field referred to a fall in physical activity, especially among children and young people since the pandemic has closed schools, playgrounds, recreational facilities, and even large parks. The results indicate that the built environment has provided opportunities for outdoor physical activity during the pandemic (McCormack et al., 2022; Mitra et al., 2020). Further, Deas et al. (2021) and examined the spatial flexibility in urban environments and found that utilizing temporary urban uses and multi-purpose urban spaces in critical conditions has had positive social, environmental, and economic effects which promote the resilience and sustainability of cities. Hong & Choi (2021) stated that social mix and retail stores in residential areas have increased the resilience of cities against Covid-19. Similarly, Wali & Frank (2021) declared that areas with mix-used development and high street connectivity exhibit a lower mortality rate and spread of Covid-19.

4.9 Socio-economic qualities and Covid-19

The results of studies can be divided into three categories including the relationship between demographic factors and the incidence rate, the relationship between social interactions and the Covid-19 pandemic, and the association between the economic resilience of cities and Covid-19. Some studies indicated that demographic characteristics such as social status, level of education, income level, and age are among the most significant ones (Kashem et al., 2021; Liu et al., 2021). Not all settlement characteristics show consistent correlations with the spread of the infection. The transmission of the novel coronavirus is strongly associated

with specific demographic factors, such as individuals aged 65 and older, and socio-economic factors, such as GDP per capita, within urban communities (Gargiulo et al., 2020). A positive relationship is observed between race and ethnicity and the Covid-19 infection rate in the United States. Blacks, low-income workers, and people who live in shared workspaces and homeless shelters are more at risk than other citizens due to the impossibility of maintaining social distance (Kashem et al., 2021; Upshaw et al., 2021; Wali & Frank, 2021). Finucane et al. (2022) stated that the transmission of Covid-19 in black neighborhoods is more than in other areas and more importantly the behavioral reactions caused by the virus in such neighborhoods pose serious threats to public health. In addition, Kang et al. (2020) indicated that informal and temporary workers, women, youth, elderly people, refugees, and self-employed people experienced more financial pressure due to the transmission of Covid-19 than others ones.

Some other studies have focused on the relationship between social interactions and the outbreak of Covid-19. For example, Sridhar (2021) and Lak et al. (2021) argued that more social activities and interactions are reported in prosperous areas due to greater access to parks and public open spaces., These areas, like slums, exhibit a high rate during the outbreak of Covid-19 since restricting activities in wealthier areas costs extremely high. According to You et al. (2020), there is a positive relationship between social interactions and economic activities and the incidence rate. The results indicate that the spread of the virus can hardly be controlled due to socio-economic inequalities, resulting in putting the entire city at risk. Plus, the participation of citizens and the right to the city, which emphasizes the idea that urban spaces should be inclusive, democratic, and accessible to all residents has faded during the outbreak of Covid-19 (Lim et al., 2021).

Hou et al. (2021) investigated the economic resilience of cities during the pandemic and claimed that a significant association is observed between the annual growth rate of gross domestic product (GDP), the annual growth rate of total electricity consumption, and the rate of the Covid-19 pandemic. Cities with economic crises and lower GDP rates exhibit less resilience in the face of the pandemic. Moreover, Setiadi et al. (2021) reported that strategies that lead to community synergy and economic prosperity have played a critical role in the stability of *Buñol* city during the pandemic.

Based on the reviewed studies, policies such as supporting disadvantaged groups with quick and effective actions in the short term during pandemics (Kang et al., 2020), improving the socioeconomic conditions in slums and informal settlements (Sridhar, 2021), prioritizing measures to reduce social and economic inequalities in the post-pandemic era (Sen & Nagendra, 2021), increasing the density of social services such as hospitals in cities (You et al., 2020), and paying special attention to the concept of the right to the city and citizen's participation at the local scale (Lim et al., 2021) are considered as effective in this field.

4.10 Environmental qualities and Covid-19

Except for one study, investigating the impact of lockdowns on urban heat island (UHI) intensity, others have focused on the relationship between the air quality and the built environment during the pandemic since the lockdowns created a golden opportunity to investigate the hidden aspects of this relationship.

According to the reviewed literature, impacts of lockdown measures on various pollutants such as PM2.5, PM10, CO, NO_2, SO_2, and O3 have mainly been explored based on comparisons of concentration levels of air particles during the lockdown period with either pre-lockdown or post-lockdown (Cai et al., 2021; Fardani & Aji, 2021; Han et al., 2021; Nakada & Urban, 2020; Sannigrahi et al., 2021). As Addas and Maghrabi (2021) proclaimed significant improvements in air quality during lockdowns globally, more than 50% of reviewed studies in the present paper announced the same result on the city scale.

Over 60% of the studies focused on NO_2, followed by PM2.5 about 50%, and about a third of the works reported the O3 trends. By comparing the statistics, as opposed to the Ozone, which generally increased during the lockdown period, other pollutants reported a fall by different intensities after lockdown restrictions were introduced. For instance, in Xi'an, China, the concentration of O_3 rose by 100.61 %, and those of PM2.5

and PM10 dropped by 22.4 % and 20.7 %, respectively (Han et al., 2021). In a study by Nakada and Urban (2020) in Sao Paulo, a relatively same trend was observed in NO_2 and O_3. While NO, NO_2, and CO were reduced in urban areas, ozone concentrations saw an opposite trend. Results shed light on the impact of human activities in the form of vehicular movement on the urban air quality, as a consequence of the restrictions on vehicle traffic (Fardani & Aji, 2021).

A common area in about a third of studies was the existence of human activities as an effective principle for the environmental quality of cities during the pandemic. Wu et al. (2021) concluded that road traffic dominated the reduction in air pollutants in Wuhan, China. The NO_2 concentration was reduced by about 73.3 % caused by human mobility during the lockdown period, only 10.0% by meteorological conditions, and 16.7% by emissions from industry and households. Another study that reveals the impacts of human anthropogenic emissions in Jakarta, Indonesia, is done by Fardani & Aji (2021). The notable point of this research is not the reduction of NO_2 levels but the existence of different trends of decreasing inside and outside Jakarta. There has been a decrease in NO_2 in both regions, but the change that occurred in outer urban areas is not considerable. A such difference indicates that human transportation plays an obvious role in the environmental quality of the inside cities. Sannigrahi et al. (2021) investigated economically the impact of reduced anthropogenic activities on a resident lifetime by assuming that premature deaths (caused by air pollution) can be avoided with the reduction of NO_2, PM2.5, and PM10. This study put to light the relationship between urban air quality and public health during lockdown restrictions.

Wai et al. (2021) worked on a study focusing on understanding the relationship between human activity and the urban heat island (UHI) intensity. A direct correlation between Covid-19 lockdown timelines and the UHI intensity was reported, which means that a reduction in human activity can decline the UHI intensity; however, other factors such as global climate and geographic features can dominate the overall temperature of the built environment. Although this research could not identify which human activities influenced the UHI most, the link is clear. Besides, the UHI intensity figure in cities with higher population density and urban built-up areas was more affected by the pandemic events. High-density cities such as New York City, Tokyo, and Melbourne experienced higher UHI intensity patterns. When compared to Dublin and Oslo after lockdown restrictions were introduced (Wai et al., 2021). It could be concluded that these results not only challenge experts' hypotheses about the way of connection between density, built environment and its environmental quality but also reveal some hidden aspects of this relationship.

Finally introducing new public policies for promoting adaptive socio-ecological models is recommended in studies to understand the relationship between the reduced human interventions and the environmental health of cities systematically (Sannigrahi et al., 2021), Immediate controls of decreasing emission sources, like limiting vehicles, prohibiting raising dust, and reforming production equipment is recommended to achieve the urban environment's sustainability (Han et al., 2021). Also, Wai et al. (2021) believe that there are new opportunities in the areas of energy consumption, transportation, and building materials to mitigate the UHI (Urban Heat Island) effect. They recommend: 1) installing solar panel systems in houses to provide cheaper and cleaner off-grid electricity; 2) developing renewable energy projects to replace fossil fuel power plants to reduce GHG emissions in the future and, ultimately, the UHI effect; 3) limiting car parking space for non-essential vehicles in the inner city to reduce traffic volume into the city and the risks of community spread of the virus in the future; 4) Encouraging people to use digital tools or apps to monitor and analyze their modes of transportation; 5) improving bike lanes and road infrastructures to provide safer and user-friendly road conditions for people to commute by bike; 6) reducing building materials with good solar heat absorption, such as concrete, glass, stainless steel, and ceramic gravel; 7) avoid using dark colors on buildings and road surfaces to reduce radiation absorption; 8) increase the green areas and green infrastructures in the urban area to improve the cooling effect.

In these studies, a few limitations are identified which include: 1) studies have been conducted only from 2020 to April 2021. Thus, further research should be performed on the literature published after April 2021 to have a better understanding of the impact of lockdown on air quality; 2) focusing on only some specific countries or cities, thus future studies could consider other cities or regions worldwide, to further explore the interruption-recovery patterns of urban air pollution and elucidate inherent mechanisms of the variation in urban air quality during the Covid-19 pandemic (Cai et al., 2021).

4.11 Tourism and Covid-19

The studies conducted in this field have discussed the impact of the Covid-19 outbreak on the tourism industry and provided some recommendations. The peak time of disease outbreaks, quarantine policies, and reduced movement of people were among the factors affecting the tourism industry (Bugalski, 2020; Liang et al., 2021). Liang et al. (2021) assessed 12 international cities during the mandatory quarantine and asserted that the pandemic has led to a decrease in the demand for accommodation in the city center, a sharp decrease in foreign tourists, and a decline in people's tourism activities. In addition, Cai et al. (2020) found that Covid-19 negatively affected foreign travelers in Japan more than domestic ones during the early months. Further, Bugalski (2020) indicated a fall in the reservation rate in countries (such as Japan with a 96% decrease in Beijing and European countries with a 41% decrease) and a short-term rental market's stagnation. Moreover, Goh (2021) argued that the tourism crisis created by the Covid-19 pandemic proved the over-dependence of the Malaysian economy on the tourism industry, which creates an opportunity to reflect on cultural and environmental policies supporting tourism. Gao et al. (2021) also reported some changes in the tourism industry of Nanjing, China during the pandemic, including changing the attention of tourists from urban architectural attractions to urban natural ones, increasing the number of tourists visiting the city center (Nanjing Old Town), attracting to large-scale natural landscapes and green open spaces in the post-pandemic era.

A number of studies in this field have examined the method of adapting tourism to the pandemic and consider the current crisis as a golden opportunity to reflect and redefine tourism development strategies. Kowalczyk-Anioł et al. (2021) categorized the measures taken in the city of Krakow, Poland, into three levels national, regional, and city. National measures to financially support the tourism economy in Krakow were taken to stop the loss of businesses that could not operate due to pandemic restrictions. Regional measures in Krakow focused on financial support for promotional activities and urban measures were taken to create a new image of the city during and after the Covid-19 pandemic. Campaigns such as being an internal tourist and providing free tours to sightseeing places, museums, and the like were implemented to help the tourism industry in the city. The policies adopted in Krakow include supporting the development of tailor-made products; dealing with the effects of tourism hypertrophy; controlling the sharing economy; supporting the development of the MICE industry (meetings, incentives, conferences, and exhibitions); integrating cultural and creative industries with tourism; promoting nightlife; and utilizing new technologies to improve the tourism industry. In addition, Andrade et al. (2021) recommended five strategies for tourism development during the pandemic, which are locally adapted to the specific characteristics of each port city. Such strategies include understanding the behavior and movement of cruise passengers, strengthening the local identity, regionalizing the cruise business, dispersing visitors in different areas of the city, and increasing the value of the industrial heritage of the port. Additionally, Urban areas should designate certain sensitive zones as "protected areas" where restrictions can be implemented to minimize the impact of tourism. These measures should focus on reducing the overall use of these sensitive areas, adjusting the timing and distribution of visitors, and implementing strategies to encourage more responsible behavior among tourists (Corbisiero & La Rocca, 2020).

The most significant limitations and recommendations of studies in this field include reviewing the main reasons for the difference in tourism demand in coastal cities (S. Li et al., 2021), spatial limitations (Cai et al.,

2020; S. Li et al., 2021; Liang et al., 2021), discussing the concept of poverty-tourism-environment for sustainable development (Goh, 2021), drafting proposals to reduce greenhouse gas emissions created by mass tourism movements (Andrade et al., 2021), and assessing the traditional hotel industry (Liang et al., 2021).

4.12 Smartness and Covid-19

The crisis of Covid-19 had important consequences on the development of smart technology concepts. As opposed to the pace of globalization, the pandemic will speed up the digitalization of life and work (Mohamed et al., 2021). Smart city technologies previously have improved city efficacy like managing traffic congestion, assuring electricity supply, and sanitation, including solid waste management; However, neither of these had been an issue during the pandemic since cities were concentrating on enforcing lockdowns, social distancing, and ensuring basic supplies of food and medicines (Webb & Toh, 2020). Generally, smart infrastructure has been discussed in studies in the fields of smart logistics, surveillance, healthcare, and the newfound technologies and the strategy of implementation. They have shown that the smartness of cities could not only mitigate urban dysfunctionalities but also it can enhance the well-being of communities and public health in crisis.

By summarizing the smart logistic practices implemented in the six Chinese cities against Covid-19, Zhang et al. (2020) reviewed smart cities' functional efficiency and potential in distributing supplies, managing personnel running public transport and services, and delivering medical and education services. Regarding the difficulty of maintaining the supply of vital food and medicine in the face of unusual behaviors such as panic buying, it is argued that smart city technologies could be used to monitor buying behavior and limit it in case of abnormal patterns. Furthermore, the capability to optimize supply chains accompanied with surveillance, name-and-shame, or otherwise prosecute individuals engaged in anti-social activities such as hoarding is another mentioned advantage of smart cities during the pandemic (Webb & Toh, 2020). Increasing the participation of residents, urban functionality in education and employment systems, the transparency of governmental processes, and social connectedness are other cited advantages of smart logistics in a city health crisis (Hassankhani et al., 2021).

Coronavirus has impacted trends concerning urban mobility (Kunzmann, 2020). Wang (2020) claim that the spatial layout and transportation system of a city require better intelligent approaches, especially after the impact of the epidemic. Detailed information on individual locations, personal health records, and abnormal changes in mobility and activity patterns does provide possibilities for data-driven decisions in a city during the pandemic (Webb & Toh, 2020). Taking the Urban Observatory program in Newcastle, UK as an example, a real-time data capture infrastructure monitoring program has been used for several years to store data on various metrics, including vehicular traffic, pedestrian movement, and air quality. In response to the Covid-19 crisis, the live data feeds of the platform were re-purposed to develop a data dashboard that allowed local authorities to make evidence-based adaptive decisions. (James et al., 2020).

The implications of the Covid-19 pandemic have raised many questions about how the pandemic will cause cities to continue densification strategies, or make cities more compact. In the belief of authors, the answer lies in the hands of the smartness and digital development of cities. The more the smart city infrastructure is developed, the more the city will expand to the suburb instead of becoming more compact. Based on the impacts of Covid-19, a new suburbanization strategy may be the case when access to 5G digital infrastructures in the wider city region is made available. Urban densification very much depends on smart technologies that require smart management of urban complexity (Kunzmann, 2020).

In terms of smart healthcare, it is mentioned that tracking patient numbers, hospital capacity, and balancing loads across hospitals in the city are the possible capabilities of the smart city approach in the Covid-19 crisis. Furthermore, tracking key logistical items such as protective clothing, masks, gloves, medicines, and intensive care equipment is achievable if the infrastructures of the smart city become deployed. Prioritizing medical

personnel across the city to ensure that they have access to food, transportation, etc., and better screening techniques to prioritize the severity of patients during admissions are other advantages of smart healthcare (Webb & Toh, 2020). In another study, telemedicine has been mentioned as a sustainable approach for urban planning to facilitate the continuity of everyday situations (Hassankhani et al., 2021).

Reviewing the theoretical and practical aspects of technology in smart cities, provides a scoping critique of the prospects, issues, and discussions related to the implementation of technology. Theoretically, applying 6G technology, IoT devices, Digital twins, Big Data, AI-enabled development, robots, and the like in public spaces can improve public health and well-being at the urban level (Allam & Jones, 2021; Chen & Narasimhan, 2021; Dignan, 2020). However, investigating obstacles in technical, socioeconomic, and environmental categories is essential before the technology is introduced, like the case study of the 10th of Ramadan in Egypt (Mohamed et al., 2021). Further, Cavada (2022) demonstrated that implementing truly smart gamification strategies can promote recovery for the urban setting during the pandemic. In fact, gamification technologies can provide location data, ensure open sharing of these datasets, provide educational instruments, improve social interactions which were severely damaged during the pandemic, and provide support while living and working during lockdowns.

However, technology deployment in crisis management is not without obstacles. The most cited challenges which could be mentioned are privacy, confidentiality and trust issues, social inclusiveness, political bias and misinformation dissemination, technical issues, and urban functions in education and employment. These all could be considered limitations of the development of smart city policies. It is suggested that to mitigate these side effects, policymakers should liberate the process of digitalization, increase the accessibility to digital services, and enhance digital literacy (Hassankhani et al., 2021).

5. Summery and conclusions

With the outbreak of Covid-19 around the globe, our cities faced severe changes in a wide range of issues. The pandemic once again reminds us of analyzing cities through the lens of public health as it was one of the main concerns of urban planners over the last centuries when people were struggling with some health issues and poor hygiene conditions. Coronavirus now is the reason for rethinking and revaluing the policies, values, and theories of urban design and planning to make post-pandemic cities healthier. The present study examined the effects of each element of the built environment including mobility, density, soundscape, public spaces, urban green spaces, housing, land use, socioeconomic qualities, environmental qualities, smartness as well as tourism on the spread of Covid-19. Needless to say, the following results and recommendations are not the final words as the topics are context-based and the findings may vary from one context to another. So, it should bear in mind that this study aimed to give just an overview of how cities have changed during the pandemic, and more rigorous studies are required to find solid results (see Tab.3).

With regard to mobility, the results indicated that the demand for public transportation saw a significant decline while traveling by private cars increased. This is mostly because of the possibility of increased Covid-19 confirmed cases for those who choose this mode of transport, poor transportation systems, online shopping, online learning, and remote working. The pandemic also revealed that socioeconomic inequality is one of the reasons for the virus transmission as low-income people had to use public transport to get to their work. Unlike public transportation, the number of cyclists has risen in a large number of countries as the most resilient mode of transportation in the face of any disruptive events. Plus, some papers confirmed that there is no significant relationship between walking and the Covid-19 infection rate as long as people maintain social distancing and behave responsibly. According to the impacts, some recommendations are outlined to make cities resilient in the face of unexpected pandemics: designing 15-min cities, developing mixed-use neighborhoods, using IT for the better management of transport systems, and developing active transportation infrastructures.

The studies conducted on the relationship between urban density and Covid-19 exhibit conflicting results. In some studies, urban density does not play a critical role in the spread of disease, and the overcrowding of urban environments (be it high-density areas or low-density ones), network connectivity, and socioeconomic factors are considered the driving factors for the virus spread. On the contrary, some other studies regard population density to be one of the main factors in the transmission of the pandemic due to the impossibility of maintaining social distancing and report a negative impact on residents' mental health and happiness in densely populated areas. However, it is noteworthy that we should distinguish between crowdedness and density.

Regarding soundscape, the results show that the amount of noise in urban spaces has declined during the pandemic, while indices such as eventfulness, as well as acoustic complexity and richness have risen. The main reason for such trends is because of reduced human activities in urban environments. In addition, a number of studies realized the change in the perception of soundscapes during the pandemic and indicated that natural sounds to what extent became predominant in the environment.

With respect to urban public spaces, the activity in virtual spaces has increased dramatically due to the restrictions and demarcations applied in urban spaces to control Covid-19 transmission. During the pandemic, citizens exhibit less desire to spend time in public spaces and socialize with each other. Studies indicated that the continuation of the current trend may lead to the isolation of the young population and a decrease in their sense of belonging to the place. Plus, it seems that public spaces shaped by natural forms have positive impacts on citizens' happiness and their sense of belonging, and during pandemics and similar situations urban spaces can be transformed into temporary hospitals and other needed uses due to their multi-functionality of such places.

Some studies have assessed the role of green spaces on the citizens' health, the results of which emphasized that more and better access to nature reduces the incidence and mortality rate, stress and anxiety of people during the pandemic, as well as increases physical activities and happiness. These results provide a wake-up call for policymakers to make green spaces accessible for everyone and develop such spaces everywhere, especially in neighborhoods with more disadvantaged people. Some other studies have evaluated the change in the quality of citizens' presence in natural spaces and highlighted that although there is a decline in the presence of minority groups, more people welcome green spaces on different scales and perform various activities. According to these impacts, some identical recommendations are provided, including designing pocket parks, diversifying green spaces, making workplaces and housing buildings greener, and transforming abandoned urban spaces into green spaces, among many others.

Relating to housing, the results indicated that those who are living in informal settlements, shared houses, crowded places, and even small apartments are more likely to be at higher risk of catching Covid-19. Further, the parameters related to the interior design of housing help the mental and physical health of the residents during the pandemic, while their absence can lead to depression. Plus, it seems that the instability in housing prices is among the factors which threaten the citizens' health against the pandemic, especially low-income people. Covid-19 shows how much the flexibility of housing buildings, the materials used for interior design, thermal comforts, greenery, and natural light matter.

A significant relationship was observed between the type of land use and the incidence rate, and a higher concentration of commercial activities in a specific area, like city centers, can aggravate the Covid-19 pandemic. It also seems that the lack of infrastructure and facilities in marginal areas makes people more vulnerable to the virus. Moreover, human activities have reduced due to the quarantine and closure of some uses. According to suggestions, making urban environments multi-functional and flexible to do a wide range of activities and developing mixed-use neighborhoods can result in resilient cities.

The transmission of Covid-19 also depends on various demographic factors such as social status, level of education, income level, and age of people. In addition, disadvantaged groups, minorities, and low-income

people are at higher risk of infection than other people as there is a significant relationship between socioeconomic inequalities and disease outbreaks. Cities with low economic resistance, and lower GDP growth rates exhibited less resilience. The findings also show a downward trend in the participation of citizens and social interactions. There are some recommendations in this field, including supporting deprived people and prioritizing them in the face of disruptive disease events, improving the quality of slums and similar places, and bridging the widening gap between people in terms of accessibility to healthcare and other social services. With regard to environmental qualities, the results are mainly based on the relationship between air quality and the built environment during the pandemic, indicating that pollutants such as NO, NO2, PM2.5, and PM10 decreased with variable amounts in different cities after the imposition of quarantine restrictions due to the decrease of human activities and unprecedented reduction of road traffic. The pandemic reveals that while transportation is the main culprit behind the reduction of NO2, air pollution, and the death rate caused by it, industries and metrological conditions have a small share compared to human mobility. Furthermore, the reduction of human activities has helped reduce heat islands during the Covid-19 pandemic, as well. In fact, thermal islands in densely populated cities were more affected by the pandemic.

Themes	**Effects**	**Implications**
Mobility	- The use of public transportation decreased significantly - There has been a notable increase in private car travel - The number of cyclists in many nations increased	- Designing 15-min cities - Developing mixed-use neighborhoods - Using IT for the better management of transport systems - Developing active transportation infrastructures
Density	- The level of population density in urban areas is not a significant factor in the transmission of diseases - Population density is considered a key factor in the spread of the pandemic because it makes it difficult to practice social distancing	- Supporting or opposing urban development initiatives such as compact cities can be seen as premature given the conflicting data and results available
Soundscape	- The noise levels in urban areas have decreased - Measures such as eventfulness, acoustic complexity and richness, have increased - Natural sounds become more dominant in the environment	- Enhancing the infrastructure for walking and cycling in cities can contribute to lowering urban noise levels.
Public Spaces	- People are showing less interest in public areas, potentially isolating the younger generation - The use of virtual platforms has significantly surged - Public spaces designed with natural elements can boost the happiness of citizens	- Implementing a unidirectional flow within the area during pandemics - Establishing restricted entry points to enhance the management of public spaces - Restricting specific activities in public areas during health crises - Utilizing advanced technologies to enhance the overall quality of urban public spaces - Urban spaces can be transformed into temporary hospitals and other needed uses
Green Spaces	- Having access to nature lowers the occurrence and death rate, as well as reduces stress and anxiety - It also boosts physical activity levels and overall happiness	- Ensure that green areas are easily accessible to all, particularly in neighborhoods with higher levels of disadvantage - Create pocket parks within communities - Introduce a variety of green spaces - Incorporate green features into workplaces and residential buildings - Convert unused urban areas into green spaces
Housing	- People in informal settlements, shared houses, crowded places, and even small apartments face a greater risk of Covid-19	- Adapting interior spaces to new needs - Increasing green spaces in residential areas

Themes	Effects	Implications
	- Home design can impact residents' mental and physical health during the pandemic - Fluctuating housing costs can jeopardize public health during the pandemic	- Applying traditional methods for thermal comfort and air quality - Efficient water and sewage management - Considering health-friendly materials in interiors - Incorporating large windows for natural light - Enhancing public spaces in neighborhoods - Government and social aid can lower living costs and income instability
Land Use	- Mix-used development show a lower mortality rate and spread of Covid-19 - A higher concentration of commercial activities in certain regions, such as city centers, can exacerbate the spread of Covid-19 - Insufficient infrastructure and amenities in marginalized areas increase the susceptibility of residents to the virus	- Creating urban environments that are versatile and adaptable for a variety of activities - Building diverse communities with a mix of residential and commercial spaces can lead to resilient cities
Socio-Economic Qualities	- Disadvantaged groups, minorities, and low-income people incomes are at a higher risk of being impacted by the pandemic - Cities with weak economic stability and slower GDP growth rates showed lower resilience - a decline in citizen engagement and social interactions	- Assisting marginalized individuals and giving them priority during times of disease outbreaks - Enhancing the living conditions in informal settlements and comparable areas - Addressing the increasing disparity in access to healthcare and other social services among the population
Environmental Qualities	- Levels of pollutants like NO, NO_2, PM2.5, and PM10 saw a decline due to reduced traffic - A reduction in heat islands amid the Covid-19 pandemic	- Human transportation plays an obvious role in the environmental quality of the inside cities
Tourism	- Tourism activities reduced - Tourists' focus shifted towards urban and larger natural attractions - The need for lodging in city centers declined	- Distributing visitors throughout the entire city through the development of diverse attractions in various locations - Supporting tailor-made products, - Linking the tourism sector with the creative industry - Celebrating indigenous culture and heritage
Smartness	- Emphasize the pivotal role of smartness in monitoring citizens' behavior	- Smartness should be considered in controlling disease, educating citizens, increasing public participation, providing healthcare services, managing public transport, facilitating social interactions, ensuring transparent governance, and making data-driven decisions

Tab.3 Major effects of urban design and planning on the pandemic and implications for future post-pandemic cities

The findings of studies in the field of tourism represent the effects of the pandemic on both foreign and domestic tourists, indicating that the mandatory quarantine in a larger number of countries results in decreasing tourism activities, changing the attention of tourists to urban and large-scale natural attractions, increasing the significance of open spaces during the pandemic, decreasing the demand for accommodation in city centers, and the stagnation in the short-term rental market. In addition, the findings consider the pandemic as an opportunity to review tourism development plans and introduce policies in sync with the development of the economy and the resilience of the tourism industry during the pandemic and post-pandemic era. Supporting tailor-made products, integrating the tourism industry with the creative industry, promoting local culture and identity, and dispersing tourists across the whole city by creating various attractions in different areas are among such policies.

As for smartness, the findings emphasize the pivotal role of smartness in monitoring citizens' behavior, controlling disease and tracking patients, educating citizens, increasing the participation of the public,

providing medical services and healthcare, managing public transport systems, facilitating social interactions, making governance procedures transparent, gaining real-time data and big data, making evidence-based decisions, among many others. However, there are still some concerns about technology and digitalization such as privacy, trust issues, social inclusiveness, political bias, and misinformation dissemination.

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Image Sources

Fig.1. PRISMA flow diagram

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