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Public health in times of crisis: An overlooked variable in city management theories?

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A B S T R A C T

The volume of research that associates the theme of city management with crises resulting from emerging infectious disease is modest, even after the occurrences of Ebola and Severe Acute Respiratory Syndrome. Similarly, the Coronavirus disease (COVID-19) pandemic has thus far contributed only modestly to the expansion of attention to people's health, through city management, in times of crisis. This study, by means of a systematic literature review, analyzes the gap in research on urban theory on how epidemics are confronted. The term "cities" had 2,440,607 articles published and were identified 665 that presents the combination of the term "pandemic". After the development of content analysis were identified 11 articles prior to 2019 and 10 articles published between January and June 2020, adhering to the objective of this investigation. Prior to 2019 studies addressed topics related to the construction of an urban structure aimed at reducing people's vulnerability to infectious diseases, starting in 2020, the focus of researchers' attention is on the use of information and communication technologies used as tools for prevention and control. Theories of the management of cities indicate the need to extrapolate the urban perimeter, incorporating the relations of dependence in cities with the other actors within the surroundings, especially in times of crisis. Studies have emphasized that cities are not isolated islands; rather, they are parts of a complex system with multiple exchanges. This thematic field of study enhances research that presents urban planning solutions by using data-driven management to consider conduct, parameters, and protocols relating to public health in moments of crisis.

1. Introduction

Many theories on cities position municipal management as a core area of interest for the promotion of social well-being (Fu & Zhang, 2017). This common link shows the relevance of city theories to social themes, in which people's health is considered alongside safety, the environment (Mapar et al., 2020), transport, education, and governance (Sharma et al., 2020). Events with a high impact on society, such as a pandemic, provide opportunities to identify the adequacy of the theoretical approach in addressing certain themes. It is worth mentioning that the probability of a pandemic occurring is not low: the World Health Organization detects about 7000 signs of potential outbreaks each month (World Economic Forum, 2019). In recent decades, outbreaks of emerging infectious diseases (EIDs) have been identified, such as Severe Acute Respiratory Syndrome (SARS) in 2002, influenza H1N1 in 2009, Middle East Respiratory Syndrome (MERS) in 2014, Ebola in 2014, and Zika in 2016. All of these EIDs attracted the attention of the international health system, introducing the need to establish planning for biological emergency situations in cities (Allam & Jones, 2020a). As cities are at the forefront of providing citizen services, they need to be prepared to respond to biological emergencies (Acuto, 2020). However, in many situations there are conflicts between local government, state government, and national government (Allam & Jones, 2020b). The main source of conflict arises from the perspective that national governments seek to serve the interests of the nation, while local governments serve the interests of people in their community. An example of the occurrence of such conflict can be observed with regard to cities that refused to receive patients with Coronavirus disease (COVID-19) who had come from cities where the health system was full.

In 2020, the outbreak of the COVID-19 pandemic created a crisis with impacts on society greater than those observed in the pandemics of the last two decades (Johnson et al., 2020). Thus, the effects resulting

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from COVID-19 pose new questions about the adequacy of public health management in cities in the context of a complex and interacting set of factors (Boeing, 2019; Tong et al., 2019), and they indicate the need for more integrated planning (Günaydin & Yücekaya, 2020). Integrated planning is based on the sharing of information between all levels of public management and also from private companies to the public, with the intention of establishing actions that better serve the population.

Despite common elements in cities' solutions to problems, many of the actions taken by urban planners must consider the existing infrastructure, the means of transport adopted, the predominant architecture, and the governance model (Alavi et al., 2018; Marques et al., 2019; Sharma et al., 2020). In addition, the local historical, social, and cultural factors (Günaydin & Yücekaya, 2020; Macke et al., 2019) that determine people's daily lives (Hartig & Kahn, 2016) and their relationship with their environment influence the adequacy of municipal managers' decisions (Futcher et al., 2017).

In relation to public health issues, studies that address city theories focus on three categories: (i) the population density, which relates to the size of cities (Acuto, 2020; Egidi et al., 2020; Mapar et al., 2020); (ii) the use of information and communication technologies (ICT), which includes the Internet of Things (IoT), artificial intelligence (AI), and Big Data (Patan et al., 2020; Kummitha, 2020b; Sharma et al., 2020; Yigitcanlar et al., 2020); and (iii) environmental sustainability (Allam & Jones, 2020a; Günaydin & Yücekaya, 2020; Macke et al., 2019). Despite approaches that relate city management to public health and recent EIDs, there is a lack of urban planning and design professionals contributing to current discussions about COVID-19 and to the analysis of the urban fabric from social and economic perspectives (Allam & Jones, 2020b).

Urban expansion is an ongoing phenomenon of interest to society due to the close relationships between urbanization, demographic changes, and economic growth (Cervellati et al., 2017; Egidi et al., 2020). One of the characteristics of this phenomenon is the growth of large cities and the consequent increase in their economic and social importance (Seto et al., 2011). Although smaller cities have also shown growth, they have lower rates of economic growth (Egidi et al., 2020) – but it should be noted that there is also research indicating that cities of different sizes have similar growth rates (Kourtit & Nijkamp, 2013). Urban growth has been rapid over the past century: whereas a century ago only 20 % of the population lived in cities, in 2014 the proportion of the population living in urban areas was 54 % (Neiderud, 2015). By 2050, potentially more than two-thirds of the population will be living in urban areas (Esmaeilian et al., 2018; Marques et al., 2019); however, this evolution of the urban population may involve a less sequential demographic dynamic that is more unpredictable and spatially heterogeneous (Egidi et al., 2020). Thus, large cities have become increasingly susceptible to infectious diseases that traditionally occurred in rural areas (Neiderud, 2015). This urbanization phenomenon also incorporates the proliferation of megacities, which are those with more than 10 million inhabitants (Acuto, 2020). The concentration of growing numbers of people in specific urban spaces, such as in megacities, presents more economic and social risks in pandemic situations due to the higher population density (Allam & Jones, 2020a).

The use of ICT, AI, IoT, Big Data, and smartphone applications is associated with the concept of smart cities (Sharma et al., 2020). ICT and Internet technologies have the ability to amalgamate urban infrastructure with architecture, transport, the environment, health, education, leisure, and governance (Alavi et al., 2018; Marques et al., 2019). Thus, some conceptual propositions about smart cities converge on the issue of environmental sustainability, including the environmental, social, and economic aspects of environmental sustainability (Espinoza-Arias et al., 2019). The main actors in relation to this theme are the different levels of government, service providers, policy makers, and citizens (Barns, 2018; Simonofski et al., 2019). The concept of IoT is regarded as fundamental for the infrastructure of smart cities because it allows the connection between objects and humans (Delgado et al., 2020; Kunst et al., 2018), and it can improve urban infrastructure services, such as transportation, waste management (Patel, 2019; Paulchamy et al., 2019), water management, smart buildings, health, and education (Monostori et al., 2016).

This technology has great potential to improve public health management, as the IoT enables the analysis of medical data (Patan et al., 2020) and the development of algorithms that anticipate diagnoses and facilitate preventive treatments (Al-Turjman et al., 2019). These benefits are also associated with AI supported by data sharing (Allam et al., 2020). Thus, AI is considered as one of the conditioning factors in the transformation process by which a city becomes intelligent (Yigitcanlar et al., 2020).

Environmental sustainability is also associated with smart cities (Macke et al., 2019). The dynamics of activities that take place in cities must be contextualized in relationships that provide economic, environmental, and social balance for people (Yigitcanlar et al., 2019). Thus, it is possible to identify approaches that aggregate the concepts emanating from the perspective of smart and sustainable cities (Akande et al., 2019; Machado et al., 2018).

Among the elements relevant to the concept of environmental sustainability, it is possible to identify the influence of the environment on people's health. The quality of the water supply, the sanitation technologies employed, being on a migratory bird route, and the characteristics of the urban to rural transition zone are some of the environmental factors that can influence the emergence of several diseases, including EIDs and pandemics (Spencer et al., 2020).

It is a fundamental role of the urban manager to establish the importance and relevance of cities in the provision of public health services. With the occurrence of the COVID-19 pandemic, doubts have arisen about the ability of cities to manage the pandemic containment process and to maintain the quality of health services provided to citizens. This study, by means of a systematic literature review, analyzes the gap in research dealing with urban theory on how to deal with epidemics. The intended contributions of this literature review are: (i) to identify how city theories have been considered in relation to the pandemic; (ii) to identify whether the emergence of the COVID-19 pandemic has stimulated an interest in filling this gap; and (iii) to identify whether the literature presents opportunities for future studies.

2. Methodology

This section presents the protocols that were used in conducting this study. A literature review was carried out by using a theoretical approach, according to the typology proposed by Paré, Trudel, Jaana, and Kitsiou (2015), in order to identify and highlight knowledge gaps between what we know and what we need to know. Operationally, the research started with a broad question and was refined as data were collected and analyzed (Eakin & Mykhalovskiy, 2003) in a systematic way (Webster & Watson, 2002).

The research developed a systemic literature review protocol supported by five steps (Petersen et al., 2015): (1) definition of the research questions; (2) definition of search processes; (3) definition of the criteria for selecting the article; (4) execution of data extraction; and (5) execution of analysis and classification. Fig. 1 provides a flow chart that depicts the study selection process.

The definition of the research questions was based on themes of interest relating to the theories that analyze cities and the response to pandemics. Three research questions of interest were identified. The first sought to identify whether, before the occurrence of the COVID-19 pandemic, studies addressing city theories established a framework that could deal with this eventuality and offer strategic tools for municipal management to anticipate a biological crisis and to manage the resources needed to combat it. The second research question sought to identify whether the emergence of the COVID-19 pandemic stimulated interest in responses to this pandemic by research on the performance of public health management in cities. The third research

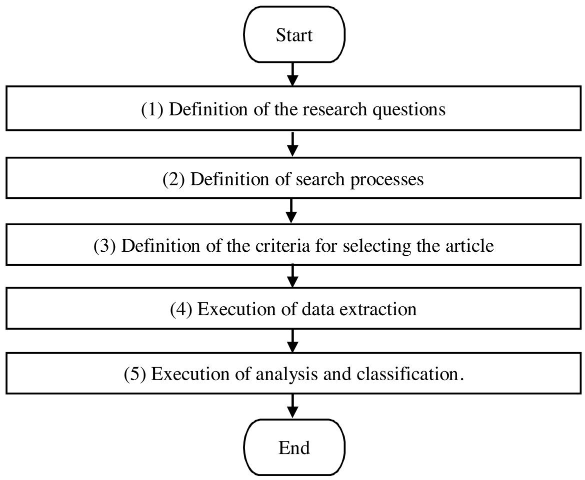

Fig. 1. Systemic literature review protocol. Adapted from Petersen, Vakkalanka and Kuzniarz (2015).

question sought to identify whether the reviewed literature presents opportunities for future studies, as the intense application of ICTs by cities encourages the adoption of a data-driven management approach that can contribute to the creation of management strategies and development of public policy. The adoption of several research objectives in this review is in line with Cooper's (1988) recommendations of what is necessary for a review study.

In defining the search processes, we used the CAPES Journal Portal (https://www.periodicos.capes.gov.br) which comprised (in this survey) a set of 41 databases, which are presented in an endnote to this paper. Another important criterion in the search process is the definition of the terms used to retrieve the articles. Due to the exploratory nature of the research, two groups of search terms were used. The first group related to the health area: Endemic; Epidemic; Pandemic. The second related to the theories of cities: Cities; Urban Planning (which incorporates City Planning); Urban Governance; Smart Cities; Sustainable Cities; Resilient City; Circular City; Ubiquitous City; Livable City; Information City. The search of the databases used Boolean operators to search for terms in an isolated way (for example: "Resilient city" OR "Resilient cities") and in a combined way (for example: ("Smart city" OR "Smart cities") AND Pandemic). Parentheses defined the first search priority, and the term AND defined the requirement that both terms be found in the search. The searches were performed on titles of works, the keywords, and abstracts. The selection criterion to answer the first research question was that articles were published up to and including 2019. To answer the second research question, the search was limited to articles published from January to June 2020. The exclusion criteria used in the analysis of the material sought to establish a quality standard of the retrieved documentation; thus, after a screening process, material identified as reviews, conference presentations, editorials, bulletins, and notes was excluded. Additionally, material that did not adhere to the research themes was also removed, as was repeated material. These criteria were used to establish a quality standard, as proposed by Paré et al. (2015).

Data extraction was oriented to answer the proposed research questions. Initially, a database was built containing the information relevant to the study. This database was used to perform the first stage of analysis and classification of articles, which made it possible to separate the material to be considered in the next stage. The second stage involved reading the selected articles, which resulted in a second database that included the focal points for meeting the proposed research questions. The analyses were performed differently by two of the authors, who subsequently compared the data in order to identify both the common points and the differences of their observations. The analyses and data comparisons were carried out in blocks of 20 articles; that is, for every 20 articles verified, the authors gathered and analyzed the material together and made adjustments that were aimed at establishing a common understanding. This work resulted in agreement on 94 % of the analyses.

The analysis and classification of articles were performed using five analysis keys. The first key dichotomously verified whether the study was adherent to the research. If the article positioned itself as adherent, it was classified, in the second key, according to the area that it adhered to: Health; Cities; Health and City. The third key dichotomously analyzed the existence of a relationship between the theory of cities and the occurrence of an epidemic. If there was no direct relationship between the themes in the previous classification, the fourth classification key sought to identify the existence of some aspect with the potential for investigation. If in the first classification the article was considered as not adhering to the research, the fifth key explained the reason for exclusion according to one of the following possibilities: Bulletin or Notes; Editorial; Congress material; Review; Repeated article; the themes of the articles are not adherent to this research. Additionally, the studies were classified by period: prior to 2019, and from January to June 2020. Table 1 presents the inclusion and exclusion criteria for the articles adopted by this study. In addition, the table presents the total number of articles found (this is detailed further in the "Results and Discussion" section), in order to provide with an overview of the information considered.

The analysis of the articles involved the process of identifying whether the theory of cities incorporates the health variable as an added value. In this sense, the approach of Whetten (1989) was used as an analysis parameter of Value-Added Contribution to Theory Development. The next section presents the results of the literature review.

3. Results and discussion

This section presents the data, which are divided into three thematic groups. The first group presents a descriptive analysis with the general exploratory scenario that supported the research, and it sets out in quantitative form the origin of the material under analysis. The second group analyzes the approach of articles that related pandemics to theories of cities prior to 2019. The third group addresses the production in 2020 (from January to June) of scientific literature that related pandemics to the theory of cities.

Table 1
Inclusion and exclusion criteria used in the study.

Publication year of articles considered	Count	Criterion adopted
Prior to 2019	11	Inclusion: Articles in which city theory includes the health variable
	14	Exclusion: Articles in which city theory does not include the health variable
	88	Exclusion: Articles dealing with cities
	210	Exclusion: Articles relating to the area of health
Subtotal	323	
January–June 2020	10	Inclusion: Articles in which city theory includes the health variable
	7	Exclusion: Articles dealing with cities
	31	Exclusion: Articles relating to the area of health
Subtotal	48	
Reason for not including the article	7	Exclusion: Bulletins or notes
	11	Exclusion: Editorials
	13	Exclusion: Congress material
	54	Exclusion: Review
	96	Exclusion: Repeated article
	113	Exclusion: The themes of the articles are not adherent to this research
Subtotal	294	
Overall total	**665**	

Source: Research data.

3.1. Descriptive analysis of the researched universe

For the descriptive analysis, we first identified a total of 3,140,929 scientific articles that addressed at least one of the terms in research. This volume of articles constituted the research universe. Chaining of terms was carried out to identify the number of articles that combined possible terms under analysis. Table 2 presents the results.

The diagonal that begins in column A and row A and ends in column M and row M of Table 2 presents the number of scientific articles that deal exclusively with each of the terms under analysis. The term "cities" (individually) had the highest number of articles (2,440,607). The number of articles dealing with different concepts of cities varied markedly, indicating different stages of development in this area.

Columns E to N in row C presents the combination of the term "pandemic" with terms related to cities, which establishes the first stage of data collection by identifying a total of 665 articles to be analyzed. The first analysis key identified 323 articles relating to the proposed objective, while 342 were excluded for not meeting the selection criteria. The second analysis key identified 210 articles relating to the area of health, 88 articles dealing with cities, and 25 articles that combined the areas of health and cities, which were addressed in the next phase. The third selection key identified only 11 articles relating city theories to the pandemic, which established the universe of analysis presented in the next subsection (3.2).

3.2. Analysis of the approach of articles that relate pandemics to city theories

This section presents the analysis of articles published prior to 2020 that addressed the possibility of a pandemic occurring (which is also valid for endemics and epidemics) within a theoretical perspective of cities. Articles are presented in chronological order of publication.

Matthew and McDonald's (2006) study of urban planning (social environment) was the first to relate city management to the occurrence of a pandemic. However, the authors reported a previous study by Smolinski, Hamburg, and Lederberg (2003) that addressed the ability of infectious agents to impact society and thus requiring the establishment of prevention and control of infectious diseases by governments. They also reported Siegrist's (1999) study on the possibility of virus use by terrorists. Matthew and McDonald's (2006) research addressed how to respond to a pandemic at the municipal level and covered the following topics: outbreak surveillance and control system; storage of medicines;

Table 2
Number of scientific articles and their respective combinations.

		A	B	C	D	E	F	G	H	I	J	K	M	M	N
		Endemic	Epidemic	Pandemic	Cities	Urban Planning	Urban Governance	Smart Cities	Sustainable Cities	Resilient City	Circular City	Ubiquitous City	Livable City	Information City	Total
A	Endemic	339,587	41,799	9076	71,550	1,861	270	70	153	56	1	7	31	63	2,512
B	Epidemic		335,183	30,304	87,633	2,132	222	231	154	42	2	42	33	106	2,964
C	Pandemic			95,444	19,508	434	50	79	40	26	0	2	6	28	665
D	Cities				2,440,607										
E	Urban Planning			6		86,481	2,897	1,952	3,005	716	50	82	458	544	
F	Urban Governance			2			8,249	410	591	181	6	15	104	97	
G	Smart Cities			1				15,873	829	176	16	102	105	205	
H	Sustainable Cities			0					8,329	313	15	50	174	109	
I	Resilient City			1						1,898	2	9	27	37	
J	Circular City			0							351	0	0	3	
K	Ubiquitous City			0								316	8	30	
L	Livable City			0									1,118	20	
M	Information City			1										2,613	
N	Total			11											

Note: The horizontal line with shading indicates the total number of articles found, while the vertical line with the darkest shading indicates the quantity of articles analyzed that is adhering to the objective of this research. The diagonal shading shows the number of studies related to the specific item.
Source: Research data.

quarantine, evacuation, distribution, and risk communication plan; regional cooperation protocols; definition of decision-making levels; existence of partnership protocols such as the private sector; and adequate means of communication. The article analyzed the readiness of the US, pointing out the strengths and weaknesses. The authors also recommended six key areas for cities to reduce their vulnerability to infectious diseases: early warning system; resource management; logistics; cooperation; command; and communication.

In a study on an outbreak of SARS in Toronto in 2003, Keil and Ali (2007) proposed that urban governance incorporate aspects relating to the occurrence of generalized diseases. They argued that urban governance should establish health care protocols, particularly in relation to EIDs. Despite the literature on urban governance being quite fruitful, studies that relate this area of knowledge to EIDs were not identified. The authors followed Rodwin and Gusmano (2002) by indicating four onerous health risks: resurgence of infectious diseases; greater inequality between social groups; barriers to accessing quality health care by the most vulnerable minorities; and terrorism and bioterrorism. Furthermore, they used the concept of the “bacteriological city” (Gandy, 2005), according to which municipal administrations should create a physical and social hygiene infrastructure to fight epidemics.

The 1898 yellow fever epidemic in the Mexican port city of Tampico was analyzed by Kuecker (2008). Due to the economic importance of Tampico, the central government of Mexico built a railway network in the region to transport goods. The construction of this railway had an impact on the geography of the city, making it a favorable place for the spread of the yellow fever epidemic. The study did not present a specific theory; however, it discussed how the local municipal government and the central federal government approached the problem. The local government focused on implementing sanitation projects, while the central government focused on quarantine to deal with the epidemic. It is worth mentioning that the effective solution to the problem began in 1890 when it was identified that a mosquito was the transmission vector of yellow fever.

The possibility of a better social arrangement for coping with a pandemic was addressed in the model proposed by Dawson and Yamamoto (2009) in a study of urban planning (physical environment) in Japan, a country with a significant level of aging. The study analyzed the movement of people throughout the city, which occurs in an agile and efficient way that facilitates the spread of EIDs. The authors’ model presents advises urban planners to avoid the allocation of the older population in facilities with many people, as this increases the rate of contagion and death of this population. Individual hygiene is presented as a critical factor, because the greater the hygiene of individuals, the lower the capacity of the disease to spread. Another factor that proved to be effective was the closure of schools. The analysis model proposed by the authors indicates that small social groups living in large houses, and the removal of the elderly and children from transportation networks significantly reduce the number of infections and deaths.

The existence of a protocol for implementing regional and local information infrastructure that supports the response to EIDs was proposed by Timpka et al. (2011) in a study on urban planning (social environment) in Sweden. Their research assumed that there is no alignment between, on the one hand, regional and local information structures, and, on the other, pandemic response programs (Krumkamp et al., 2009), due to the overloading of information resources (Dato et al., 2004; Ringel et al., 2009) that increases the occurrence of wrong decisions by managers (Lipsitch et al., 2009; Timpka et al., 2009). The study did not present a theoretical proposition and was limited to indicating the use of an information structure protocol.

Choi (2012), in a study based on the concept of the information city, performed a temporal analysis (past, present, and future) of public health surveillance. The analysis of the past focused on the history of major epidemics and on the main milestones in the development of public health surveillance. The analysis of the present addressed the components of public health surveillance, the processes relating to the collection, treatment, and use of data from the surveillance system, and public health action. The perspective established for the future presented potentialities that will help society respond to epidemics. The author did not present a formal theory that associates city management with responses to pandemics.

Prior and Roth (2013), in a study based on the concept of resilient cities, indicated the need to establish policies that have appropriate mechanisms to deal with complex crises. City management should expand its ability to predict and evaluate risks by investing in the capacity of the collaboration network comprising municipal agencies and the federal government agencies. Although the concept is common in studies on resilient cities, the authors incorporated the concern with pandemic crises, presenting an example of this concern in Singapore’s planning for the management of pandemic threats and terrorist activities. The authors included the risk of a pandemic occurring within the theoretical concept of resilient cities.

The urban planning (physical and social environment) research of Neiderud (2015) considered the advantages and disadvantages of urbanization in society. Urbanization intensifies the generation of megacities, which are potentially incubators of new epidemics and vectors of transmission for rapid spread on a global scale. The urbanization process has been accompanied by the tendency of many infectious diseases traditionally classified as rural to become intense in urban centers. This phenomenon is related to the uncontrolled growth of cities, inadequate housing in the peripheral regions of cities, and the reduction of green transition areas between rural and urban regions. Large centers offer better social and health services, but in many cities they are saturated and are inadequately accessible for the most vulnerable part of society. People’s immunization differs depending on where they live, with those living in the most peripheral regions and those with less access to social and health services being more susceptible to infection from EIDs, and therefore acting as transmission vectors. The author indicated that the theory of urban planning (in terms of physical and social environment) must establish programs of surveillance, control, prevention, and public knowledge that incorporate the process of urbanization and contain aspects relating to EIDs.

Wolf (2016) highlighted that, despite the size of cities and their concentration of people, urban governance is not the only influencing factor in the pandemic transmission process of EIDs. The author proposed three groups of factors that can be decisive in combating a pandemic: (i) a combination of the dynamics of biology, environmental influence, and social practice; (ii) multispecies ethnography, which determines the lifestyle and potential of cities; and (iii) how health is inserted into the domain of citizen security. The author expanded the theory by arguing that pandemics cannot be interpreted in a simplistic way according to universal categories of space, modernity, or risk; rather, they result from various social, political, biological, and economic aspects and scales. Thus, pandemics manifest themselves in different ways, due to different social behaviors determined by localities. Gandy’s (2006) proposed concept of the “bacteriological city” was used to support the idea that cities are dynamic and fragmented by underlying tensions and contradictions (political, economic, and social).

In a study on smart cities, Chan, Huang, Mark, and Guo (2017) discussed the system of meteorological disaster alerts and information on health protection, although they did not directly address occurrences of pandemics. However, they indicated that television information and the use of smartphone applications are an important resource for the dissemination of emergency information to society. Among the means of informing the public, the prevalence of information transmitted by television can still be observed, although variables such as age and educational level have influenced the growth of interest in information disseminated via smartphones.

Coleman et al. (2018), in a study on urban planning (physical environment), analyzed transportation in Singapore in order to identify and characterize the community of respiratory viruses. Despite the restrictions to operationalize the biological data collection, the authors indicated how the proposed methodology could help detect new pathogens with pandemic potential. The authors' proposal was positioned as a proactive monitoring of respiratory pathogens in public areas, and as a management tool that can help to identify places of high risk of contamination, allowing for more robust surveillance. In this respect, the theories of cities share a direction towards data-driven management, bringing together the technologies of data collection, analysis, and modeling in order to facilitate the management of the locality, to anticipate risks, and to enable the creation of prevention strategies, such as those observed in the COVID-19 pandemic.

The findings of the reviewed papers reinforce the data-driven approach to urban management, with the application of ICT (IoT, Big Data, AI, databases, etc.) to capture data and formulate strategies in an active and non-reactive way. Smart technologies allow urban management to be prescriptive and to be guided by data, obtained in real time, in order to anticipate crises and identify opportunities for the development of public policies and actions that improve urban life.

3.3. Scientific publications in 2020 that relate pandemics to theories of cities

The data survey identified 48 articles published between January and June 2020 that relate pandemics to concepts of cities. Using the methodology presented in Section 2, 10 articles adhering to the objective of this investigation were identified.

In addition to presenting the articles identified in the selection (Acuto, 2020; Allam & Jones, 2020b; Allam et al., 2020; Bragazzi et al., 2020; Kummitha, 2020b; Lai et al., 2020; Park et al., 2020; Queiroz et al., 2020; Spencer et al., 2020; Yigitcanlar et al., 2020), this section contains additional contributions that assist with the analysis.

Regarding the approaches taken by the articles, there was a predominance of themes relating to AI and Big Data (Yigitcanlar et al., 2020), indicating the existence of research on city management that incorporates AI as a means of predicting high-impact events (Allam et al., 2020). AI and Big Data can be used to track the virus's propagation process in real time (Bragazzi et al., 2020), providing public managers with data to plan actions and verify the effectiveness of responses. This monitoring process can also include the effectiveness of medicines and health protocols in pandemic situations (Bragazzi et al., 2020). Hua and Shaw (2020) pointed out that the use of AI, Big Data and digital technologies are some of the determining factors for the success of efforts to combat COVID-19 in China (Allam et al., 2020). According to these authors, the algorithms proposed by BlueDot and Metabiota have enabled more accurate forecasts. Despite the identification of successful cases of the use of AI and Big Data in the fight against COVID-19, the inexperience in using these resources in the management of cities has limited their adoption (Lai et al., 2020). It is worth mentioning that the Epidemic Investigation Support System developed by the South Korean government uses a smart cities application platform to analyze, manage, and protect information necessary for investigating epidemics (Park et al., 2020). The voluntary use of the application on cell phones is designed to track confirmed cases of COVID-19 within established legal restrictions, and mathematical models indicate that the spread of the virus can be reduced by up to 50 % with use of this tool (Ferretti et al., 2020).

An AI and Big Data system should not be limited to data originating in cities; they should also incorporate open information from central governments, communities, private companies, and universities in order to establish adequate responses to problems (Kummitha & Crutzen, 2019). Despite adequate synergy in crisis management by local, state, and national governments, this relationship between different levels of government encounters conflicts in many countries, such as the US, UK, Sweden, and India (Allam & Jones, 2020b).

Despite AI's potential for the city management system (Kummitha, 2020b), the massive use of technology can suppress and censor citizens' rights. The Chinese state's use of AI and Big Data to combat COVID-19 had positive results in containing transmission, but it involved violating the privacy of its citizens (Johnson et al., 2020). Thus, although smart technologies offer adequate solutions, their use is conditioned to the social, political, and institutional contexts, and local data protection laws and user privacy should be considered (Kummitha, 2020b). Although technological equivalence between China and Western countries has been noted, the use of AI has differed between them. Despite the power of the Chinese central government in controlling activities in the fight against COVID-19, contrary popular actions have been observed, mainly in the region near the city of Wuhan (the epicenter of COVID-19 in China) where residents of neighboring areas that had been unaffected by the disease built barricades or destroyed parts of roads with the purpose of blocking other people's access to their areas (Thomson, 2020).

Large urban centers with high demographic density are places with a higher probability of spreading viruses, and hence pandemic management is more complex in such places (Acuto, 2020). The possibility of contagion of people in large urban centers is increased by aspects such as greater time on public transport during the movement of people, greater concentration of people in public and commercial places, and greater concentration of people in places of social activities (such as schools and the work environment). In small communities, by contrast, factors relevant to the emergence and spread of EIDs include the water supply, sanitation technology, materials used in housing construction, and being located on a migratory bird route (Spencer et al., 2020). In the approach proposed by the authors, potential EIDs originate in rural locations with more precarious infrastructure, and they spread with greater dynamism in large and demographically dense urban centers. In this perspective, the concept of smart cities is not limited to the territorial space of cities but also includes the surrounding communities, as these influence phenomena that cross territorial boundaries of cities and are an integral part of the water and food supply chain (Queiroz et al., 2020).

Cities that already implement planning and management to respond to crisis situations include those in Japan, Thailand, Indonesia, and Sri Lanka that have response systems to deal with tsunamis and hurricanes (Beck, 2004). Cities in Australia and the US have protocols to mitigate the damage caused by forest fires (Greha, 2020). Thus, urban architects and planners are important in crisis planning and management of health events, as all cities can be affected by these problems, while for natural causes, such as earthquakes, tornadoes, and hurricanes, usually occur in places more susceptible to these phenomena (Allam & Jones, 2020a). Architectural and urban institutions should consider the management of biological risks, as proposed by the International Federation of Biosafety Association in 2014, in association with technologies (Allam & Jones, 2020b) in order to provide cities with the resilience and robustness to overcome biological risks such as the COVID-19 pandemic. Table 3 presents the main points of the analyzed approaches.

As an extract from the analyzed data, it is possible to identify the following contributions. Urban planning (incorporating both physical and social environment) that goes beyond the borders of the municipality itself is also presented as suitable for adoption by urban managers. There are cities that, due to their economic potential and training among their residents, have a better infrastructure to deal with crises, but that are surrounded by cities with fewer planning resources. This condition is common in the "dormitory cities", which are characterized by having a large number of people working in larger cities and by low levels of local economic activity, thus combining many people living in places with low tax collection. It is worth mentioning that, unlike in developed countries, the suburbs in developing countries are predominantly inhabited by people with lower purchasing power and greater economic and social vulnerability. Thus, it is possible to infer that in times of crisis, suburban residents, because they have fewer financial resources and lack resources to respond to the crisis, seek assistance in larger cities. In this scenario, larger cities will receive a greater demand from people seeking social and health care. It is noteworthy that, in developing countries, hospital care tends to focus on large centers, reinforcing the

Table 3
Characteristics of the selected studies.

Period	Author(s)	Approach
Prior to 2019	Matthew & McDonald (2006)	Six key areas for cities to reduce their vulnerability to infectious diseases: early warning system; resource management; logistics; cooperation; command; and communication.
	Keil & Ali (2007)	Four onerous health risks: resurgence of infectious diseases; greater inequality between social groups; barriers to accessing quality health care by the most vulnerable minorities; and terrorism and bioterrorism.
	Kuecker (2008)	How the local municipal government and the central federal government approached the epidemic problem.
	Dawson & Yamamoto (2009)	Model: small social groups living in large houses, with removal of the elderly and children from transportation networks significantly reducing the number of infections and deaths.
	Timpka et al. (2011)	Cities need to have a protocol for implementing regional and local information infrastructure that supports the response to EIDs.
	Choi (2012)	Cities have to consider potential scenarios in order to help society respond to epidemics.
	Prior & Roth (2013)	Cities need to establish policies that have appropriate mechanisms to deal with complex crises.
	Neiderud (2015)	The theory of urban planning must establish programs of surveillance, control, prevention, and public knowledge that incorporate the process of urbanization, and contain aspects relating to EIDs.
	Wolf (2016)	Factors that can be decisive in combating a pandemic: (i) a combination of the dynamics of biology, environmental influence, and social practice; (ii) lifestyle and potential of cities; and (iii) how health is inserted into the domain of citizen security.
	Chan et al. (2017)	Televisions and smartphone applications are important resources for the dissemination of emergency information to society.
	Coleman et al. (2018)	Cities must monitor respiratory pathogens in public areas as a management tool to identify places at high risk of biological contamination.
January–June 2020	Yigitcanlar et al. (2020), Allam et al. (2020), Bragazzi et al. (2020)	City management needs to incorporate artificial intelligence as a means of predicting high-impact events such as EIDs.
	Kummitha (2020b)	Although smart technologies offer adequate solutions, their use is conditioned to social, political, and institutional contexts, and local data-protection laws and user privacy should be considered.
	Lai et al. (2020)	A lack of experience in using artificial intelligence in the management of cities has limited their adoption.
	Park et al. (2020)	Utilizing an Epidemic Investigation Support System supported by a platform to analyze, manage, and protect information is a good solution to combat EIDs.
	Allam & Jones (2020b)	Despite adequate synergy in crisis management by local, state, and national governments, the relationship between the different levels of government entails conflicts in many countries.
	Spencer et al. (2020)	EIDs originate in rural locations with more precarious infrastructure, and spread with greater dynamism in large and demographically dense urban centers.
	Acuto (2020)	Large urban centers with high demographic density have a higher probability of spreading viruses, and hence pandemic management is more complex in such places.
	Queiroz et al. (2020)	The concept of smart cities is not limited to the territorial space of cities but also includes surrounding communities, as these influence phenomena that cross territorial boundaries of cities.

Source: Research data.

movement of suburban residents towards large centers in search of health care. This phenomenon of moving the suburb towards the urban center establishes two points of attention: people's behavior, and the synergy among city managers.

In times of crisis, it is possible to identify people who manifest exacerbated self-preservation that is associated with low solidarity with the most vulnerable, and who make efforts to avoid the movement of people to places where there are fewer cases of contamination or where there are better public health services (Allam & Jones, 2020a; Keil & Ali, 2007; Kuecker, 2008; Prior & Roth, 2013). As justification for this attitude, EIDs are identified as emerging from simpler communities (Spencer et al., 2020). Consequently, large cities that are surrounded by smaller cities that have less capacity for public health surveillance (Choi, 2012) need to establish integrated plans to promote the sharing of humanitarian resources and ensure hospital care for all those in need. The planning of a city is not restricted to its urban perimeter; rather, it must include the city's surrounding rural area, its supply chain, and all the people, communities, and interfaces that carry out exchanges with it.

Urban planning (incorporating both physical and social environment) for EIDs involves aspects relating to the maintenance of stocks of water, food, medicine, clothing, and essential items (Acuto, 2020; Spencer et al., 2020). It should also ensure a public services structure, with an emphasis on the public health system, so that people can be assisted in crisis situations.

AI, Big Data, and smartphone applications are also important resources in a pandemic (Allam et al., 2020; Bragazzi et al., 2020; Lai et al., 2020; Yigitcanlar et al., 2020). However, many variables need to be solved for the full adoption of these resources. The first relevant aspect relates to the need to make people's individual freedom compatible with the control and interference by government agencies in the decision-making process (Allam & Jones, 2020a). Regulators and society should discuss, in a broad and harmonious way, data privacy and the degree of intervention that the state can use in times of crisis. The dialogue between the parties about the degree of decision-making that each one has, and how much interference is admissible, should be carried out well in advance of crises. This temporal detachment from the crises themselves is necessary for the dialogue to be balanced and to prevent the state from imposing measures that restrict individual freedom. This will ensure that society, and each individual in it, has the opportunity to establish a relationship with the state, which guarantees the confidentiality of their data and their freedom of decision in times of crisis.

A relevant aspect to consider when incorporating AI, Big Data, and smartphone applications is the financial cost of investment, implementation, maintenance, and eventual replacement of the systems (Allam & Jones, 2020a). In the vast majority of cities, public management has a budget that is determined by the social demands of its residents, so the inclusion of AI and Big Data means an additional demand on available public resources. Municipal managers should look for suppliers of AI and Big Data technology who present better costs and use data protocols that allow for the future switch of service provider. Moreover, the implementation of AI and Big Data by the municipal management can be designed to incorporate elements that reduce the costs of public services. Therefore, urban managers should include, as one of the benefits of implementing AI and Big Data, the reduction of operational costs.

4. Final comments

This section summarizes the material analyzed, presents perspectives not consolidated in thematic studies of city management, and discusses knowledge gaps. These values indicate that previous occurrences of EIDs, such as Ebola (Allam & Jones, 2020b; Spencer et al., 2020) and SARS (Acuto, 2020; Bragazzi et al., 2020; Choi, 2012; Coleman et al., 2018; Keil & Ali, 2007; Yigitcanlar et al., 2020) did not act as a stimulus for researchers of city management to develop studies incorporating the occurrence of pandemics. The publications from 2020 that combine the themes of city management and EIDs have as a link the occurrence of COVID-19 (Acuto, 2020; Allam et al., 2020; Allam & Jones, 2020b; Bragazzi et al., 2020; Kummitha, 2020a; Lai et al., 2020; Park et al., 2020; Queiroz et al., 2020; Yigitcanlar et al., 2020), indicating this phenomenon had probably motivated the research. The discovery of vaccines and drugs that mitigate the effects of COVID-19 may lead to a lack of interest in continuing research on this area, extending the theoretical gap.

The COVID-19 pandemic should be interpreted as an inflection point for the growth of research on the response by cities to EIDs and, more generally, to biological risks, including bioterrorism (Choi, 2012; Coleman et al., 2018; Keil & Ali, 2007; Matthew & McDonald, 2006; Neuert, 2017; Prior & Roth, 2013; Timpka et al., 2011; Wolf, 2016). It was possible to identify research on themes relating to cities that presents pertinent approaches to pandemic responses. However, these surveys do not provide answers to many of the challenges, nor do they allow for saturation of the subject.

This research on approaches to COVID-19 presents both successful and unsuccessful initiatives, protocols established by cities, innovations that have emerged during the period, databases that have enabled actions to mitigate the effects of the pandemic, the influence of population density on the spread of the disease, solutions identified for urban transport, and the influence of urban structure and forms of housing on transmission of the disease. Consideration of all of these aspects can increase the robustness of urban planning, urban design, the management of cities, and expansion of theories related to cities. In addition to the development of research addressing these themes, systematic reviews have condensed the acquired knowledge to identify what is most useful (Bragazzi et al., 2020; Neiderud, 2015; Queiroz et al., 2020; Timpka et al., 2011; Yigitcanlar et al., 2020). Thus, compendia of works that present the performance of cities in the period of COVID-19 have positioned themselves as useful for urban planners to prepare their cities for possible pandemics.

The analysis in this study has made it possible to identify emerging themes with the research potential for establishing a body of theory that addresses the theme of city management, especially in addressing biological crises. There are only a few publications on this topic, but research on smart cities and urban planning constitute most of the studies in this area, and they have the greatest potential to establish theory relevant to the planning for biological crises. Publications in these areas surpass those on the resilient city, which in principle should be more relevant to crisis responses.

There is a change in profile in studies that relate cities to infectious diseases. While prior to 2019 studies addressed issues related to the construction of an urban structure designed to reduce people's vulnerability to infectious diseases, studies from 2020 establish a focus of attention the use of information and communication technologies, being used as tools prevention and control.

In summary, research on theories that deal with cities and biological crises is fruitful, but there is a low correlation between the two. Strategies such as health surveillance and crisis management recur in the literature, but they do not incorporate AI and ICT in the creation of data that integrate citizens, the government, businesses, and civil society in general. The similar number of articles published prior to 2020 with those published in the first half of 2020 indicates that the COVID-19 pandemic has the potential to act as a trigger for research relating to biological crises, ICT, and the management of municipalities. Thus, COVID-19 presents research opportunities in several areas and in search of answers to the following questions: Which technological solution architecture can enable municipal data-based management? What data should public management monitor, and how often? How can data from public management, the private sector, civil society, and smart solutions be extracted and incorporated into strategic public administration? What is the technological and functional structure necessary for the implementation of AI in the municipal sphere? What are the characteristics of a data-driven municipal management development framework? At what stage of development of city management should predictive, prescriptive, and exploratory models be used for the development of strategies? What is the best flow of information to be adopted in municipal management?

Notes

[1] By using the CAPES Journal Portal (https://www.periodicos.capes.gov.br), it was possible to aggregate (in this survey) a set of 41 databases: Advanced Technologies & Aerospace Database; AGRIS (United Nations, Food and Agriculture Organization); American Association for the Advancement of Science; American Medical Association Journals; Annual Reviews; ASCE Library; BMJ Global Health; Cambridge Journals; Civil Engineering Abstracts; Directory of Open Access Journals (DOAJ); Duke University Press; Elsevier; Emerald Insight; Engineering Research Database; IEEE Xplore; Journals.ASM.org (American Society of Microbiology); JSTOR Archival Journals; Lippincott Williams & Wilkins Journals; Materials Science & Engineering Database; MEDLINE/PubMed (NLM); OneFile (GALE); Oxford Journals; PLoS; Pollution Abstracts; Project MUSE; ProQuest; Public Library of Science; Sage Journals (Sage Publications); Science & Engineering Database; Science Citation Index Expanded (Web of Science); ScienceDirect; Scopus; Social Sciences Citation Index (Web of Science); Sociological Abstracts; Springer; Springer Science & Business Media B.V.; Taylor & Francis Online – Journals; Technology Research Database; The JAMA Network (American Medical Association); U.S. National Library of Medicine (NIH/NLM); Wiley Online Library.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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