DOI: 10.1590/1413-812320202510.30712018

Sanitation, Arboviruses, and Environmental Determinants of Disease: impacts on urban health

Lorena Sampaio Almeida (https://orcid.org/0000-0002-6653-9370) [1]
Ana Lídia Soares Cota (https://orcid.org/0000-0001-8220-7846) [1]
Diego Freitas Rodrigues (https://orcid.org/0000-0001-5698-596X) [1]

Abstract *What are the repercussions of poorly planned urbanization for population health? Understanding urban health, the risks posed by cities, health repercussions, and urban social relations helps urban planners to decide where to target prevention interventions. We conducted a qualitative descriptive analytical study based on a document analysis and bibliographical review to explore the relationship between urbanization and urban health, focusing on diseases transmitted by the mosquito* Aedes aegypti. *Our findings show that environmental degradation and inadequate infrastructure pose a serious risk to human health, insofar as the disposal of waste in dumps and landfills can cause exposure to hazardous chemicals. In addition, inadequate urban infrastructure and sanitation is conducive to the transmission of water-borne diseases and the reproduction of vectors of other diseases such as* Aedes aegypti*, responsible for the transmission of arboviruses (dengue, chikungunya, and Zika). Research on environmental and urban health therefore provides an important foundation for improving the quality of life of people living in cities and developing measures designed to prevent diseases related to unplanned urbanization.*

Key words *Urbanization, Urban health, Zika*

[1] Centro Universitário Tiradentes. Av. Gustavo Paiva 5017, Cruz das Almas. 57038-000 Maceió AL Brasil. lorenasampaioalmeida@hotmail.com

Introduction

The topics of health and the environment have always been intrinsically linked throughout the history of public policy worldwide. A practical example is the urbanization process, in which the formation of cities has a fundamental impact on the incidence and spread of infectious diseases, epidemics, and pandemics throughout the world[1].

Urban areas are growing at a phenomenal pace, with the world population expected to pass from 6.7 billion in 2007 to 9.2 billion in 2050, with around 6.4 billion people (60% of the global population) living in urban centers[2].

The situation in Brazil is no different. Urbanization has taken place in a disorderly manner and without adequate planning, leading to problems related to water supply, sanitation, and unlawful land occupation and significantly increasing the risk of waterborne infections and diseases spread by vectors that proliferate in these vulnerable areas[3].

Understanding the relationship between health and the environment is important to ensure more effective disease prevention, bearing in mind that the control of disease vectors in areas that have experienced rapid urbanization requires not only health actions, but also policies that integrate social mobilization, health, environmental education, access to adequate housing and sanitation, and measures to curb deforestation[3].

Built around these relations, a new field of public health has emerged based on a concept known as *urban health,* which explores urban risk factors in cities and their impact on health and urban social relations[4].

Based on this new concept and concerns relating to urban health, three points should be clarified: despite its advantages, urbanization can have significant social, economic, and environmental impacts that are difficult to assess; the physical and social aspects of a city and its neighborhoods can affect health; and, adopting a broader vision, an individual's health problems may be associated with the urban environment he/she lives in, which often overrides individual factors[4].

It is within this context that the concept of the "social function of the city" emerges, based on the idea that the city should enable its inhabitants to achieve a balance between the economy, society, and the environment. In this regard, Article 5 of Brazil's Federal Constitution determines that the social function of the city is the fulfillment of the right to life, security, equality, property, freedom, and the social minimum, which encompasses the right to education, health, leisure, work, welfare, maternity, childhood, and relief, among others[5].

Population growth, migration, easier access to air travel, urban sprawl, poor health services, and increasing population density are key factors that influence the capacity of cities to fulfill their social function and contribute to the spread of infectious diseases, especially arboviruses such as dengue, chikungunya, and Zika. Urban areas are ideal breeding grounds for the main vector of these arboviruses, the mosquito *Aedes aegypti,* and studies show that social and environmental conditions in Brazil are conducive to its reproduction[6].

Focusing on infections transmitted by *Aedes aegypti*, this study therefore examines the relationship between urbanization and urban health by seeking to respond the following guiding question: what are the repercussions of poorly planned urbanization on population health?

Methods

We conducted a qualitative descriptive and analytical study of the urbanization process, the adverse consequences of unplanned urban growth, and the relationship between this process and the determinants of health using the following main methods and procedures: purposive sampling, collection of open-source data, text and image analysis, checklist and interaction diagram, and interpretation of findings.

Primary sources included legislation and official documents (city master plans; maps, and epidemiological bulletins), while secondary sources consisted of relevant scientific articles published in national and international periodicals and books. After selecting the texts that constituted the methodological foundation of the study, we performed a content analysis of relevant documents and a spatial analysis to illustrate specific cases correlating urbanization and public health.

The results were presented in three units of analysis: synthesis of concepts of urbanization and metropolization and the association between this process and population health; distribution of vulnerability and the risks posed by the urbanization process, focusing on environmental impacts; and summary of the main environmental impacts responsible for the proliferation of *Aedes aegypti* and Zika virus infection, focusing on lack of sanitation.

Ciência & Saúde Coletiva, 25(10):3857-3868, 2020

Results and discussion

Metropolization and health

Health and the environment have always been interlinked. As far back as 460 AC, Hippocrates highlighted this in his work "On Airs, Waters, and Places", in which he pointed out that the environment was a determining factor in the emergence and evolution of pathologies, although at that time nature was regarded as an element that should be should be passively observed, without intrusion or dominance[7].

In the sixteenth and seventeenth centuries, the term *environmental* came to prominence once again with the *miasma theory,* which held that disease was transmitted by bad air and smell. Although this was the dominant theory up to nineteenth century, growing urbanization across Europe and factory production gave rise to social movements that highlighted that living conditions were an important factor in the emergence of diseases, focusing on the social environment[8].

Thus, society should maintain a balance between economic growth and the environment. With regard to urbanized society, the social function of the city is framed within article 3 of the Federal Constitution, which states that the fundamental objectives of the Federative Republic of Brazil are: to build a free, just, and solidary society; to guarantee development, eradicate poverty and substandard living conditions, and reduce social and regional inequalities; and to promote the well-being of all, without any form of prejudice[5]. It is evident therefore that the principle of the social function of the city defends a better quality of life for city dwellers.

Concerns with the health consequences of environmental degradation and urban conditions date back to the eighteenth century and the onset of the industrial revolution, when insufficient infrastructure to accommodate the rising urban population led to the emergence and spread of diseases linked to poor sanitation and poor housing. This led to the emergence of the sanitary movement, with a discourse grounded in basic sanitation and vector control, broadening the approach to tackling urban social and environmental problems[1].

The Ottawa Charter, presented at the first International Conference on Health Promotion held in Canada in 1986, reinforced this approach by stating that the fundamental conditions and resources for health are peace, shelter, education, food, income, a stable ecosystem, sustainable resources, social justice and equity[1], reaffirming that health was not merely the absence of disease, but a set of characteristics that determine physical, mental and social well-being.

The urban revolution and growth of cities had and continues to have considerable environmental impacts, particularly in developing countries, which do not have effective environmental control legislation. In these countries, rapid and often unplanned urban expansion results in inadequate infrastructure and housing and a lack of essential services, such water supply, sanitation, and waste collection and disposal, posing significant health risks[8].

Discussions in the literature surrounding health and the environment center on living conditions. It is impossible to protect people's health without taking care of the environment, just as we cannot talk of environmental degradation without mentioning its effects on human health. This discussion involve topics related to soil, water, basic sanitation, diet, housing, and disease, highlighting the close link between urbanization, environmental problems, and health[9].

The interaction diagram below (Figure 1) schematizes the possible consequences of rapid unplanned urbanization in Brazil, highlighting possible impact pathways.

The word "urban" comes from Latin *urbanus*, which has two meanings: "cultivated" and "of or belonging to a city". This gave origin to two words, *urbe* and *urbs,* the latter of which refers to the city of Rome, capital of the Roman Empire. The term urban came into use in the sixteenth century to refer to cities and their surrounding areas and the word "urbanity" was used to refer to health associated with urban areas from a cross-sectional perspective. The word "urbanization" refers to the "complex process through which cities grow (or diminish), change, and influence health (longitudinal perspective)"[4].

The urbanization process began in Brazil in the first half of the twentieth century, gaining momentum in the 1950s, a period in which industry was the most important sector of the national economy, characterizing a transition from an agriculture and export-based economy to urban-industrial economy. However, it was only in the 1970s that the urban population overtook the rural population[10].

With the increasing urban population, over the course of the rest of the twentieth century and beginning of the twenty-first century, urban centers concentrated poverty, social displacement, and crime. Lack of planning and inadequate in-

frastructure had an impact on population health. Infectious diseases proliferated, demonstrating the importance of evaluating urban health and urban environmental quality, the latter of which is influenced by the spatial, biological, social, and economic characteristics of the urban environment[11].

Rapid urbanization has been accompanied by a process of metropolization, the "process of integration of a territory stemming from a core city shaping an expanded territory sharing a set of functions of common interest". This type of ongoing urban occupation transcends municipal boundaries[10].

Together, these processes have led to a considerable increase in large urban areas with millions of inhabitants, resulting in the agglomeration of a large part of the Brazilian population in metropolitan areas[10].

The 2010 census conducted by the Brazilian Institute of Geography and Statistics (IBGE), reported that 55% of the urban population and 47% of the overall population live in the country's 39 metropolitan regions[12].

Metropolization has a number of effects. While on the one hand expanding economic relations, on the other it increases environmental vulnerability and social inequality, insofar as it promotes spatial proximity, higher urban population densities, and economic connectivity, thus fueling economic growth, with Brazil's 15 largest metropolises accounting for 50.3% of the country's GDP[13].

Metropolitan areas are characterized by high levels of socio-spatial segregation between rich and poor, with the development of "subnormal agglomerations", commonly known as *favelas* or slums, built on steep slopes and other high-risk

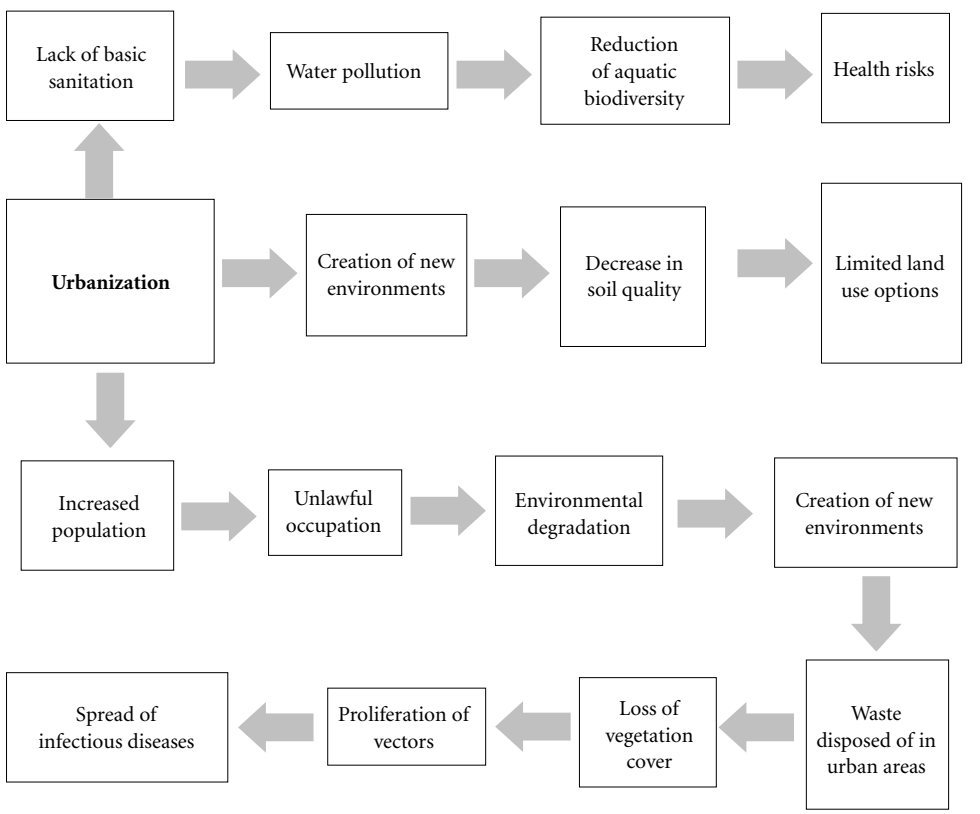

Figure 1. Urbanization Interaction Diagram.

Source: authors' elaboration.

Ciência & Saúde Coletiva, 25(10):3857-3868, 2020

areas unsuitable for construction in the periphery or central areas lacking adequate urban infrastructure, sanitation, waste collection, and public transport. People living in these areas face high levels of physical, environmental, and social insecurity[14].

Around a quarter of world's urban population live in slums, which the United Nations defines as contiguous settlements that lack one or more of the following five conditions: access to clean water, access to improved sanitation, sufficient living area that is not overcrowded, durable housing, and secure tenure[15].

Favelas are a visible manifestation of unequal development, resulting in uneven income distribution and inequality in the way urban space is used[14]. These inequalities are evident in the following numbers: the poorest 20% in cities struggle to reach the age of 55, while the richest 40% live beyond 70 years[15].

The conditions in these places pose a risk to population health, insofar as health is a social product influenced by the urban space, making urban populations vulnerable to outbreaks of infectious diseases and diseases transmitted by vectors whose presence is influenced by environmental factors, such as arboviruses[1,15].

The disorganization of cities provides favorable conditions for the spread of various diseases. The mosquito *Aedes aegypti,* the main vector of the arboviruses dengue, Zika and chikungunya, has adapted easily to the urban environment due to the high population densities and the abundance of artificial breeding grounds[1].

There is an intimate relationship between *Aedes aegypti* and quality of urban life, mediated by urban planning, waste collection, and sanitation and hygiene[1]. It is therefore vital to understand the urbanization process and the link between urban growth and health to be able to prevent the health problems resulting from this process.

It is important to note that, although the main vector for the transmission of the above arboviruses is *Aedes aegypti,* other mosquitos less common in the Americas are able to transmit these diseases, such as *Aedes albopictus, Aedes africanus, Aedes luteocephalus, Aedes vittatus, Aedes furcifer, Aedes hensilli*, and *Aedes apicoargenteus,* as well as mosquitos from the genera *Anopheles*, *Eretmapodites*, and *Mansonia*[16].

March 2016 saw a turn of events in research into the ZIKV. Constância Ayres, a scientist from the Oswaldo Cruz Foundation (Fiocruz) in Pernambuco, revealed that she found the virus in the salivary glands and intestine of the mosquito *Culex quinquefasciatus*, commonly known as the southern house mosquito, demonstrating that the mosquito was able to replicate the virus. The finding was made when a team of scientists infected 200 mosquitos from the genus *Culex* and found that after feeding on infected blood for seven days the virus was still alive. However, according to Ayres, the findings should be treated with caution because the fact that the mosquito is infectable does not necessarily mean it can transmit the virus[16,17].

Although research is still in the early stages, if evidence confirms the role of *Culex* in the transmission of the ZIKV, Brazilians will face an even greater problem, given that this genus of mosquito is much more abundant than *Aedes.* Not to mention that *Culex* does not necessarily require clean water to lay its eggs, thus increasing the number of areas of risk. Furthermore, in contrast to *Aedes*, *Culex* is also active during the night, meaning that people would be exposed to risk 24 hours a day[16,17].

Risks and vulnerability resulting from urbanization

Intense urbanization and urban growth combined with inadequate land use intensify threats from natural events, such as storms, floods and landslides, or those related to the incidence of public health problems such as disease and violence. These threats are present in cities throughout the world and are particularly pronounced in Latin America and Brazil[18].

In Brazil, the occupation of areas of risk, such as permanent preservation areas and steep slopes, combined with poor socioeconomic conditions leads to increased risk for these diseases among populations living these areas[18]. However, before describing the risks and vulnerability, it is important to understand the meaning of these terms, as shown in Chart 1.

Figure 2 below shows an area of risk located in the Jacintinho neighborhood of Maceió called Vale do Reginaldo with inadequate infrastructure, high population density, lack of basic sanitation, and garbage strewn around open spaces close to houses.

Any society is prone to risks inherent to the way we live and human communities. Natural events were, until very recently, the greatest risks faced by society. Generalized urbanization has shifted this pattern, making cities vulnerable to various disruptive agents, be they exogenous, endogenous, natural, or technical. For this reason, it

Chart 1. Definitions of vulnerability, risk, and area of risk.

Vulnerability	The degree of loss for a given element, group, or community from given area likely to be affected a phenomenon or process.
Risk	Possibility of the occurrence of a given process or phenomenon and the extent of damage or economic and/or social consequences for a specific element, group, or community. This concept is linked to vulnerability: the greater the vulnerability, the greater the risk.
Area of risk	Area liable to be affected by natural and/or induced phenomena or processes that cause an adverse effect. The population living in these areas, the so-called precarious settlements, is susceptible to damage to physical property and material losses and generally belong to low-income groups.

Source: Adapted from Cidade, 2013; Brasil, 2007.

Figure 2. Vale do Reginaldo, Maceió, Alagoas.

Source: Google Earth.

is estimated that two-thirds of the people affected by catastrophes such as landslides and flooding live in urban areas[19].

Thus, understanding urban risks is vital for preventing other risks. One example is the unlawful occupation of land, which can negatively influence the local climate and generate conflict between people[19].

Environmental impacts are all too visible in our cities. Environmental degradation caused by urbanization that ignores physical and environmental concerns is manifested in erosion, landslides, compromised water quality, and the silting up of water bodies, increasing flood risk and causing both material and social damage.

To understand this process it is necessary to understand the various concepts of environmental impact. Brazilian legislation defines environmental impact as any physical, chemical, or biological alteration of the environment caused by any type of matter or energy resulting from human actions that directly or indirectly affects the "health, safety and well-being of the population; social and economic activities; the biota; the aesthetic and sanitary conditions of the environment; and the quality of environmental resources"[19]. Other authors suggest that environmental impact is any alteration to and/or effect on the environment resulting from human action1[19,20,21].

Environmental impacts become a chain reaction, insofar as they are interlinked. For example, the deforestation of slopes for the construction of roads and houses may trigger erosion and slope destabilization, which in turn causes sediment run-off, polluting water and increasing the risk of diseases spread by contaminated water and pests and vectors that reproduce in this type of environment[22,23].

The various environmental impacts resulting from lack of adequate infrastructure may also pose risks to human health, while the improper disposal of waste in open dumps and landfills can cause exposure to chemical substances, reflected in an increase in congenital anomalies, low birth weight, miscarriages, neonatal deaths, and the incidence of certain types of cancer[24,25].

Furthermore, poor sanitation is related to water-borne diseases like diarrhea, hepatitis, and schistosomiasis and facilitates the reproduction of vectors of other diseases, such as *Aedes aegypti,* the main vector of yellow fever and arboviruses.

The conversion of rural environments to urban areas will always result in environmental changes; however, it is up to human beings to minimize these impacts, balancing urbanization with environmental concerns. Urban planning that integrates environmental concerns reduces environmental impact. Sustainable planning should aim to organize physical space and meet

Ciência & Saúde Coletiva, 25(10):3857-3868, 2020

human needs, ensuring an environment that provides quality of life to current and future populations[26].

Inadequate urban infrastructure facilitates the reproduction of pests and vectors that spread a host of diseases. For example, as mentioned above, the main vector of arboviruses, *Aedes aegypti,* lays its eggs in standing water and urban areas with garbage accumulated on the streets, precarious water supply, and lack of sanitation are therefore ideal breeding grounds for this mosquito. As a result, populations living in these areas face a higher risk of being infected by the viruses transmitted by this vector.

Environmental determinants of health and the Zika Virus (ZIKV)

Infectious diseases have certain peculiarities that differentiate them from other diseases, such as the unpredictable and explosive nature of the global spread of these diseases, disease transmissibility, the close relationship between human behavior and the environment, and capacity for disease prevention and eradication[24].

A large part of the pathogens responsible for infectious diseases that affect humans are zoonotic diseases, meaning that they are maintained in nature through cycles involving a vector and wild animal (a monkey or bird for example). As a result of human actions, primarily economic activities, many vectors such as mosquitos become synanthropic, becoming adapted to living in close association with people and thus facilitating the transmission of pathogens to the human population[24].

That is why a number of diseases transmitted by mosquitos have emerged over the last 10 years, principally arboviruses like chikungunya, West Nile virus, and the ZIKV[24]. Rapid urbanization, resulting in deforestation of vast areas and generating ideal conditions for water accumulation, have resulted in the proliferation of vectors.

The trajectory of *Aedes aegypti* is associated with the human habitat, with the mosquito displaying synanthropic and anthropophilic behavior, accompanying man and his movements. Various studies have described the factors that determine the geographical distribution of this vector and, consequently, infection by arboviruses. Factors include: climate, with tropical and subtropical climates providing more favorable conditions for the vector; population flows; poor basic sanitation; inadequate water supply; inadequate housing; irregular waste collection, leading to the accumulation of garbage and creation of breeding grounds; and cultural and educational factors[25,26].

One of the factors that influences the spread of arboviruses is population movements, including commuting, leisure activities, and involuntary displacement, as in the case of refugees for example, increasing the risk of transmission of pathogens to other areas and regions, including resistant serotypes, and giving rise to outbreaks. Global warming is also an important factor influencing the transmission of pathogens. Rising global temperatures affect vectors, reducing larval development times and rapidly increasing mosquito populations. Increased temperatures also reduce the length of the extrinsic incubation period, decreasing the time the virus takes to reach the mosquito's salivary glands, making it a potential transmitter[24].

It is important to stress that urban sprawl hampers vector control, combining with the pollution of rivers and ditches to give rise to an abundance of breeding grounds for mosquitos, especially *Aedes aegypti*[24].

A major concern in urban areas with disastrous consequences is the creation of open dumping grounds: improper land disposal sites where waste is disposed of in the open air without appropriate environmental and public health protection measures[18]. Dumps generally emerge in open areas where the population discards garbage. Figure 3 illustrates the birth of one of these sites from the accumulation of domestic waste in Rio Largo, in the State of Alagoas.

Arbovirus epidemics are often the fruit of areas like the one depicted above, just one of the symptoms of the exclusionary development model adopted in Brazil over the centuries, showing total disregard for environmental concerns and resulting in inadequate sanitation, the improper disposal of urban waste, and lack of water supply. The incidence of mosquito infestation is highest in densely populated neighborhoods with little vegetation cover and lack of infrastructure, where mosquitoes find hosts more easily[27].

An aggravating factor related to *Aedes aegypti* is that its eggs can withstand dry conditions and remain viable for many months. This hampers control in urban areas, because, in addition to removing standing water, environments must be constantly cleaned to destroy all possible traces of reproduction[27].

Thus, the *mata-mosquito* or "mosquito killer" model successfully implemented by Oswaldo

Figure 3. The birth of a dumping ground, Rio Largo, Alagoas.

Source: Google Earth.

Cruz to eradicate the mosquito in the twentieth century and the use of genetically modified mosquitoes to cause infertility and insecticides is no longer enough to tackle the complexity of today's reality: unplanned urbanization, high population density, and an uncooperative population. We need to put aside insecticides and clean our cities and implement effective environmental sanitation in a participatory and integrated manner[27].

Migration from rural areas to cities with inadequate infrastructure and sanitation contributes to the proliferation of mosquitos. In Brazil's Northeast Region, more than 75% vector reproduction sites arise due to precarious water storage, while in the Southeast Region the majority of sites occur in household environments, in containers, plant pots, roof gutters, etc.[25].

Increased frequency of rainfall leads to the accumulation of water in containers, particularly those discarded in the streets, increasing the number of natural and artificial breeding grounds. In contrast, in drought regions, the population is forced to store water in barrels and other types of containers, which can also become breeding grounds[24].

Although social, environmental, and climatic factors in tropical countries like Brazil provide conditions that are conducive to the transmission of new infectious diseases, some arboviruses also circulate in certain temperate countries[24].

The association between vector proliferation and sanitation is clearly illustrated in Natal, the capital city of the State of Rio Grande do Norte, where a study showed that the majority of Zika cases occurred in the city's North Zone, where only 5% of sewage is adequately treated[28]. It is important to highlight that the ZIKV can also infect animals, which in turn can play an important role in the spread of cases in Brazil[29,30].

With regard to the socioeconomic factors that influence the distribution of the vector and consequently the incidence of ZIKV and arboviruses in general, Wilkinson and Pickett[31] explain that social relations, inequality, and position in the social hierarchy influence health, where those further up the ladder are healthier than those at the bottom. This association may be applied to cases of Zika, where the proliferation of the mosquito that transmits the virus is higher in areas with inadequate basic sanitation, open sewers, and inadequate housing, generally populated by those at the bottom of the pyramid of social stratification.

Lack of sanitation and the ZIKV: a causal relation?

In October 2015, Brazil witnessed a sharp rise in the number of babies born with microcephaly, months after evidence showed that this problem is caused by the autochthonous transmission of the Zika virus. A total of 215,319 cases of Zika and 2,366 cases of microcephaly were confirmed up to 2016[30].

Due to the high incidence of the virus in Brazil and its grave consequences (microcephaly is a chronic condition that seriously affects quality of life), scientists have upped research efforts aimed at promoting the prevention of this disease.

The primary ZIKV transmission vector is our old friend *Aedes aegypti*, which has been a concern in Brazil since the beginning of the twentieth century, insofar as it is also responsible for outbreaks of yellow fever, dengue, and chikungunya. These arboviruses began to spread in the west of the country due to conditions that are conducive to the proliferation of the mosquito, which lays its eggs in household containers capable of holding water and transmits the virus while feeding on human blood[32].

Urban sprawl gives rise to a number of conditions that facilitate vector proliferation, such as inadequate infrastructure and basic sanitation, increased waste generation, inadequate housing, and deficient basic services. This is aggravated by weaknesses in public health campaigns, including lack of training for endemic disease control agents and awareness raising among the general public about the diseases caused by the vector[1].

Ciência & Saúde Coletiva, 25(10):3857-3868, 2020

Érico Andrade, professor of philosophy at the Federal University of Pernambuco, conducted an in-depth analysis of causal relations in the spread of the arboviruses where he delimits the boundaries of the "geography of Zika", dengue, and chikungunya. Andrade affirms that infection reflects urban sprawl, class divisions, and urban segregation, illustrating the close relationship between the ZIKV and microcephaly and social inequality[33].

The relationship between social inequality and health is confirmed by Wilkinson and Pickett, who show that life expectancy is lower and infant mortality higher in more unequal countries. These authors also suggest that income inequality is such a big problem that improving health in rich countries depends more on reducing inequalities than economic growth[31].

The influence of inequality on human health has been widely discussed in the public health literature. A system that knows how to produce, but does not know how to distribute becomes insufficient and this is reflected in quality of life. Disease and health are multiply and dynamically influenced by cultural, contextual, and social factors and it is therefore necessary to investigate underlying risk factors, such as individual and group behaviors, lifestyles, and local settings, with the understanding that social circumstances are important determinants of health and disease[34].

Environmental management seeks to balance environmental, economic, and public health concerns. With regard to ZIKV incidence, for example, sanitation plays an important role, insofar as the World Health Organization defines sanitation as "the control of all the factors in a person's physical environment that have, or can have, a damaging effect on their physical, mental, or social wellbeing". Thus, environmental management and public health should walk hand in hand. In a sense, environmental concerns and public health have always been linked. However, it was only in the 1950s that a field dedicated exclusively to these issues began to take shape[35,36].

Considering that they are preventable diseases strongly associated with urban centers, the National Office for the Coordination and Control of the Combat of Dengue, Chikungunya Virus, and Zika Virus published Guideline Number 3 on basic sanitation. The document provides guidance to state and local governments on the development of basic sanitation actions focusing on water storage and waste elimination aimed at eliminating *Aedes aegypti* breeding grounds[37,38].

In this regard, the serious microcephaly epidemic caused by congenital Zika virus infection draws attention to the need for increased investment to improve the living conditions of Brazil's urban population. The challenges in this respect are numerous, including: lack of water supply to households, meaning that residents are forced to store water, creating potential breeding grounds; accumulated rainwater in inadequate housing or residences with accumulation of garbage or other materials; and open sewers, which are also used to dump waste. All these conditions conducive to the reproduction of the vector can be avoided by ensuring a supply of clean water, adequate basic sanitation, and effective waste collection services[37].

It is clear therefore that the provision of adequate water and sanitation is a prerequisite for preventing arboviruses and a synonym for lower mortality rates. It is important to stress that there is no single solution to tackling this epidemic; however, it is important to capitalize on existing strategies[38,39].

An example of a place that has become a perfect breeding ground for vectors is the area surrounding the Riacho Salgadinho (literally salty stream) in Maceió, the capital of the State of Alagoas. Figure 4 shows that it is an area with standing water and accumulation of garbage, providing ideal conditions for mosquito reproduction. The photograph depicts a stretch of the stream in the center of the city. However, the stream is part of the Reginaldo River Watershed and its source, which used to be located in Poço Azul in the Petrópolis neighborhood, no longer exists, drying up in 2006 due to the deforestation of native vegetation, soil waterproofing for housing construction, and drilling of private artesian wells, turning the stream into giant wastewater corridor and storm water drain[40].

Urbanization has brought economic development and the growth of cities. One would imagine that, by triggering economic growth, this process would also have brought improved health and quality of life; but that is not the case. Rather, it has brought about environmental degradation, deepening poverty, and inequality, in addition to new health problems and the maintenance of diseases that were thought to be under control.

One example of pathogens that spread under these conditions are arboviruses. Currently in the spotlight due to their high incidences rates, these infections can be seen as just one of the effects of deficient infrastructure, water supply, waste

Figure 4. Riacho Salgadinho, Maceió, Alagoas.

Source: Google Earth.

collection, and living conditions in urban centers, facilitating the reproduction of the vector responsible for transmitting these viruses.

Our findings show that the world has seen a remarkable expansion in urban areas in recent decades. This trend is set to continue into the future, revealing the need for further research on environmental and urban health in order to improve the quality of life of the billions of individuals living in cities and avoid preventable diseases.

Collaborations

LS Almeida, ALS Cota, and DF Rodrigues participated in study conception, methodology design, the review of relevant articles, contextualization of the results, and in the final drafting of this article.

Acknowledgements

We are grateful to the Fundação de Amparo à Pesquisa do Estado de Alagoas (FAPEAL); PROCAPS/UNIT/AL.

References

1. Mendonça FA, Veiga e Souza A, Dutra DA. Saúde pública, urbanização e dengue no Brasil. *Sociedade & Natureza* 2009; 21(3):257-269.
2. World Health Organization (WHO). *World Urbanization Prospects: The 2007 Revision. United Nations Department of Economic Social Affairs/Population Division*. New York: WHO; 2008.
3. Machado CJS, Miagostovich MP, Leite JPG, Vilani RM. Promoção da relação saúde-saneamento-cidade por meio da Virologia Ambiental. *Revista de informação legislativa* 2013; 50(199):321-345.
4. Calaffa WT, Ferreira FR, Ferreira AD, Oliveira CL, Camargos VP, Proietti FA. Saúde urbana: "a cidade é uma estranha senhora, que hoje sorri e amanhã te devora". *Cien Saude Colet* 2008. 13(6):1785-1796.
5. Brasil. Senado Federal. *Constituição da República Federativa do Brasil*. Brasília: Senado Federal; 1988.
6. Barbosa IR, Silva LP. Influência dos determinantes sociais e ambientais na distribuição espacial da dengue no município de Natal-RN. *Revista Ciência Plural* 2015; 1(3):62-75.
7. Hipócrates. Aires, aguas y lugares. In: Organización Panamericana de la Salud (OPS), Organización Mundial de la Salud (OMS). *El desafio de la epidemiologia: problemas y lecturas seleccionadas*. Washington: OPS/OMS 1988.
8. Gouveia N. Saúde e meio ambiente nas cidades: os desafios da saúde ambiental. *Saúde Soc* 1999; 8(1):49-61.
9. Camponogara S, Viero CM, Erthal G, Diaz PS, Rossato GC, Soares SA, Peres RR. Visão de profissionais e estudantes da área de saúde sobre a interface saúde e meio ambiente. *Revista Trabalho, Educação e Saúde* 2013; 11(1):93-111.
10. Romanelli C, Abiko AK. *Processo de Metropolização no Brasil*. São Paulo: USP; 2011.
11. Ribeiro H, Vargas HC. Urbanização, globalização e saúde. *Revista USP* 2015; (107):13-26.
12. Instituto Brasileiro de Geografia e Estatística (IBGE). *Censo Demográfico 2010. Características da população e dos domicílios: resultados do universo*. Rio de Janeiro: IBGE; 2011.
13. Observatório das Metrópoles. *As Metrópoles no Censo 2010: novas tendências?* [acessado 2016 Nov 16]. Disponível em: http:// www.observatoriodasmetropoles.net/ download/texto_ Metropoles
14. Gottschalg MF. *Segregação Sócio-Espacial Urbana e Intervenção Estatal: Uma abordagem geográfica-social*. Minas Gerais: Conselho Regional de Serviço Social de Minas Gerais; 2012.
15. Un-habitat. *Urbanization and Development: Emerging Futures*. World cities report 2016. United Nations Human Settlements Programme. Nairobi; 2016.
16. Fiocruz. *Fiocruz identifica mosquito Culex com potencial de transmissão do vírus Zika*, Fundação Oswaldo Cruz: por Solange Argenta. 2016. [acessado 2016 Nov 18]. Disponível em: http://portal.fiocruz.br/pt-br/content/fiocruz-identifica-mosquito-culex-com-potencial-de-transmissao-do-virus-zika-no-recife

17. Guedes DRD, Paiva MHS, Donato MMA, Barbosa PP, Krokovsky L, Rocha SWS, Saraiva KLA, Crespo MM, Rezende TMT, Wallau GL, Barbosa RMR, Oliveira CMF, Melo-Santos MAV, Pena L, Cordeiro MT, Franca RFO, Oliveira ALS, Peixoto CA, Leal WS, Ayres CFJ. Replicação do Zika vírus no mosquito *Culex quinquefasciatus* no Brasil. *Emerging Microbes & Infections*. 2017; 16:1-11.
18. Cidade LCF. Urbanização, ambiente, risco e vulnerabilidade: em busca de uma construção interdisciplinar. *Cad. Metrop*. 2013; 15(29):171-191.
19. Mendonça FA, Leitão SA. M. Riscos e vulnerabilidade socioambiental urbana: uma perspectiva a partir dos recursos hídricos. *GeoTextos* 2008; 4(1 e 2):145-163.
20. Brasil. Ministério das Cidades. *Mapeamento de Riscos em Encostas e Margem de Rios*. Brasília: Instituto de Pesquisas Tecnológicas; 2007.
21. Brasil. Conselho Nacional do Meio Ambiente (Conama). Resolução nº 001, de 23 de janeiro de 1986. *Diário Oficial da União* 1986; 17 fev.
22. Sanchez LES. *Avaliação de impacto ambiental: conceitos e métodos.* 2ª ed. São Paulo: Oficina de textos; 2013.
23. Westman W. Measurin the inertia and resilience of ecosystens. *BioScience* 1978; 28(11):705-710.
24. Gouveia N. Resíduos sólidos urbanos: impactos socioambientais e perspectiva de manejo sustentável com inclusão social. *Cien Saude Colet,* 2012; 17(6):1503-1510.
25. Mota S. *Urbanização e Meio Ambiente*, 3° edição, ABES. Rio de Janeiro, 2003.
26. Lima-Camara TN. Emerging arboviruses and public health challenges in Brazil. *Rev Saude Publica* 2016; 50:36.
27. Marcondes CB, Ximenes MFFM. Zika virus in Brazil and the danger of infestation by Aedes (Stegomyia) mosquitoes. *Rev Soc Bras Med Trop* 2016; 49(1):4-10.
28. Sousa EPP. *Influência das variáveis climáticas em casos de dengue nas cidades da Baixada Santista (sudeste do Brasil) e Cingapura (sudeste asiático)* [tese]. São Paulo: Universidade de São Paulo; 2013.
29. Peres AC. Aedes: ampliando o foco. *RADIS* 2016; (161):12-17. [acessado 2017 Jan 10]. Disponível em: http://www6.ensp.fiocruz.br/radis/sites/default/files/radis161_web.pdf
30. Luz KG, Santos GIV, Vieira RM. Febre pelo virus Zika. *Epidemiol Serv Saúde* 2015; 24(4):785-788.
31. Wilkinson R, Pickett K. *O nível: Por que uma sociedade mais igualitária é melhor para todos.* Rio de Janeiro: Editora Civilização Brasileira; 2015.
32. Brasil. Ministério da Saúde (MS). *Boletim Epidemiológico: Monitoramento dos casos de dengue, febre de chikungunya e febre pelo virus Zika até a Semana Epidemiológica 52, 2016.* Secretaria de Vigilância em Saúde. 48(3):1-10. 2017. [acessado 2017 Fev 24]. Disponível em: http://portalarquivos.saude.gov.br/images/pdf/2017/fevereiro/05/2017_002-Dengue%20SE52_corrigido.pdf
33. Brasil. Ministério da Saúde (MS). *Informe Epidemiológico n° 57 – Semana epidemiológica (SE) 52/2016 (25 a 31/12/2016) Monitoramento dos casos de microcefalia no Brasil.* 2017. [acessado 2017 Fev 24]. Disponível em: http://www.combateaedes.saude.gov.br/images/pdf/Informe-Epidemiologico-n57-SE-52_2016-09jan2017.pdf
34. Fauci AS, Morens DM. Zika virus in the Americas: yet another arbovirus threat. *N Engl J Med* 2016; 374(7):601-604.
35. Trata Brasil. A geografia do Aedes. *Correio Braziliense*. 2016. [acessado 2016 Nov 18]. Disponível em: http://tratabrasil.org.br/a-geografia-do-aedes
36. Ferreira MAF, Latorre MRD. Desigualdade social e os estudos epidemiológicos: uma reflexão. *Cien Saude colet* 2012; 17(9):2523-2531.
37. Ribeiro H. Saúde pública e meio ambiente: evolução do conhecimento e da prática, alguns aspectos éticos. *Saúde Soc* 2004; 13(1):70-80.
38. Brasil. *Diretriz SNCC n° 3 – Saneamento Básico.* Sala Nacional de Coordenação e Controle para o enfrentamento à dengue, ao vírus chikungunya e ao vírus Zika. Brasília, 2016. [acessado 2016 Nov 18]. Disponível em: http://combateaedes.saude.gov.br/images/sala-de-situacao/diretriz-sncc-n-3-saneamento-basico.pdf
39. Mujica OJ, Haeberer M, Teague J, Santos-Burgoa C, Galvão LAC. Health inequalities by gradients of access to water and sanitation between countries in the Americas, 1990 and 2010. *Rev Panam Salud Publica* 2015; 38(5):347-354.
40. Albuquerque E. *Responsabilidade sobre a poluição do riacho Salgadinho da capital do Estado de Alagoas*. Maceió: Fits; 2012.

Article submitted 30/04/2018
Approved 15/02/2019
Final version submitted 17/02/2019