

Spatial planning for reducing the epidemic risk – the state of knowledge and practice from the perspective of the COVID-19 pandemic

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Abstract: The ongoing public health crisis caused by the COVID-19 pandemic has highlighted the link between community safety and health and the urban environment and has raised many challenges for cities that want to continue to provide a safe living environment. The Coronavirus pandemic has provoked many controversy and questions about its impact on urban forms. The goal of research was to document the status of knowledge and emerging research paths in the year following the COVID pandemic's disclosure. The study includes a scoping review to determine the relationship between urban planning and the epidemic risk. Literature research showed that compact structures, because of their proximity to health centers, give higher epidemic safety. Accessibility to vital services prepares cities and their residents for unanticipated threats. The promotion of a dispersion strategy, with social distance regulations already in place, can lead to the rise of prejudice and xenophobia. Urban planners and architects should also pay more attention to urban geometry, building configuration, communication networks, or green spaces. In order to strengthen urban resilience, appropriate infrastructure, the implementation of new technologies, and the construction of urban systems and structures are essential.

Keywords: cities, COVID-19; epidemic risk, urban planning

INTRODUCTION

The COVID-19 pandemic that affects the world has once again highlighted the close relationship between human health and the urban environment [GOUVEIA, KANAI 2020]. Outbreak of COVID-19 improved air quality in the short term and significantly contributes to global carbon emission reduction [WANG, SU 2020]. Significant association between contingency measures and clean beaches and environmental noise reduction [ZAMBRANO-MONSERATE *et al.* 2020] as well as water use patterns [KAZAK *et al.* 2021] was observed.

These interactions are evident in studies examining how human activities that alter or destroy biodiversity create conditions for the emergence of further viruses [DASZAK *et al.* 2001], but also by observing the impact of housing, population density, sanitation, and transport provision on epidemic risk. Appropriate urban planning and control can be very important

tools for improving public health and reducing the spread of infectious diseases [NEIDERUD 2015].

The basic strategies used to minimise the epidemic spread, namely social distance or isolation, are contrary to the desires of individuals who naturally want to pursue social interactions, but they are also contrary to the way cities function and their existing vision [KELLY *et al.* 2012]. The politics of social distance can affect individual cities differently, as these cities rely on extensive and intense socioeconomic interactions [STIER *et al.* 2020]. The ability to succeed in tackling a rapidly growing epidemic depends on maintaining as much person-to-person interaction as possible (e.g. through technology), while stopping the transmission of disease. Therefore, the situation raises questions about the difference between trends that seek to design for increased social relationships [ROMANELLI *et al.* 2019] and the need for population separation in epidemic emergencies [KIMMELMAN 2020]. It is not possible to draw broad conclusions about the future of settlement units under epidemic risk. However, it is worth paying attention

to imponderables, which often identify the processes taking place more accurately than the slim and insufficient data we have [KUBICKI 2020].

The World Health Organization (WHO) indicates that the tools to assist in its work are ‘healthy’ cities and appropriate city planning processes [DUHL, SANCHEZ 1999]. Urban planning should therefore involve designing cities and environments in ways that can provide healthy living environments for individuals. In fact, public health crises have become one of the greatest threats to contemporary development.

The COVID-19 pandemic, announced by the WHO on 11 March 2020, caused changes in the functioning of cities, including the sphere related to the spatial management system. The social, environmental, and health changes caused by the pandemic are significant enough to require consideration in spatial policy [NOWAK, BŁASZKE 2020].

Based on observations of preventive measures in public life, during the COVID-19 pandemic, a variety of approaches and varying degrees of rigidity in the enforcement of restrictions in different countries can be seen. There is considerable discussion in the literature about the changes and their extent, which is supported by examples from around the world. However, despite the differences and caveats, what is important is that private and public organisations understand the value of public space, which can not only help in the fight against a pandemic, but also ensure a better quality of life in the future.

This paper explores the impact of epidemic risk on the design of cities and urban areas and the relationship between urban design and community health. The article presents the state of knowledge and practice 12 months after pandemic announcement. Our goal was to describe the status of knowledge and emerging research paths in the year following the COVID pandemic’s disclosure. It was not our objective to establish new theories or hypotheses, but rather to chronicle the state of knowledge across a defined time horizon in line with the assumptions of the scoping review approach. From an academic and practical point of view, we were interested in the issues of shaping public spaces and designing the surroundings to ensure the highest possible degree of health safety. How to design green spaces to reduce the spread of infectious diseases. How to provide residents with access to green spaces. Whether it is necessary to modernise transport and communication systems. How can new technologies help us prevent and control epidemics. How can we shape spatial policies to better protect city dwellers against COVID threats?

MATERIALS AND METHODS

The research includes performance of a scoping review of national and international literature on the links between spatial planning and epidemic risk, including:

- analysis of past epidemic threats in cities and their impact on urban planning,
- presenting of the challenges of spatial management and the possibilities of architectural and urban planning solutions used in different cities and which may affect the epidemic risk in cities and their different components,
- presenting of information and analysis of the themes raised to identify the state of knowledge and research progress on the impact of spatial planning on epidemic safety.

Scoping reviews are extremely useful for overview research findings and are frequently used to categorise literature in a specific topic based on its nature, characteristics, and volume. Scoping reviews are performed “preliminary evaluation” of the prospective quantity and range of the ongoing research literature. The purpose of a study is to determine the kind and amount of research evidence. A scoping review is quite similar to a systematic review of the literature. The main distinction is that there are no constraints on the materials that can be used. The scoping review’s goal is to locate all information on the issue. The extent of the search is determined by time and scope limits. May include research in progress. There is no formal quality assessment [GRANT, BOOTH 2009]. Scoping reviews are beneficial for investigating emerging data when it is uncertain whether further, more specific questions may be presented and valuably addressed by a more detailed systematic review [MUNN *et al.* 2018].

The paper uses the methodology of a scoping literature review aimed at a comprehensive identification and overview of the available literature on the impact of spatial planning on epidemic risk.

The scoping review of the literature covers five phases of this study:

- 1) preliminary literature review, definition of the research objective and formulation of research questions;
- 2) collection of available literature;
- 3) selection and initial assessment of the set and definition of criteria;
- 4) analysis;
- 5) results.

In the first phase, the preceding work and literature were reviewed to revise the state of knowledge relating to reducing epidemic risk reduction through appropriate spatial planning. Before proceeding with the full search, the main objective of the study was defined: to determine the impact of spatial management on minimising epidemic risk.

Research questions were also formulated at this stage:

- what changes should be made to public spaces?
- how to plan and design transport infrastructure in a city?
- what is the impact of urban green spaces on the epidemic risk?
- how to design modern neighbourhoods that help maintain sanitary safety rules?
- should highways and footpaths be redesigned or upgraded?
- how can modern technologies be used in cities to help control epidemic risk?
- what urban planning concepts work during an outbreak?
- what are the most distinctive features of cities’ strategies for a COVID pandemic?

To perform a comprehensive scoping review, a literature search process was required [BOOTH *et al.* 2012]. Search techniques included:

- searching electronic databases (including Google Scholar, Research Gate, Scopus, among others);
- searching for material that is not controlled by commercial publishers (grey literature);
- checking the bibliography of items previously obtained;
- searching by citation index;
- reviewing relevant scientific journals;
- materials identified at conferences and industry meetings.

Before proceeding with the full search, keywords were extracted, chosen to provide extensive yet meaningful coverage of

existing articles and studies on cities, their planning, and solutions that may affect epidemic risk. The keywords included: “pandemic”, “urban planning”, “cities”, “urban design”, “healthy cities”, “infectious disease”, “smart city”.

To concretise the search results in some databases, the string TITLE-ABS-KEY (“COVID” or “pandemic”) and (“urban” or “cities” or “urban planning” or “urban design” or “city” or “healthy cities” or “infectious disease” or “smart city”) was used.

We conducted the literature survey on March 16, 2021 the results reflect the state of the database on the day of that survey. We related the historical timeframe to the conditions of Poland. An epidemic emergency was declared on March 14th, 2020, while an epidemic state was introduced on March 20th, 2020. It was a key moment to introduce some restrictions to prevent the spread of the virus. The restrictions have been successively introduced and abolished [KAZAK *et al.* 2021].

The results of the initial search in the databases varied. After applying the sequence indicated above, they returned the following number of records:

- 1) Scopus: 1393,
- 2) Google Scholar: 288,
- 3) Research Gate: 101.

A cursory review revealed that many of the returned articles were not relevant for our purposes. Due to the number of articles found during the initial search in the Scopus database, it was decided to limit results to urban planning, planning, design, or city management. After that we obtained the number of articles to 653. After reviewing the abstracts to ensure the relevance of the remaining articles, 155 records remained in the Scopus database.

The Scopus-returned literature collection was subjected to a broader review, after which the amount of materials related to the topic of this paper was reduced to about 100. Then, to the database of articles obtained from Scopus, nonrepeatable articles from other databases were added, as well as several items taken from the bibliography of returned records and materials indicated during conferences and professional meetings. Additional sources of information are scientific journals and grey literature, i.e. publications. In the end, the literature collection included nearly 150 materials.

Our analysis has some limitations and weaknesses. We did not use a systematic approach in our work in selecting keywords. This is undoubtedly a shortcoming that we would like to correct in the future. The selection of keywords was conducted on the basis of successive approximations of successive approximations. We noted that, increasing the comprehensiveness (or sensitivity) of the search reduced its precision and retrieved more irrelevant articles. The number of keywords used is the result of a compromise to strike a balance between making the search comprehensive enough to cover everything on a given topic, and precise enough to capture only those results that are particularly relevant. This article consists solely of an overview of past studies. Our goal was to overview as many publications as possible that were published within a year of the COVID pandemic being declared. We took an exploratory approach. That is, we did not make any preliminary assumptions. Rather, we concentrated on documenting the current state of knowledge and research viewpoints around the world. At this point, we are not to suggest a new meaning or implication, as we understand that the formulation of complex hypotheses and theories requires time

and a sufficiently long critical perspective. We believe that our summary provides a snapshot of the state of knowledge and practice related to urban planning in the context of a pandemic.

RESULTS AND DISCUSSION

CONCEPT MAPPING

The results of the Scopus database review can be divided into several main categories – socioeconomic impacts, urban governance and management, public health, and urban design. Among the records identified, the topics of urban management, urban design, and social impacts dominate. This is also indicated by the results of the co-occurrence analysis of terms (keywords), carried out using the VOSviewer software, a tool useful in textmining and bibliometric analyses (Fig. 1) [VAN ECK, WALTMAN 2010].

MANAGEMENT OF URBAN SPACE

Cities have been epicenters of infectious diseases for centuries, and it is within them that the greatest epidemic risk occurs. The strength of cities, however, can be seen through the number of trials to which they have been exposed. The Black Death, cholera, or Spanish flu epidemics of 1918 did not cause the permanent decline of cities. Each time they returned to potentially normal functioning, but with some experiences and changes.

Various factors related to urban form and design can influence the dynamics of epidemic spread, but most sources focus on factors related to population density. Numerous materials and publications point to the influence of population density on epidemic spread. However, with increasing research and analysis, the relationship between population density and virus spread is becoming less ambiguous. The size of the city matters in terms of the availability of health services. Large urban centers offer their inhabitants easier access to such services and also ensure that the authorities can respond more quickly to an emerging threat. In rural areas, which are often excluded, the distance to the nearest clinic can be a problem, which actually results in fast and effective treatment [WHO 2010].

The world is facing serious public health problems that require adaptation of urban life to the epidemic threats that occur. In the face of many constraints and restrictions, there is uncertainty of many factors, indicating how to ensure stable survival and lead sustainable development, which has become the focus of governments and researchers around the world. Therefore, appropriate urban planning can be a key factor in improving overall health in the near term. Consequently, a number of concepts, considerations, and approaches are emerging, presenting potential solutions that can help to contain and prevent epidemics.

URBAN EPIDEMICS OVER THE YEARS

Cities are the most affected by the epidemic threat and crises associated with this danger, as they are the largest concentrations of people. Large settlement units are the most dynamically developing economic, social, and cultural centres. At the same time, they are the most experienced, and it is their future in the changing reality that raises the most doubts [SAGAN 2021].

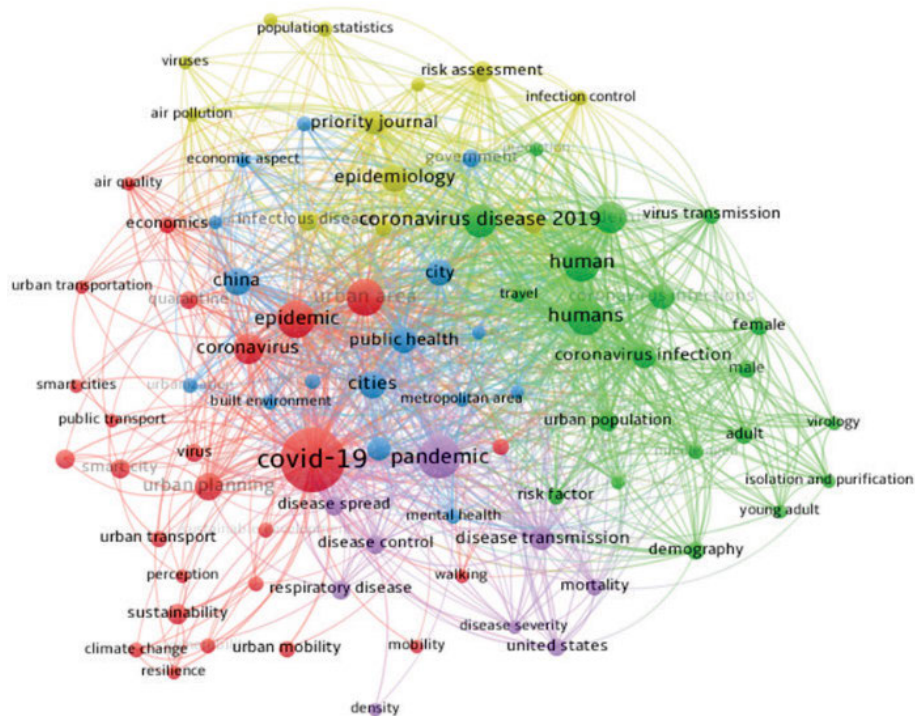


Fig. 1. Network of co-occurrence of concepts; own elaboration

Urbanisation results in increased mobility and settlement of the population in the so-called urban environment [PHILLIPS 1993]. However, there is no universal definition of the word 'urban'. The problem of identifying a universal definition makes it difficult to compare different countries and cities in relation to public health and the burden and impact of infectious diseases [ALIROL *et al.* 2011]. It is difficult to get a consistent picture and understand the burden of infectious diseases in different settings, as urban units around the world can be very diverse, including in terms of diseases and local activities. Rapid urbanisation around the world leads to great challenges in city planning. Rapid influxes of migrants can lead to overcrowding, and local authorities may not be able to provide safe housing, drinking water, and adequate sanitation facilities, all of which pose potential health spreads and must be taken into account in safety planning.

Infectious diseases have always been the enemy of urban life. Epidemic threats occur in different regions of the world every few or several years. Historical epidemics and pandemics have not only affected the health of the society at the time, but have also influenced the economic, strategic, or architectural aspects of urban management [ELTARABILI, ELGHEZANWY 2020]. With reference to major natural disasters in the past, infectious diseases have always exposed communities and social organisations to new challenges, leading to significant changes in settlement systems with consequences in the use of urban space [CONNOLLY *et al.* 2021]. Historical pandemics show that the way in which a virus spreads can be a source of innovation in the future to help contain infection and to guide the development of new values and visions.

It is worth noting that the epidemic threat that exists today differs from those that existed in the past. In fact, the characteristic that distinguishes it from previous epidemics is its spread through everyday contact with other people. The epidemic threat is associated with the spread of the disease spreading through general human contact, making it impossible to continue daily interactions as before.

With technological progress, there are increasingly innovative solutions to reduce contact with the face. Housing in less densely populated areas, catering delivered to one's doorstep, online shopping, and the ability to wash from home are all on the rise. In these times, we should persevere and strengthen our defences against future outbreaks. Pandemics create uncertainty because they strike at the heart of our urban world. Over the past five centuries, humanity has become linked with ever closer ties between continents and within cities. These ties enable trade, build friendships, and facilitate the spread of pestilence. If we do not invest enough in preventing future pandemics, the downside of population density may become too severe and our world will begin to fragment. A more fragmented world will mean less innovation, less economic growth, and much more suffering for the disadvantaged. The COVID-19 pandemic is projected to lead to the redevelopment of urban infrastructure and improved living conditions in urban centers [MIR 2020].

PLANNING AND ARCHITECTURAL SOLUTIONS TO REDUCE THE EPIDEMIC RISK

Environmental, social, and economic factors cause health inequalities among city dwellers, prompting researchers to propose 'smart' urban planning as a public health tool. Both historical epidemics and the ongoing COVID-19 pandemic should spur the optimisation of cities by incorporating into their planning and design process, observed social behaviour, citizen awareness, and possible health impacts [ELTARABILI, ELGHEZANWY 2020].

The changes following the global pandemic will not necessarily be the appearance of our cities, but how we use them. Contemporary cities are fluid, polycentric assemblages of local microcentres that spill over into surrounding towns and neighbouring areas. There is no doubt that the pandemic will have long-term consequences [BOSCHETTO 2020] that will require deep

interdisciplinary research [CHIGBU, ONYEBUEKE 2020]. It is likely to benefit the suburbanisation processes underway. Suffice it to recall that one of the arguments of the modernists in favour of urban sprawl was precisely the epidemic argument, in compact buildings it is easier for infections to grow rapidly. Cities of the post-pandemic era will compete for people with their plans and strategies to prevent and combat future disasters [SHENKER 2020].

The literature offers diagnoses of how the spatial management system should be adapted to new conditions. It is pointed out that it is necessary to redefine the meaning of public spaces – enabling solutions that favour social distance, questioning the concept of dense cities [BAILEY *et al.* 2020], adapting solutions to the changing demand for office buildings [CARSON *et al.* 2020] or modifying public transport and promoting specific forms of transport [ACUTO 2020].

Epidemics have led to an increase in research and ideas on how cities and public spaces should look to minimise the spread of public becoming infected. In the face of a pandemic, two visions of cities can be created:

- 1) some of such ideas warn of long-term changes in privacy; images of empty towns and cities raise fears that centres will never regain their original interest; this can lead to depopulation of cities and significant changes in community;
- 2) hopeful views, on the other hand, point to rapid and radical changes in consumption habits or lifestyles and high investment by governments in national economies that can lead to a fair and sustainable urban future.

Oncologist at the University of Pennsylvania, Dr. Ezekiel Emanuel in collaboration with two other scientists, created the COVID-19 risk index, which estimates how dangerous our daily activities are. It was created to respond to the doubts and fears of Americans who, after easing restrictions, were not sure which actions were safe and which situations posed the greatest risk. The work identified four key factors that influence the amount of risk:

- 1) type of space (closed/open);
- 2) duration of the interaction;
- 3) the presence of other people and their density;
- 4) behaviours associated with dynamic exhalation of air (sneezing, singing, shouting, laughing).

Researchers also point to other factors that influence the risk of infection, among them the ventilation of rooms and environmental conditions. The Spanish newspaper *El País* published a visualisation created which shows the possible spread of viruses in different rooms and how the risk of infection decreases when certain mitigation tactics are used. Cramped and poorly ventilated rooms pose a greater risk than vast outdoor spaces ZAFIRA and SALAS [2020].

Faced with a resurgence of epidemic risk, cities around the world have been tested in terms of cities' ability to respond quickly, to function under specific conditions, and to recover. The difference in cities' ability to cope with risks and hazards is due to the varying resilience of cities.

POPULATION DENSITY

The design of cities and urbanised areas in adaptation to the epidemic risks requires appropriate analyses of population density, which is one of the main factors influencing the spread of epidemics. The spread of epidemics is higher in areas with a high population density. It is useful to refer to historical events

and past rationales, as it was precisely excessive population density that necessitated various precautions. Noteworthy are the attempts of Paris town planners who, in 1850, in order to stop the spread of the then prevailing cholera, took measures to reduce the high population density. In addition, they widened streets and increased the amount of green space and designed sewage systems.

Avoiding crowded places, where people of different groups gather, reduces risks. Research by Eugenie Birch [BIRCH, WACHTER (ed.) 2006] shows that making all neighbourhoods more pedestrian friendly, including the provision of jobs and services, can significantly alleviate intense congestion and overcrowding in particular areas and systems, e.g., public transport. This practice can promote social activity, have a positive impact on the health of residents, and increase the value and accessibility of urban spaces. Also GILES-CORTI *et al.* [2016] indicates that the inclusion of walkability index in urban environments has a very positive impact on health and other economic and social aspects.

Urban design has a strong influence on the risk of infection and spread of pathogens, as the epidemic risk increases with congestion and therefore centralisation of daily activities. Places of work, study, or other frequent activities, concentrated in the city centre, favour interactions between inhabitants of distant neighbourhoods and thus increase the transmission. Distributing activity centers throughout the city (preferably within each neighbourhood) results in better access for a larger proportion of the population, and thus reduces the likelihood of interactions between residents of remote areas and may inhibit the spread of pathogens [BRIZUELA *et al.* 2020].

Numerous studies show that the greatest epidemic spread is therefore in densely populated places. This applies both to places of residence and to population densities in places where individuals spend most of their time.

In contrast, a report by the Organisation for Economic Cooperation and Trade indicates that urban crisis management problems are not necessarily caused by population density, but rather by poverty, insufficient local health system capacity, and deprivatisation of neighbourhoods [OECD 2020].

HAMIDI *et al.* [2020] in their study, also found no strong correlation between infections and densely populated areas. Surprisingly, they observed lower mortality in high-density areas than in developing areas. In fact, density leads to closer contact and more interaction between residents, making them considered potential hotspots for the rapid spread of emerging infectious diseases. However, their better health and education systems can help mitigate the course of disease, thus leading to higher recovery rates and lower mortality.

Similar findings were presented by KANG *et al.* [2020], citing a study in New York City by Citizens Housing Planning Council (CHPC, 2020). They show that there is no consistent pattern in the relationship between population density and the spread of disease (here COVID-19). When the study used postcodes, it found no significant relationship between incidence and population density.

TRANSPORT

Transport is one of the key systems of any city and urbanised environment. However, due to its nature, it carries a very high risk of epidemic threats. Transport infrastructure, as well as

population movements that increase population mobility, are factors that contribute to the spread of infectious diseases. The significant impact of this component on epidemic risk was documented during the Ebola epidemic, among others. A similar relationship is also indicated by the analyses carried out in 2020 Italy, when the relationship between mobility and the spread of the virus was investigated in different regions of Italy. CARTENI *et al.* [2020] reported that the number of confirmed daily confirmed cases of COVID-19 infection is strongly associated with travel up to 21 days earlier. Furthermore, observations in China confirm the impact of transport (or more precisely, population mobility) on the spread or containment of pandemics. The author further argues that such a rapid spread of COVID-19 in China and the rest of the world, in a very short period of time, was influenced by the timing of the outbreak around Chinese New Year, the large number of connecting flights, and the excellent rail links around Wuhan.

Furthermore, the findings of JAMSHIDI *et al.* [2020] highlight the importance of considering spatial scale in interpreting the spread of infection. They indicated that on the most detailed spatial scale, mobility index was found to be the factor with the highest contribution to the spread of epidemic (about 34%), followed by households (26.14%), population (23.86%) and population density (13.03%).

Addressing urban mobility is therefore a very important and pressing issue for cities in epidemic crisis. Moreover, in such an emergency, public transport systems cannot operate at full capacity, so public transport services are not guaranteed to function properly, and thus may lose their competitiveness over private cars in the city [BATTY 2020]. To find answers to the emerging questions about what urban mobility should look like to ensure sanitary security, the European Economic Commission (UNECE) has established a task force to develop a set of principles for green, healthy, and sustainable mobility. Experts will develop principles for green and healthy transport, based on sustainability and resilience, and explore long-term and strategic developments. The ongoing crisis can thus become a rationale for the urban revolution based on green principles put forward by WALKER [2017].

The epidemic threat raises concerns that the public will reject public transport in favour of private motor vehicles, scooters, or bicycles. Analysis in Hubei Province showed that COVID-19 spread from one person to nine in one long-distance bus trip [NULL, SMITH 2020]. Research indicates that people are afraid to travel by public transport and will abandon this form of transport if possible. Without changes to vehicle design and operation, as well as infrastructure, interest in public transport may not return to previous levels.

Many researchers believe that the epidemic crisis will trigger the development of concepts that seek to free up as much street space as possible for pedestrians and cyclists, which will have an impact on our health and bring cities closer to green and low-carbon solutions [NIEUWENHUIJSEN 2020; ROBERTS 2020].

The first cities have already taken the first decisions to influence the quality and safety of walking and cycling routes. ALTER [2020] points out that urban planners and architects are discussing the need to widen pavements and redesign pedestrian crossings to meet recommendations on social distance. Milan was the first city to announce permanent changes involving the widening of pavements, the construction of 35 km of new cycle

paths, and the removal of lanes for motor vehicles [EFE 2020]. Other cities such as New York, Boston, London, Portland, and Vancouver have also started working on similar measures [HAWKINS 2020].

With regard to the issue of street reconstruction, new standards for pavement use of pavements should also be taken into account. In an epidemic emergency, social distance is important, including when queuing to enter a shop or service point. This can be alleviated by widening streets and paths to ensure a safe distance of approximately 1.5–2.0 m. Congestion is also high at entrances to public buildings, health centres, and public transport stops. Therefore, also in these places, consideration should be given to increasing waiting space, providing seats for the elderly, and highlighting the following.

The threat of epidemics, which causes fear of using public transport, has led to an increase in interest in cycling infrastructure. A very large increase in popularity has been seen in London, where the number of users of publicly accessible bikes has increased by 157%. In this city, up to 90 km of cycleways have been added since May 2020.

Cities around the world are taking steps to help transform the streets of space to accommodate pedestrians and non-motorised modes of transport. BARBAROSSA [2020] pointed to the example of Paris as an entity planning a radical transformation of the city by 2024. The authorities have created a plan “Paris à Vélo. Paris City Hall” fitting into the idea of a “ville du quart d’heure” (already formulated earlier by Jane Jacobs), i.e. a city where everything residents need should be reachable within a 15-minute nonmotorised journey. The districts will be provided with the necessary facilities for recreation, commerce, health care, education, and public services, which will be located within walking or cycling distance. Implementation work began in 2019 and has since resulted in an increase in bicycle use of more than 50%. The city government has earmarked €300 million for the construction of permanent or temporary cycle paths, many of which will run along the existing metro line, to offer residents a good alternative to public transport.

Similar solutions are also being implemented in major cities in Italy, including Milan, Florence, Turin, Bologna, and Rome. Post-COVID mobility projects have been developed there to increase sustainable urban mobility after the end of restrictions. In the Italian capital Rome, it envisages the construction of about 150 km of new cycle paths, according to the provisions of the Sustainable Urban Mobility Plan approved by the city authorities. The examples mentioned above clearly show the awareness of local authorities to promote cycling as the most efficient means of transport for urban populations under conditions of epidemic risk and adaptation to climate change adaptation.

HONG *et al.* [2020] point to the need to use data on the cycling of the public during pandemics, in later plans and pandemics. Learning about their routes and most frequented places may allow to create a perfectly sustainable cycling infrastructure in the future.

Many cities have decided to redesign their main traffic routes during the pandemic. Such measures were also taken by the Warsaw City Hall (Poland), which announced changes to some streets, as well as moving parking spaces from pavements to streets. The changes also affected Plac Zbawiciela, where there was a temporary trial closure of traffic lanes, allowing for the expansion of open-air bars and cafes while maintaining the

recommended distance. The existing epidemic threat may encourage cities to implement low-budget and temporary solutions to calm traffic and pedestrians, in line with the principles of tactical urbanism [LYDON, GARCIA 2015]. Some cities may refer to the Barcelona model of superblocks [RUEDA 2019]. Superblocks are organisational units, approximately 400 × 400 m in size, composed of several smaller blocks. They are surrounded by peripheral roads that remain open to vehicular traffic, while internal roads are closed to through traffic and remain accessible to residents, public transport, bicycles and pedestrians.

PUBLIC SPACE

Consideration of health in public space design has been taking place for years, but is far from the main purpose of public spaces [NIEUWENHUIJSEN, KHREIS 2019]. However, public spaces are a key feature of strong cities, not least because of their ability to transform for health purposes in emergencies [POLKO 2012]. In terms of epidemic risk, we can see the value of flexible spaces. Large spaces, exhibition halls or convention centres are transformed into field hospitals during a crisis in Vancouver, New York, and London [BOOTH *et al.* 2020] but also in many other cities.

During an epidemic emergency, many public spaces such as theatres, museums, libraries, cultural and religious centres or cinemas cannot function or function with a limited number of spectators. To ensure safety without having to stop the operation of such places, consideration should be given to redesigning them according to conditions and designing them as flexible spaces, resilient to the threat. These venues may need to formulate new guidelines in terms of distance, population density, and the presence of potential public health hazards, with distances indicated [ELTARABLY, ELGHEZANWY 2020].

In response to the threat of epidemics and the need to transform public spaces, several guidebooks are being produced on how to plan urban living with a sanitation regime. One such program, the Design for Distancing Ideas Guidebook, was prepared by the City of Baltimore in collaboration with the John Hopkins Bloomberg School of Public Health, the Baltimore Development Corporation, and urban activists from the Neighborhood Design Center. The document consists of more than a dozen concepts and plans, which create temporary spaces. The proposed changes in development are intended to increase usability and allow social interaction to be maintained at an appropriate distance in squares, plazas, pavements, etc. The effects presented were prepared specifically for the city of Baltimore, but the authors assure that they are versatile enough to be adapted to any city. Among the projects is the 'Curblet Commons' concept for transforming strip streets, usually occupied by parked cars, into areas for local services, shops, and restaurants. The "MicroDistrict" plan shows the possible use of city squares and plazas to create neighbourhood interaction centres. The authors point out the possibility of using them as local health checkpoints, places for children's activities and education, a catering area, a mobile library or a hairdresser, without having to use transport or travel towards the city centre. The 10 selected plans also include the "Space Frame" project, which presents a range of furniture and structures that allow the entire service and sales process to be brought outside.

GREEN AREAS

Contact with the natural environment has many benefits, as green spaces play a very large role during social, physical, and mental disorders in people [KLEINSCHROTH, KOWARIK 2020]. Also, AKPINAR *et al.* [2016] indicate that the number and size of urban green spaces are related to the number of days people report mental complaints in urban areas. Access to green spaces, also understood as places that encourage physical and social activities, can increase the resilience and their ability to cope with newly emerging pathogens [COPPEL, WÜSTEMANN 2017]. Urban parks and other green spaces provide environmental, social, psychological and health functions, in addition, they provide many opportunities for recreation, support human health, community cohesion, and sustainable development.

In terms of epidemic risk, the implementation of both the so-called green infrastructure [RONCHI *et al.* 2020] and green spaces themselves in cities is extremely important. Over the past year, the problem of uneven distribution of green space in cities and excessive reduction of this green space by commercial investments has been observed [AHMADPOOR, SHAHAB 2021]. At the same time, Venter and colleagues [VENTER *et al.* 2020] note that in defining the role of green spaces in the context of COVID-19, conclusions in this regard must be made carefully, taking into account the specificities of the pandemic situation. This is because the increased interest in natural areas and their new functions, was associated with a reduction in the role of other public spaces.

As MCCUNN [2020] notes, under conditions of epidemic threat, urban planners and urban decision-making institutions face a difficult task, who believes that it is critical to develop innovative yet simple and low-budget strategies and concepts to enhance the utility of urban nature while adhering to sanitary guidelines. In fact, numerous studies show that during lockdowns, green spaces become a significant source of wealth for society.

Data from the first months of the COVID-19 pandemic in Poland confirm the assumptions of urban planners. The publication of SAS [2020], which examined changes in the mobility of the population in Poland from February to June 2020, shows that during this period green areas that recorded the largest increase in the number of visits. The biggest change was recorded for 23 June, when the percentage of change reached 89%.

The shift towards healthy cities will require significant efforts to make cities greener. The epidemic threat may change the type and distribution of recreational areas. There is likely to be a greater demand for smaller neighborhood parks. Cities with an existing decentralised network of small green spaces, such as Valencia (Spain) or Nantes (France), are better equipped to provide easily accessible recreation areas [HONEY-ROSES *et al.* 2020]. Additionally, preferences and expectations towards these areas may change, beginning to be seen as spaces for individual and intimate use rather than for collaborative activities. Following changes, cities may revisit the potential of under-used spaces, such as industrial areas or rooftops. DiNARDO [2019] and FRANCIS and JENSEN [2017] find Chicago leading the way, with Barcelona identifying grey roofs and several already converted into gardens [SANYÉ-MENGUAL *et al.* 2016]. These types of solutions offer an alternative to public parks and can develop principles of safe distancing.

Creating a system of green spaces is also a very good green infrastructure solution. Developed systems are much more useful than randomly scattered parks and involve the creation of networks of parks of different scales and purposes. This makes it easier for people to move through and through them. An excellent green space system has been developed in Singapore [WANG *et al.* 2019]. The Park Connector Network is a network that connects densely populated areas to natural places in the city, so that there are green corridors through Singapore for easy movement.

The PCN also includes six loops created with different themes - Central Urban Loop, Eastern Coastal Loop, Northern Explorer Loop, North Eastern Riverine Loop, Southern Ridges Loop and Western Adventure Loop. With an extensive network of park corridors, it is easy to move between loops, indulgent in different types of entertainment and recreation.

Access to green spaces is likely to reduce disease transmission and increase social and community cohesion [GENG *et al.* 2021]. Closing or significantly restricting access to such areas may result in public congregation in less desirable public spaces that were not designed to encourage and maintain distance [BARKHORN 2020]. Research also confirms that restrictions on access to green spaces can cause serious physical and mental health problems, particularly in populations living in urban areas [SALLIS, PRATT 2020; SLATER *et al.* 2020]. Green spaces allow people to disperse, reducing crowding in other urban areas [FREEMAN, EYKELBOSH 2020]. Additionally, parks (even under sanitation regimes) can influence social cohesion and help build a sense of community integration, which can reduce antisocial behaviour, particularly during public health crises [SEAMAN *et al.* 2010].

RESIDENTIAL AREAS

The situation in which the world is at the beginning of 2020 has shown which solutions work best. All the signs are that we are facing a change in the values, habits, and appearance of our homes. Given social behaviour, lack of responsibility, and the difficulty of complying with isolation, multi-story buildings are not very practical.

From the perspective of convenience and greater sanitary safety, living in houses is significantly better than living in flats. These observations are consistent with the findings of a number of studies looking at the increase in morbidity, mental health, and social wellbeing in houses compared to single family homes. This is also supported by a study by SENNETT and SENDRA [2020], who in his book 'Designing Disorder: Experiments and Disruptions in the City' predicts that a new thought in the design of buildings and the appearance of neighbourhoods will soon emerge. The layout of multi-family buildings is also of great importance, as common entrances, interior spaces, corridors, stairs, and lifts are very good environments for pathogen transmission. Designing buildings with less height, with several entrances, can reduce infection [HONEY-ROSES *et al.* 2020]. Also, BALDWIN'S study [2006] showed that residents in highly urbanised areas were also affected by the orientation of the building they lived in, its height, and its immediate surroundings.

The occurrence of epidemic and the need for isolation draws attention to the quality and functionality of designed houses and the need to improve the overall performance of houses. Many architects note the importance of natural elements

that can contribute to reducing isolation stress and other psychological effects [KELLERT, CALABRESE 2015].

Poorly designed buildings can also cause various diseases, known as sick house syndrome [YU *et al.* 2004]. The design of a building and its many components affect human health and can cause illness in people. Sick house syndrome (SHS) can manifest as headaches, dry cough, itchy skin, dizziness and nausea, fatigue, difficulty concentrating, sensitivity to odours, and eye and respiratory irritation.

WORKPLACES

Places of work, education, and services are among the places where daily human contact occurs and where there is thus an increased risk of epidemics. One of the most visible changes in the functioning of the urban system is the popularisation of remote working. One can expect an even greater popularisation of flexible working systems, without the need for daily office visits. The fundamental restructuring of the labour market is also likely to play a significant role in the structural changes of cities in the longer term, but its direction is clear. Workers may prefer to work from home, without commuting, even after the COVID-19 pandemic has subsided. If remote working becomes the new norm in a post-pandemic world, many companies are likely to consider reducing office space in major business districts and relocating less essential functions to areas with lower rents. The choices of residential locations will adapt to the new normal and the dispersal of business locations. In addition, households may have less incentive to live closer to firms, reducing the concentration of their demand for housing in dense city centres. The decentralisation of jobs, both in space and time, will have a significant impact on urban mobility patterns, interrupting the usual circular migration. The introduction of remote work will relieve the pressure on city centers. With remote working, offices lose their appeal. A new approach to the planning and functional development of business centers could be the development of a hub system of office spaces, similar to the organisation of airline hubs. This solution will enable people to work closer to where they live, avoiding crowded spaces on public transport [ELLDER 2017].

The situation facing the world in 2020 has changed the way work is organised in offices. Companies have had to adapt to a more flexible model. It is expected that despite the changes that take place in the office and corporate market, the position and importance of this sector will not change. The introduction of a rotating work system, which combines remote work with office work, will affect the functionality of office spaces. They should be adapted to rotating work and arranged so that changes in the arrangement of workstations can be made as quickly as possible.

Post-pandemic modernisation will also affect the reorganisation of common spaces and will require the provision of more quiet places to work. Telephone booths or soundproof cubicles can be created for this purpose. And special partitions – mobile free-standing walls or desktop screens – should be installed in open spaces.

Architects point out that the epidemic threat will result in the widespread use of contactless solutions. In large office centres, automated systems, including biometric and voice-controlled systems, are possible, because the arrangement of buildings will now serve mainly to maintain sterile cleanliness and create a safe

working environment. Therefore, in addition to the solutions mentioned above, ventilation and air filtration systems will be very important.

URBANISM V.3.0.

In order to adapt cities to the prevailing conditions, the concept of Urbanism v.3.0. is emerging to combine available digital technologies with the orientation of development in line with green-blue infrastructure, in order to ensure the autonomy and sustainability of buildings, neighbourhoods, and cities. Already, the emerging ideas of New Urbanism in the 1980s aimed at an even settlement across communities [CAVES (ed.) 2004]. This rationale is also taken into account when developing Urbanism v.3.0. for the post-pandemic city – smaller municipalities and settlement units should implement the zero-kilometre theory. Additionally, such an arrangement will result in fewer contacts and prevent the spread of epidemics [JAYAWEEERA *et al.* 2020].

As SHENKER [2020] argues, cities in the post-pandemic era will compete for residents by coming up with ever newer plans and strategies to prevent and combat future disasters, which at the same time are supposed to strive for a comfortable standard of urban living. The implementation of a green approach to urban development, combined with the ideas of new urbanism, smart city, and the vision of Urbanism v.3.0. can be developed as a complex strategy for urban evolution and progress, based on three pillars: smart technologies, green infrastructure, and culture [MIR 2020]. Governance measures must be adaptable and integrative at different levels, while engaging varied players, approaches and practices [BELČÁKOVÁ *et al.* 2019; FURMANKIEWICZ *et al.* 2021; SOLECKA *et al.* 2022; SPYRA *et al.* 2020]

CASE STUDIES

Urban planners and officials involved in spatial planning and management should carefully explore how a “people-oriented” philosophy might be implemented into spatial-planning systems to limit the negative consequences on both cities and people. Using Changchun as a case study, the effects of COVID-19 on spatial planning, well-being, and behavioural change can be examined. People’s lifestyles have altered as a result of the move to home working, which has had an impact on their subjective well-being and has profoundly impacted spatial planning inside cities, imposing increased demands on architectural design and community spatial planning. As a result, more open public areas and a more supporting infrastructure are needed. Second, it is discovered that Changchun has not built an effective community-based spatial planning system, which should have been considered in the future master plan. Third, findings indicate that having a resilient city is critical for the long-term growth of second-tier cities like Changchun, as evidenced by urban development patterns, catastrophe avoidance, and long-term functional layout, among other factors [SONG *et al.* 2021].

The case study in Brisbane proved again that time spent in nature is a possible method of coping with the negative psychological and health effects of major life events. Increased urban green space use during the COVID-19 pandemic has the potential to mitigate some of the stressor’s harmful impacts, but the ability and inclination to spend more time in green space differs dramatically throughout society. A sufficient supply of

urban green space for all segments of society will maximise the potential to use a nature-based coping strategy during times of personal or collective stress. The change in utilisation happened independent of the quantity of green space accessible near the participants’ homes. In addition, no link was found between the nature of the relationship and the change in use [BERDEJO-ESPINOLA *et al.* 2021].

Case study of Main Urban Area of Wuhan showed, that the epidemic communities were concentrated in metropolitan regions with high population density and dense commercial centers along the Changjiang River, indicating substantial spatial aggregation features. Epidemic density is closely linked to the variables of construction planning in epidemic neighbourhoods. According to the findings, transportation convenience, business services, and medical accessibility are all strongly associated to the virus’s spread. Study suggests the prevention and management of epidemics in urban residential areas should begin with strengthening the community’s built environment. It indicates that by establishing a diversified and rich community flexible space, the community may successfully avoid the epidemic and then achieve the city’s complete anti-epidemic and development growth [LIANG *et al.* 2021].

Podgorica, Montenegro, would be an example for resilient adaptation of residential structures and neighbourhoods. The approach covers apartment unit flexibility, the presence of indoor and outdoor common areas for social activities within the building, and direct touch with nature, and it is suitable in a broader geographical context. The concept is sufficiently relevant in all circumstances, and its implementation would considerably enhance residents’ quality of life not only during the existing pandemic and accompanying constraints, but also in general – under post-pandemic conditions [BOJOVIĆ *et al.* 2022].

Lucy Saunders had a unique job spanning the public health and transport sectors from 2013 to 2019, working with Transport for London, the Greater London Authority, and Public Health England to integrate health into transportation policy and practice. This job allowed her to put her Healthy Streets Approach into action. The approach is founded on ten evidence-based Healthy Streets Indicators, each of which describes a different component of the human experience of being on the streets. These 10 must be prioritised and balanced in order to increase social, economic, and environmental sustainability through the design and management of roadways [Healthy Streets 2021].

Post-pandemic activities in cities throughout the world have been compiled in a variety of databases, including the “Shifting Streets” COVID-19 Mobility Dataset and the Mike Lydon database. During the COVID-19 epidemic, the Shifting Streets Dataset analyses quick responses to changing demands on public space. It is designed to serve as a resource for scholars, practitioners, and anyone interested in how cities have responded to changes in travel demand and the requirement for social distancing [COMBS *et al.* 2020]. COVID19 Livable Streets Response Options by Mike Lydon is a continually updated spreadsheet that shows the location, mileage, and progress of full lanes response strategies, such as temporary bikeways and slow/shared streets [Street Plans 2020]. Also The National Association of City Transportation Officials (NACTO), group of 92 major North American cities and transit agencies shares transportation

ideas, insights, and practices and to handle national transportation challenges [NACTO 2021].

Many towns redesigned their roadways to accommodate more bikes and pedestrians during the epidemic. The most hopeful say that the epidemic is going to speed up cities' transition into greener, more sustainable places to live. Observation allows for the determination of changes in how areas are used or how people behave in public settings. Knowledge-based approach ensures completely understanding of individual's behaviours based on age, gender, and place of origin [HONEY-ROSES 2020]. Specially, creation of "age-friendly cities" has emerged as a key subject of research in the built environment. This trend is motivated by the perception that cities are becoming increasingly crowded with an aging population [VAN HOOFF *et al.* 2019]. Age-friendly urban environments should take use of chances for retrofitting homes with low-cost technology as well as incorporating relevant technologies into new housing building plans. Outdoor area should be accessible (i.e., wheelchair users, individuals with mobility and impairments) as well as safe and secure (i.e., free of rubbish, broken glass, and other instruments). To stimulate physical exercise, such venues should feature a variety of devices as well as green space. Public areas considered for remodeling should have adequate (accessible) seats as well as well-designed pavements suited for all residents strolling through the relevant environment [VAN HOOFF *et al.* 2021].

CONCLUSIONS

The ongoing COVID-19 pandemic has numerous consequences in the social, medical, economic and environmental spheres. Since March 2020, an ever-increasing number of publications and numerous research projects focusing on the topic of epidemic risk can be observed. The increasing amount of data should translate into more relevant conclusions and analyses. From the very beginning of the pandemic, researchers began to analyse the potential impact of the pandemic and the crisis it caused on the functioning and development of urban areas, the property market, the state of the environment, or the health care system.

There is no doubt that spatial planning should focus on ensuring increased urban safety and implementing innovative solutions. However, the measures taken and the restrictions imposed by the epidemic risk do not favour economic development, which is a very important pillar of cities. However, the need for changes in urban space will become increasingly apparent, influenced by the progress of information and communication technology.

Urban areas, apart from their settlement function, they have service, industrial, educational, transport, medical, administrative, and cultural functions. High population density, compactness of buildings, concentration of services, and workplaces have an impact on the epidemic risk in cities. Cities therefore play a very important role in implementing measures to reduce this epidemic risk and in adapting policies to local conditions.

Authors often question the sanitary safety associated with compact buildings. However, the prevailing view is that these areas provide greater epidemic safety, due to their proximity to health centers. In order to strengthen urban resilience, the building appropriate infrastructure, the implementation of new

technologies, building urban systems and structures is important. It also seems much more effective to improve accessibility to key services, including health centers and grocery shops in particular parts of cities. Promotion of a dispersal policy, with rules of social distance already in place, can also contribute to increasing prejudice and hostile attitudes towards other people, including even xenophobia. Authorities are obliged to act to maintain a healthy civil society, minimising anxiety and fear. In an effort to minimise the epidemic threat, urban planners and architects should also pay more attention to the issue of urban geometry. Based on a review of the available source materials, we can formulate the following findings for spatial policy-making:

- compact buildings provide greater epidemic safety, due to their proximity to health centres,
- accessibility to key services, including health centres and grocery shops in particular parts of cities prepare cities and their inhabitants for unexpected risks,
- promotion of a dispersal policy, with rules of social distance already in place, can contribute to increasing prejudice and hostile attitudes towards other people, including even xenophobia,
- urban planners and architects should also pay more attention to urban geometry, configuration of buildings, communication networks, or green spaces,
- in order to strengthen urban resilience, appropriate infrastructure, the implementation of new technologies, building urban systems and structures are important.

Cities characterised by greater resilience to potential hazards should therefore be based on pillars such as green technologies, smart solutions, and safety of inhabitants. Sustainable urban strategies are continuous adaptations of already established political conceptions. The concepts of public engagement, availability of public information, access to knowledge and data-driven planning choices, stakeholder cooperation, and design principles for public spaces should have been applied in urban settings a long time ago. Many planning issues have become more apparent for households as a result of the COVID epidemic. Concern for one's own health, along with a better understanding of the procedures involved in regulating a city's growth processes, implies that people are increasingly placing pressure on public authorities. We must understand the characteristics of age-friendly and unfriendly surroundings at the local level in order to establish a baseline assessment collaboratively, leading in the selection and prioritisation of a plan or strategies involving actions and key targets for pushing advancements forward. Co-create programs, projects, events, campaigns, and initiatives for various target audiences (involve partners in co-creation) must play a crucial role.

In order to promote spatial planning that minimises the epidemics spread and is in line with the changes that have taken place in recent years, a number of studies should be carried out. These analyses should examine the impact of mobility and people's lifestyles on the appearance of public spaces, means of transport, and housing estates. Despite the epidemic threat that has occurred several times in history, only the COVID-19 pandemic prompted further research, studies, and concepts to affect the safety of urban residents and participants. Threats to the health and safety of the population have highlighted the close relationship between health and the urban environment. A series of changes based on the principles of sanitation and social

distance will be permanently incorporated into urban spatial policy, with the aim of ensuring the overriding value of urban settlements, a safe place to live and work for present and future societies.

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