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The phenomenon of urbanisation from a public health perspective. Urban spaces as a possible source of epidemics and pandemics caused by an infectious disease Fenomen urbanizacji z perspektywy zdrowia publicznego. Przestrzenie miejskie możliwym źródłem epidemii i pandemii chorób zakaźnych

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Abstract.

Introduction

Urbanisation is a global process leading to development of urban infrastructure and thus an increase in the population of urban areas. Health threats, including epidemics of infectious diseases that may break out in growing urban areas, can spread quickly and their effects could spread outside of the local territory.

Purpose

To outline the relationship between globalising, post-modern urbanisation processes, in particular the specific form of extended urbanisation, and the risks posed by infectious diseases that could give rise to new epidemics or pandemics.

State of knowledge

Health risks occurring at the local level of an urban area react to, and simultaneously affect, health situation occurring at an indefinite distance from the original site of the event. An important impact on the situation are the expanding or newly emerging urban areas, which cause negative changes in social conditions, and the increase in spatial mobility of the global population, which facilitates the spread of infectious diseases.

Summary

Understanding 21st century urban trends is the key to improving collective health. Adopting a "public health perspective" regarding values and attitudes towards social phenomena and reality, as well as the necessary methods of conduct, seems to be one of the main challenges of the current era in which people around the world, regardless of the country's development status and level of resources, currently live in within one "ecosystem of infectious diseases". Planned and controlled urbanization, taking into account the achievements of modern epidemiology, including molecular epidemiology, will help will help along the remediation of the cities of the future.

Keywords: globalisation, urbanisation, peri-urbanisation, urban poverty penalty, urban health, infectious diseases, public health

A snapshot of the present day

The time of significant change we are currently experiencing has been addressed by many terms, some of which refer to a new type of social system (information society, consumer society), but most of which tend to indicate that the previous state of affairs is coming to an end (post-modernism, post-materialism, post-modernity, post-industrial society). This implies that it is difficult to find an appropriate name for what is just emerging. The term also suggests that there is something that does not fit with the past reality, which means it is post, while also being some kind of continuation, a progression of an earlier state of affairs, but altered, having different characteristics of an order that is 'post-modern'. This would mean that the emerging features of post-modernity can already be observed, and there are important institutional tendencies that suggest that such an order may become a reality. This situation implies that it becomes advisable to identify the new challenges that post-modernity is creating, including those related to the phenomenon of urbanisation and resulting in health risks troubling the world population, including emerging infectious diseases of pandemic extent potential. The widespread phenomenon of urbanisation, which is one of the elements shaping the image of post-modernity, is a consequence of a global process of economic, social and cultural change leading to the development of urban infrastructure and, consequently, to an increase in the population of urban areas. Exceptionally intensive growth of urban populations is observed in the countries of the Global South, among which African cities, which are increasing their population twice as fast as any other urban population in the world, attract particular attention. The manner in which areas of the Global South, including Africa, are preparing for an urban future will have far-reaching health implications, not only for individual countries, but also for the world, as the rapid pace of urban expansion in these regions is already depleting the capacity to adequately plan, design and implement a sustainable urbanisation model at both national and local levels, threatening the health security of their populations. This phenomenon is reflected by, for example, the 'urban poverty penalty' associated with the low-quality living environments that are forming in Africa's large cities and metropolises with particular intensity. The expanded urbanisation associated with rapid urban expansion exposes suburban and peri-urban areas to higher levels of biodiversity and corresponding sources of disease than in other urban zones. The new and expanding urban periphery is becoming a place where diseases that cross the species boundary between animals and humans (zoonoses) are particularly prevalent and where new disease vectors can emerge. The situation in peri-urban areas is significantly affected by sudden turbulence in social conditions, whether related to natural or political disasters, leading to the creation of temporary shelters such as refugee or migrant camps. These centres, especially in the Global South, often bear a resemblance to suburban slums: crowded conditions, inadequate sanitation, limited access to medical care, scarcity of clean water and food, dislocation, multi-ethnic composition and inadequate barriers against disease-transmitting vectors. Globalisation processes mean that the health risks, including infectious disease outbreaks that can occur in these temporary shelters, spread rapidly and their effects, by detaching from any specific country, become unlimited by territory. This happens because, as a result of the technological developments that have characterised the modern age, not only has the number of people travelling increased on an unprecedented scale, but also the speed with which they are able to move from one point of the globe to another has increased. The above-mentioned processes make understanding the urban trends of the 21st century one of the keys to comprehending the phenomenon of post-modernity in which people all over the world, regardless of their country's development status and level of resources, live within a single 'ecosystem of infectious diseases'.

It is important to be aware that what happens at the local level of a distant suburb or peri-urban area reacts to, and at the same time influences, global health risk factors operating at an unspecified distance from that location. The risk of epidemics or pandemics of infectious diseases is increasing for reasons that include: demographic processes that are causing poverty belts to grow on the outskirts of major cities in the Global South; globalisation processes increasing the number of people moving both globally and locally; and the fact that the nature and mode of transmission of diseases is often not well understood by societies, particularly in the Global South, nor properly controlled by governments, particularly in the formal and informal peri-urban settlements commonly associated with processes of expanded urbanisation in developing countries. It remains an open question whether transnational bodies, which are increasingly exerting a decisive influence on the decisions of state bodies of

countries especially those of lesser international importance, will devote sufficient attention to the challenges and health risks associated with the phenomenon of urbanisation, especially the risks associated with infectious diseases.

General insight into the matter

Globalisation

The term 'globalisation' refers to the gradual expansion of the division of labour, market exchanges and links between all human societies on a global scale. This phenomenon results in increasing rates of movement of technology, information, goods, services, capital, and labour on a global scale. One definition states that globalisation is the intensification of worldwide social relations which link distant localities in such a way that local happenings are shaped by events occurring many miles away and vice versa. This process is dialectical in that local events can take a very different turn from the related distant events that shape them [1]. Many metaphors are used to describe the configuration of interconnections associated with the phenomenon of globalisation, the most popular of which is the term network. The term attempts to capture the logic of a decentralised, spreading structure of links and describes the conditions by which separate points, called nodes, are connected to each other through multiple and complex, intersecting and numerous ties. In this sense, a network is a collection of nodes. What a node is - depends on the type of specific networks. Nodes can refer to stock markets and banks in a network of global financial flows. Nodes include transnational corporations, quasi-political bodies, international non-governmental organisations and media corporations in a political network that influences important decisions made by governments [2]. Nodes can also be coca and poppy plantations, laboratories, street gangs and money laundering institutions in the drug trafficking network. In the interesting aspect of the global public health network where the nodes are global, regional and national public health institutions, specialised public health centres in epidemiology, infection control and biomedical sciences, it is significant that health threats are also being globalised, the effects of which, by being detached from any particular country, become unlimited by territory. It is also interesting to note that the phenomenon of globalisation also increases various forms of risk perception. Thus, the globalisation of risk in terms of intensity can be associated with the sense that a future war using nuclear weapons could threaten the survival of all humanity, and the globalisation of risk in terms of an increasing number of accidental events that affect everyone, or at least a large number of people on the planet, can be associated with the sense of another epidemic or pandemic threatening humanity.

Urbanisation

The concept of urbanisation is nowadays associated with terms such as 'urban revolution' or 'great displacement of nations'. Based on this assumption, it can be assumed that urbanisation is a global process of economic, social and cultural change leading to the development of urban infrastructure and thus an increase in the population of urban areas. This phenomenon means that we are currently witnessing a phenomenon of global urbanisation, which is based on the expansion of infrastructural networks and human settlements [3]. An important element of this process is the slow integration into the urban orbit of rural migrants who have long maintained their previous lifestyles in the vast 'poverty belts' taking shape on the outskirts of large cities, which is particularly evident in the countries of the 'Global South'. This term has replaced the pejoratively sounding 'Third World countries' or 'developing countries', causing the term 'Global North' to be used to describe rich countries, as they are mostly located north of poorer countries, referred to as the previously mentioned 'Global South'.

According to data quoted by Szymańska, although the world population increased by 30% between 1800 and 1850, and by 110% between 1950 and 1993, during the same period the urban population of the world increased by 175% and 295% respectively [4]. This means that since at least the 19th century, we have been living in a period of urbanisation, which has resulted in several countries in the world now having urban populations close to 100% of the total population — for example Monaco, Singapore, Qatar, Kuwait and Malta. The year 2008 went down in the history of urbanisation as the year in which, for the first time, half of the world's population lived in urban areas, and forecasts predict that by 2050, two-thirds of the world's population (6.5 to 7.0 billion people) will be inhabitants of cities. The phenomenon of urbanisation can be seen in both the countries of the Global North and the Global South.

In the first case, taking the United States of America (USA) as an example, over 70% of the population was living in urban areas as early as 1960. Today, more than 80% of Americans live there – and forecasts assume that this percentage will be 85% by 2025 and 90% by 2050 [5].

Even more intensive urban population growth is predicted in the countries of the Global South, which are expected to absorb more than two billion new residents by 2050. Of particular interest are African cities, whose population will in some cases grow twice as fast as any other urban population in the world. By the middle of the 21st century, the urban population in sub-Saharan Africa alone is expected to quadruple, bringing 1.15 billion new city dwellers, whereby it should be mentioned that sub-Saharan Africa has remained the region with the fastest growing population since the 1980s [6]. The way areas of the Global South, including Africa, are preparing for their urban future will have far-reaching social, economic and environmental consequences – not

only for the individual regions, but also for the world, as the rapid pace of urban expansion in these regions is already depleting the capacity to adequately plan, design and implement a sustainable urbanisation model at both national and local levels.

The urbanisation process in Poland after the Second World War was also extremely dynamic and marked by an accelerated pace as a result of the country's industrialisation and socio-economic transformation. Between 1950 and 2000, the proportion of the urban population in Poland increased from 42.5 per cent to 61.8 per cent, turning Poland from a country with a predominantly rural population to one with a clear urban predominance over the course of fifty years [7]. The peculiarities of Polish urbanisation were primarily a consequence of the pursued model of the country's industrialisation, at the expense of profound neglect in technical and social infrastructure. Hence, urbanisation in Poland up to the mid-1980s is sometimes referred to as 'flawed' and its course as clearly abnormal. It can be asserted quite unequivocally that also in the following years the urban layouts built by zoning, promoted by the modernists and rejected by their successors, were still being created [8] in Poland which means that in certain aspects the situation of Polish cities still does not have much in common with the principle to plan the construction of new settlements taking into account broader needs than just providing a 'roof over one's head'. Instead of access to services, including health, education or culture, we have suburbanisation – which, as the prefix used in the name suggests – is a kind of sub-standard, incomplete city, consisting of megamalls, office zones, crowded transport arteries, gated communities and a neglected environment [9].

It is obvious that the reactions associated with the phenomenon of urbanisation cannot be brought down to a struggle against cities in general, as a civilisational phenomenon. This would be tantamount to a Luddite [10] desire to halt or set back civilisation, which bears no relation to actions based on logic. One has to accept that the functioning of the current world is based largely on the urban economy, especially as it is assumed that in 2025 around 65% of the world's GDP will be generated by the world's 600 largest cities [11], and that this phenomenon, as can be easily guessed, will further drive the process of more rapid urbanisation.

Our interest in increasing urbanisation is due to the fact that the rate of urban population growth, particularly evident in the case of large metropolitan areas, is significantly surpassing the rate of overall globe population growth. This is an important phenomenon, especially in the view that the future of global health is urban health [12] and studies on health in the built environment show that the health of people in urban areas tends to be worse than those who live in less urbanised areas – a disparity referred to as the urban health penalty [13], but also point to certain features of urban life that are beneficial to the health of their inhabitants. Better health facilities and resources, easier access to health and social services, are urban assets that enable faster responses to a new threat and strengthen the ability to stop the spread of infectious diseases [14].

Travel and population movements.

As a result of increased globalisation processes, people are now moving on a scale that has never been seen before. In 2016, European airports handled 2 billion [15] passengers and the number of international travellers symbolised by Bauman's 'tourist', in 2019, has been estimated at 1.4 billion [16]. Although the COVID-19 pandemic and associated restrictions caused a temporary reduction in travel, international tourism has already seen a 182% increase in January-March 2022 compared to the previous year [17]. Nomadic families [18], which often change their place of residence due to the work of one or both parents, are also contributing to the increase in population movements. It is also estimated that in the 1990s around 70 million people, mainly from countries in the Global South, were already working legally or illegally in other countries [19]. In the pre-COVID-19 pandemic period, in 2015 alone around 2 million people in the European Union were posted to work abroad of their own country [20]. The phenomena listed above do not cover all reasons for movement. Travel related to professional activities, e.g. military personnel taking part in international missions or manoeuvres, and recreational travel are only part of the reasons for people moving. Individual or group travellers can be refugees, immigrants, students and pilgrims. Travel can also take place over shorter distances, and here too the increase in daily spatial mobility is huge. Research supported by the business platform Statistica has indicated that the global average daily driving distance for passenger cars is 25 - 50 km [21]. An important part of the mobility trend are also journeys whose causes are less recognised in the general public consciousness. A businessman saying 'When are you going to be in Dubai?', the lunches for which people from the world of show business travel down Sunset Boulevard, the scientists travelling across continents to present a fifteen-minute slide show in a conference room – this is not just about tourism, gastronomy or scientific activity. They all need, just as people did centuries ago, to see the eyes of their colleagues and enemies in order to confirm and update the foundations of trust and, by meeting them, maintain collegial credibility [22].

Lastly, one cannot fail to mention the travel-related information provided by studies of the long-term evolution of the transport system. They indicate a characteristic sequence of change, with faster modes of transport replacing slower ones. This pattern of change has been shown to be the same not only in different countries, but also in different economic systems. This means that not only is the number of people travelling increasing, but the speed at which they are able to travel is also increasing.

Detailed discussion

Health risk analysis

Challenges of urbanisation

Among the challenges found in the urban spaces of the Global South countries [23] (though of course not only in the Global South) are: the increasing rate of unemployment, particularly affecting the youth, the development of the informal economy, the inability to generate a middle class and the growth of gated settlements, a factor that exacerbates the development of segregated urban populations. Slums, known as bustees in India and favelas in Latin America, which are home to between 800 million and 1 billion people, are a significant problem. 62% of the urban population in sub-Saharan Africa lives in slums, 43% in South Asia, 37% in East Asia and 27% in Latin America and the Caribbean [24]. Slums are particularly prominent in Africa's large metropolises – it is assumed that 60-70% of the population in these cities are slum residents, with many lacking access to clean water, sanitary facilities and other basic services [25]. The situation associated with the unequal, both socially and spatially, distribution of the weight of ill-health is reflected in the so-called 'urban poverty penalty', linked to the formation of low-quality living environments [26]. The importance of this issue has led to increasing claims that health disparities arising as one of the effects of unsustainable urban development require decisive action [27].

Expanded urbanisation and the spread of infectious diseases

The assumption that rapid and intensive urbanisation associated with urban population density is a factor favouring the spread of infectious diseases [28] is nothing new, as is the judgement that rapid urban sprawl and expansion is very likely to lead to outbreaks of infectious diseases. The opposite is supposed to occur in cities shaped in a planned way, with a stable population, where the incidence of infectious diseases is assumed to decrease [29]. Current processes of urban expansion, especially those referred to as expanded urbanisation, are linked to the reorganisation of the global urban periphery. It involves the movement of populations to the urban outskirts and the creation of new central points (jobs, infrastructure, density) away from the traditional urban core. In many parts of the world, especially in areas of the Global South, peri-urbanisation is the preferred term for extended urbanisation, whereby the term 'peripheral' can also refer to structures erected by informal communities, a characteristic part of urbanisation concerning refugee settlements or mining camps near urban centres. The phenomenon of peri-urbanisation can be described as the location of economic and residential structures in an intermediate space between the countryside and the city, where the price of land is relatively low and legal regulations are imprecise. Although the areas surrounding cities may suffer the worst consequences of their development, such as crime, poverty, pollution and environmental degradation, they offer the chance to find shelter and employment. The influx of migrants into existing urban centres results in a change in the epidemiology of infectious diseases that are already present in the cities. Many newcomers are characterised by a lack of adaptive immunity to these diseases. This circumstance, combined with a reduced standard of health care for the migrant population, makes newcomers more susceptible to infections and their more severe course.

Expanded urbanisation, associated with rapid urban expansion, may also expose suburban and peri-urban areas to higher levels of biodiversity and associated disease sources than in other urban zones [30]. The new and expanding urban periphery is the place of particular prevalence of diseases that cross the species boundary between animals and humans (zoonoses), and it is also in these areas that new disease vectors can emerge. The situation in peri-urban areas is influenced and will continue to be influenced for the foreseeable future by sudden turbulence in social conditions, whether related to natural or political disasters, which lead to temporary living conditions, such as refugee camps and other temporary shelters that create conditions for the emergence and spread of infections. The above mentioned places of temporary residence, especially in countries of the Global South, often bear a resemblance to suburban slums: crowded conditions, inadequate hygiene, limited access to medical care, scarcity of clean water and food, dislocation, multi-ethnic composition and insufficient barriers against disease-transmitting vectors. An example is the situation that developed after the movement of 500 000 - 800 000 refugees from Rwanda to Zaire in 1994. Nearly 50 000 people died in the first month as epidemics of cholera and bacillary dysentery swept through the refugee camps [31].

The impact of urbanisation on public health – what is changing?

So far, most of the discussion on urbanisation and, more specifically, on the links between expanded urbanisation and health/disease has focused on the increase in chronic diseases associated with urban lifestyle [32]. The top of the risk list typically includes obesity, cardiovascular disease, diabetes and problems associated with mental health disorders. Although much has been written about the impact of urbanisation on the development of urban lifestyle disorders, too little attention is still paid to the impact of the effects of rapid urbanisation on the development of various 'extreme populations'. The use of addictive psychoactive substances, alcoholism, instability and vulnerability to family breakdown, as well as poverty [33,34,35] increase the chance of HIV-induced immune suppression occurring on a mass scale, resulting in a relative increase in the infectivity of endemic pathogens. To illustrate this phenomenon one can look at people infected with mycobacterium tuberculosis who generally have a less than 10% risk of developing the disease, which becomes 21-34 times higher when co-infected with HIV. This has resulted in the tuberculosis epidemic accompanying the HIV/AIDS

epidemic in many areas of the world [36]. Other examples of such situations are cases of prolonged SARS-CoV-2 infection and the associated production of new viral variants in people with advanced acquired immunodeficiency syndrome and failure of antiviral treatment [37] having a devastating effect on their health and increasing their risk of spreading the infection. In this way, cities, and especially those areas affected by the worst consequences of their development, become home to dynamic systems in which social, biological and technological processes combine in ways that allow pathogenic microorganisms to exploit new ecological niches. Furthermore, the particular socio-political relations and spatial arrangement of expanding peri-urban regions strongly influence the fact that the biodiversity of animal and plant species, which are reservoirs of pathogenic microorganisms that previously lived in their natural habitat and are now becoming elements of the urban ecosystem, increases significantly [38].

The effects of intensive urbanisation arouse understandable worldwide interest. In addition, given that many areas of the Global North are facing similar problems as countries in the Global South, the phenomenon of urbanisation is becoming a global challenge. However, it appears that most countries in the Global South are far less well equipped to solve the problems and thus prevent the deterioration of the mental and physical well-being of their citizens [39].

Many studies on the topic of health challenges related to urbanisation have used the concept of 'epidemiological transition' as a starting point, i.e. the assumption that in the Global North, in industrialised societies, more individuals are living well into old age, resulting in an increased prevalence of chronic diseases accompanying old age, as opposed to infectious diseases. This trend is probably related to the theory of the 'epidemiological transition' according to which, developed societies have undergone a health transition resulting in infectious diseases no longer being considered as major causes of mortality and morbidity [40]. Such views have led one prominent US physician to publicly state: it is time to close the textbooks on infectious diseases and direct all attention to chronic diseases, such as cardiovascular disease.

However, recent events indicate that this opinion needs to be corrected as a result of the outbreak of infectious diseases [41], many of which were previously endemic but have now been observed to be expanding. In addition to HIV/AIDS, there are new pathogens that are threatening health security, such as the Ebola virus, which causes haemorrhagic fever, the dengue virus and new strains of the bacterium that causes cholera [42]. An important problem is the viruses responsible for influenza epidemics, including avian influenza, caused by certain strains of H5 and H7 subtypes of influenza A virus in the years (2003-2009), swine influenza, caused by strains of H1 and H3 subtypes of influenza A virus (2009-2010), the SARS (severe acute respiratory syndrome) epidemic (2002-2003) and subsequent SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) epidemic, which became pandemic in nature [43].

The re-emergence of infectious diseases at the beginning of the 21st century was the catalyst for work on the new International Health Regulations (IHR), which were adopted by the WHO in 2005. The approach adopted therein differed significantly from the earlier regulations, which originated in the 1960s, and was based on the concept of public health emergencies of international concern, instead of the previously closed list of quarantine diseases [44]. This change enables us to build readiness to identify the emergence and early response to new pathogens. In the years that followed, many pathogens were recognised by the WHO (at least temporarily, as was the case with the Zika virus, for example) as being a public health emergency of international concern. Unfortunately, despite the passage of time, many countries have still not fully implemented the provisions of the IHR [45], which prevents an effective response to emerging threats. The current IHR system has little power to ensure governments comply with their responsibilities or report accurately, which was evident during COVID-19 pandemics. This situation caused a discussion whether a similar organisation should be formed under the auspices of the United Nations (UN).

The literature lists several key factors influencing the emergence and spread of infectious diseases that have been identified by various urban studies. These interrelated elements are population mobility and demographic changes, infrastructure and urban governance. Of course, changes in customs, worsening access to healthy food or climate change can also be mentioned, but the key factors listed above are the most frequently mentioned factors in studies on the links between urbanisation and infectious diseases and are closely linked to processes of expanded urbanisation [46]. At the same time, the assessment of urban risk factors shows that urban sprawl, caused by the migration of people to urban areas, is not in itself as significant a problem as the lack of appropriate urban planning policies and the creation of necessary infrastructure in rapidly growing and expanding settlements [47]. Research findings also indicate that at least one aspect of the built environment is detrimental to health, and that is living in sprawling suburban neighbourhoods [48]. For this reason, it is important for the health of communities and individuals not only to know whether they are in rural or urban areas, but also where in the world and in which urban region they are located and how these particular areas have changed and continue to change in relation to their natural and social environment.

If urbanisation is one of the most important global trends of the 21st century, and all signs point to this being the case, then urbanisation in the countries of the Global South, and how urban growth is occurring in these areas, is, in combination with the increasing mobility of the world's population, one of the most important factors

affecting global public health. Especially since an increasingly important part of the present is the growing inequalities in the wealth sphere and therefore in living conditions both at the level of individual citizens and at the level of countries, especially when considering the division between the Global North and the Global South. The risk of epidemics or pandemics of infectious diseases, which are rapidly evolving, is also increased by the fact that the nature and mode of disease transmission is often not well understood by societies in the Global South in particular, nor properly controlled by governments, particularly in the informal peri-urban settlements commonly associated with processes of expanded urbanisation in these countries. An additional factor that should also be noted is the ability of individual governments to respond to emerging health issues in their societies. The period in which the sovereignty of state institutions was sanctioned by the Treaty of Westphalia, as a result of which states gained independence from any other authority in their relations with other subjects of international law and self-governance in the regulation of their internal affairs is fading into oblivion[49]. Nation-states, especially the less internationally important ones, still officially perform their main functions, but they are nevertheless progressively more constrained in their decisions by the replacement of state power by the power of global markets and transnational co-governing institutions [50]. This situation means that the decisions of the highest state bodies are more often than not merely an adaptation to external trends, regulations, expectations or pressures exerted by transnational bodies [51] also on matters relating to health challenges and threats, including those related to infectious diseases.

Studies of living conditions in contemporary society reveal a particular similarity between the consumption of a multitude of goods, including the good of mobility, fuelled by aggressive marketing, and aggression; both phenomena are nowadays becoming equally pointless and unpredictable [52]. People are travelling with increasing frequency and modes of transport are becoming sites of infection, even on an epidemic scale. When travelling, people of all origins are confined and forced to stay in close proximity to each other for hours or days at a time, to then disperse to many distant parts of the world. These temporary places of residence, passenger lounges, jumbo jets or ocean liners, are sometimes places where micro-organisms are spread via contaminated surfaces or water and ventilation systems (as happened, for example, with *Legionella pneumophila*, food-borne infections) or create conditions conducive to the transmission of disease directly from person to person (influenza, tuberculosis). However, in order to determine the epidemiological consequences of such travels, it is necessary to take into account how many stops the infected traveller has made along the way, how many different ecosystems he has visited during his journey and how close he has interacted with the people he has met along the way. The distance travelled becomes less important than the differences in biological life in the areas he reached and the susceptibility and vulnerability of his organism to pathogens [53].

When examining the health situations prevailing in the urban space of any part of the world, it is important to be aware that what is happening at the local level of a specific suburb or peri-urban area quite probably reacts to, and at the same time influences, social, political and also health events happening at an unspecified distance from that place. The effects of the events do not necessarily prove to be – and usually do not turn out to be – a set of changes leading in the same direction, but involve contradictory tendencies. The growing prosperity of an area on one continent may, through complex networks of global interconnections, causally combine with the deterioration of living conditions in some conurbation elsewhere on the globe, whose products are no longer competitive on world markets and whose expanding ‘poverty belt’ creates the conditions for the emergence of infectious disease outbreaks.

In conclusion, it is fair to say that understanding 21st century urban trends is not only one of the keys to the notion of post-modernity [54] processes but also the key to the art of improving collective health [55]. Adopting a ‘public health perspective’ on values and attitudes towards social phenomena and realities, and the necessary approaches to be adopted, seems to be one of the main challenges of the current era, in which people all over the world, regardless of their country’s development status and level of resources, now live within a single ‘infectious disease ecosystem’.

Recapitulation

How to make cities resilient to epidemics?

In the perspective of further planned and controlled urbanisation, the node leading to the remediation of cities of the future is the achievements of modern epidemiology, including molecular epidemiology. There is growing evidence that inappropriate exposure to the diversity of the microbiome in urban environments plays a significant role from birth through the development of non-communicable diseases accompanying unhealthy ageing to premature disability and death. The industrialisation of food processing with massive use of antibiotics and the sanitisation of the urban environment are bringing noticeable changes to the symbiotic microbiota. This opens the way to a new human - the ‘Holobiont’ of the future and diseased urban populations. Metagenomics and other -omics are shedding light on the relationship between human-associated and independent, environmental microbiomes. The microbiome of urbanised environments are microbes associated with urban structures: homes, offices, public buildings (including schools), public transport, water treatment plants, etc. The theory of hygiene leading from the ‘Corpus Hippocraticum’ (5th-4th century BC) is living up to its slow transformation in our minds. Hygiene and ‘barrier thinking’ were an indispensable part of humanity's fight against epidemics,

including the COVID-19 pandemic. They allowed the spread of SARS-CoV-2 to be delayed until vaccines were introduced and immunization by vaccination or natural contact was achieved to such an extent that the virus no longer causes mass fatalities. However, in the Chinese population, protected for a long time by an active zero-tolerance strategy to exposure to the virus, it is currently taking its toll with delayed effect.

We are reluctantly beginning to accept the presence of a diverse microbial world. Removing all microorganisms from the environment does not protect us from pathogens and is not the best 'hygienic' approach. Rooke's 'Old Friends' hypothesis implies planned and controlled exposure to microorganisms in early childhood to immunomodulate and build a diversified and beneficial commensal microbiota. We can achieve part of this immunomodulation through vaccination. In the next human era, the 'Symbiocene' according to Glenn A. Albrecht will encompass the essence of the interdependence of all animate beings.

How can these theories be translated into attitudes in urbanisation ?

Ensuring important interactions with environmental microbiota is the basis of the Microbiome-Inspired Green Infrastructure model. According to the model, spaces should be transformed to ensure the presence of vegetation, animals and microorganisms that provide appropriate immunomodulation. The use of microorganisms in the bioremediation of wastewater and anthropogenic gases (methane) is one of the first steps in this direction. Methanotrophic bacteria can be added to cover organic waste in landfills. Changes in the architecture of urbanisation spaces should include metagenomic and metatranscriptomic data regarding human-microbial interactions, oriented towards improving public health. Green areas with appropriate biodiversity, restoring indigenous species; green barriers and roofs, rain gardens; hedgerows and roadsides; flower meadows; animal paths will provide microbiota with dynamic diversification, providing immunomodulatory biomolecules to a dysbiotic urban environment. Environmental sensor technologies can improve ecosystems by monitoring air and water purification but also soil regeneration, spreading of seeds and pollen of important plants. This idea of 'restoring wildness' to the human environment is in apparent contradiction to the well-established practice of hygienisation. The approach is changing from avoidance to tolerance. Contact with nature is supposed to promote overcoming allergies, as well as immunological, psychological and social resilience.

However, does this not increase the risk of contact with zoonotic pathogens and 'spillover' of the epizootic? After all, all pandemics of recent centuries have been of zoonotic origin and we attribute the long-recurring outbreaks of EVD – a disease related to Ebola virus, avian flu, swine flu or COVID-9 – to their spillover from the environment of e.g. fruit bats and transmission to humans via the animal reservoir of intermediate hosts (poultry, pigs, civets, horses, pangolins and even camels). Nevertheless, according to recent Global One Health hypotheses, humans are participating in the circulation of the newly emerging pathogen on an equal footing with animals hitherto considered to be the 'natural reservoir' and intermediate hosts. This changes the paradigm for tracking newly emerging epidemics. We should set the radar on detecting anthropomorphic loops of amplified transmission of the new pathogen in humans (including primarily in urban rather than rural areas) and not mainly on fencing off animal reservoirs, including through so-called sanitary carnage.

Studies of the microbiome of underground railways in cities are being carried out. Interestingly, the underground in each of the cities studied has its own bacterial 'fingerprint'. This is also interesting from the point of view of forensic techniques. Unfortunately, passengers during their journey acquire many carriers of genetic information that are useful to microorganisms in the development of multidrug resistance. Adequate ventilation, non-adhesive surfaces and their cleaning as well as monitoring are the technological challenges of the future of mass transport.

Hospital hygiene practices and high frequency of antibiotic therapy lead to selection pressure on hospital microbiota and selection of microorganisms resistant to both antibiotics and disinfectants, creating a so-called microbial resistome. This leads to an increase in nosocomial infections. It appears that properly promoted microbiota can form an 'immune system', reducing the accumulation of opportunistic pathogens in hospitals. Isolation rooms should remain pathogen-free, other hospital spaces should be designed for controlled microbial accommodation. Introducing plants and aeration recover biodiversity. More precise interventions include regaining biocontrol of microbiota by introducing non-pathogenic *Bacillus* spores. Detergents containing probiotic spores (e.g. Probiotic Cleaning Hygiene System, PCHS) competitively suppress nosocomial infection pathogens by 90% (*Staphylococcus* spp., *Enterobacteriaceae* spp., *Acinetobacter* spp., *Mycetes*, *Pseudomonas* spp., and *Clostridium difficile*). PCHS exhibits a restriction effect on resistance genes, and – enzymatically – reduces the presence of fungi and viruses (e.g. HCoV-229E, SARS-CoV-2, HSV-1, influenza type A, modified vaccinia ankara virus).

Some practical solutions of future in the management of an infectious disease risk posed by urbanisation

Disinfectants that selectively manipulate the microbiome are one of the conceptual branches of the new hygiene of urban spaces, which includes the previously mentioned microbiome-inspired green infrastructure to help regenerate nature, preserve and improve biodiversity. Greener cities and more contact with nature are supposed to be a remedy for autoimmune and non-communicable diseases, known as civilisation diseases. Smarter mass transport systems and changes in architecture will reduce the spread of multi-drug resistance genes and introduce beneficial environmental microbiomes. Smart monitoring technologies will allow us to anticipate microbiome

perturbations and the emergence of new pathogens and inhibit future pandemics. These innovations, while catchy, require careful scientific validation in real-world conditions, as well as social and political acceptance.

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