Toward healthy and liveable cities: a new framework linking public health to urbanization

Chao Ye1,2, Patrick Schroder3, Dongyang Yang4, Mingsingh Chen5,*, Can Cui6 and Liang Zhuang2,∗

1 Department of Medical Psychology, Second Affiliated Hospital of Naval Medical University, Shanghai 200003, People’s Republic of China
2 Key Laboratory of Geographic Information Science, Ministry of Education, & School of Geographic Sciences, East China Normal University, Shanghai 200241, People’s Republic of China
3 Chatham House, Environment and Society Programme, London SW1Y 4LE, United Kingdom
4 Key Research Institute of Yellow River Civilization and Sustainable Development, Henan University, Kaifeng 475001, People’s Republic of China
5 Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, People’s Republic of China
6 School of Urban and Regional Sciences, East China Normal University, Shanghai 200241, People’s Republic of China
* Contributed equally.
* Authors to whom any correspondence should be addressed.
E-mail: chenmx@igsnrr.ac.cn and zhuangbetter@163.com

Keywords: sustainable urbanization, public health, healthy China, liveable cities, space

Abstract

Urbanization and public health are becoming intertwined together with global natural and social changes. As recommended by the Tsinghua-Lancet Commission on Health Cities in China, cities hold the key to a healthy China. However, China is facing enormous health risks and challenges stemming from rapid and unhealthy urbanization patterns, which are still dominated by centralized planning for large-scale spatial extension and industrial production facilities. We propose a new conceptual framework to explain the evolving relationship between urbanization and public health, from a spatiotemporal perspective. Healthy China should be given a strong focus on healthy urbanization, wellbeing, and sustainable development. To achieve this objective, we explore the potentials of the concept and approaches of liveable cities to complement the deficiencies of the current centralized planning approach of urbanization. Furthermore, to make the concept of Healthy China operational for policy and urban planning, we propose a set of indicators that can be applied together with the spatiotemporal framework to assess the health and livability of cities.

1. Urban habitat and potential health risks

Theoretically, urban areas are habitable by offering better living conditions, including medical facilities, income, education, and public services [1–3]. While, complex urban habitat often lurks health risks. First, urban environmental pollution with chemical, biological, and physical hazards can directly cause health illness, even malignant diseases. Related health risks are common in many cities or regions across the world [4–6]. Thus, scholars often appreciate health risk assessment of soil, water, and air pollution [7–10]. Second, social determinants are considered to be related to communicable and non-communicable disease. Unhealthy occupational activities, economic inequality, life stress, and many others, can trigger neuropsychiatric or mental diseases and other non-communicable chronic diseases, such as diabetes and cardiovascular disease [4, 11–13]. Third, studies have documented that dense populations are positively related to incidence of some infectious diseases or epidemic disease, such as hand, foot and mouth disease and bacillary dysentery [14, 15]. Urban is a concentrated and crowded space of population, which will be conducive to disease transmission and increase incidence of infectious disease inevitably. Besides, urban limited green space, inactive travel modes (such as vehicles), and other similar features greatly reduce physical activity, which would further result in decrease in physique and immunity, obesity, and even mental illnesses [4, 16, 17].
2. ‘Healthy China’ strategy and urbanization in China

During the 19th Party Congress of the Communist Party of China on 18 October 2017, President Xi Jinping put forward the ‘Healthy China’ strategy, indicating an important turning-point in national development by putting health at the centre of individuals, communities, cities and the whole country [18]. In their comprehensive review, the Tsinghua-Lancet Commission on Healthy Cities in China provided a thorough assessment and concluded that 'key efforts are needed to combat urban health challenges in China and these should be unified with the Healthy Cities movement’ [19]. Urban health issues in the 21st century require a wider systems perspective and approaches that address causes of poor health, rather than simply providing medical treatments for symptoms. As the world and China are increasingly becoming urbanized and interconnected, the link between sustainable cities and health becomes more important, which requires considering citizens' well-being, education, sustainable lifestyles and alternative urban development pathways [20, 21]. China is already facing enormous challenges stemming from rapid urbanization [22, 23]. To achieve the aim of Healthy China, it requires to rethink its urbanization path going forward.

Urbanization was accompanied throughout by strong characteristics of industrialization in China. Prior to China’s economic reform, the central government of China had developed ‘prioritize the development of heavy industry’ as a national strategy, which produced massive contaminated land areas in many cities today [24, 25]. The economic reforms in the 1980s advanced urban development impressively and sent urbanization into a new stage of rapid development [26]. Industry with important roles in powering economic growth and urbanization were often favoured by governments, and China witnessed rapid and massive industrial land expansions in urban areas [27]. Coexisting with rapid growth in industrialization, which is extensive resource intensive and highly energy-consuming, Chinese urbanization led to massive environmental pollution and damage. Furthermore, health risks, such as the non-communicable disease incidence rates, related to environmental pollution increased markedly in recent decades [5, 28]. Especially, worsening ambient air pollution is contributing to rising medical costs and consumers' spending on protection against exposure. Not all citizens are affected equally: there is evidence showing that socio-economic inequality, means to afford protection and levels of exposure to air pollution are linked, with lower income groups disproportionately affected [29].

On 17 April 2018, The Lancet published an invited paper titled ‘The Tsinghua-Lancet Commission on Healthy Cities in China: unlocking the power of cities for a healthy China’. This review suggests a direction for a healthy China that unlocking the power of cities addresses a series of health challenges caused by China’s rapid urbanization [22]. Simultaneously, Summerskill also highlighted that healthy cities are the key to China's healthy future [30]. These latest research findings are conscious of the importance of urban development for a healthy China and provide important recommendations such as integration of health into all policies, increase participation and target setting by cities. China’s urbanization, if following business-as-usual development, will continue to show a posture of accelerated development, which will further drive energy consumption, environmental pollution, and negatively affect public health. The challenge will be to operationalize a healthy China through a new type of urbanization.

3. A new framework about relation between urbanization and health

Urbanization is a spatiotemporal dynamic process of industrial structural transition, urban space expansion, and urban population increases within the urban–rural territorial systems [31, 32]. Understanding the relations and interactions between urbanization and health is essential to discover how health risks are generated during the process of urbanization [33, 34]. Although researchers have noted the interaction between urbanization and health [4, 22], the real connections between urbanization and health are ambiguous and not fully established due to the lack of integrated spatiotemporal analysis. We propose an ‘Urbanization-Health Process’ conceptual framework to better explain the evolving relationship between urbanization, space and health from a cyclical perspective (figure 1), which can provide a more systematic guide for empirical analysis and inform policymaking that can avert medium and long-term health implications of urban spatial planning processes.

Based on elements of this conceptual framework, urbanization, space and health can be integrated into an interacting process and divided into three interconnections with various feedback loops. And every element is embodied in three aspects, each of which corresponds one by one and collectively contributes to a reciprocating closed path. Using this framework, we describe the links and relationships between urbanization consisting of industrial transitions, land expansion and wellbeing of people. The health dimension is divided into pollution sources, carriers and sufferers, which correspond to three aspects of urbanization respectively. Whilst their interrelations might be underlying and indirect, insights from this cyclical perspective can help identify the reasons and how specific aspects of urbanization induce negative health outcomes through changing spaces. The three aspects of urbanization generate different spatial dimensions: industrial parks, land expansion...
and residential sprawl, which produce various pollution sources (including stationary and non-stationary sources), pollution carriers and pollution sufferers. We emphasize the need to focus future analysis on the pollution sufferers (i.e. people), especially vulnerable and marginalized groups with higher exposure risks. Under different stages of rapid urbanization, health impacts can emerge at any time in urban spaces ranging from short term (less than 1 year), over medium term (1–10 years) to long term (over 10 years) [35–37]. This framework also allows us to understand the feedback between various health consequences and urbanization across different space-scales, including many places of urbanized or non-urbanized areas, which are so far little understood. For example, there is emerging evidence of ‘smog migration’, where many highly educated employees and entrepreneurs are leaving polluted cities, not only resulting in negative impacts on the economy and talent loss, but also fuelling a building boom in China’s southern provinces such as Yunnan and Guangxi [38], with so far unknown consequences of human health and impacts on biodiversity hotspots in these areas.

Chinese urbanization exposes the newly urbanized populations to a polluted environment spatially, with a medium to long-term exposure in time. For instance, cases of chronic bronchitis, premature mortality, and respiratory and cardiovascular hospital admissions are associated with medium to long-term exposure to high concentrations of PM10 in urban areas of China, which has been evidenced already more than 20 years ago [39]. However, these findings have not significantly changed the centrally planned urbanization processes, putting health as a priority on the urbanization agenda has so far not happened. Hence, the increasing risks of public health are corollary caused by rapid urbanization, especially the combination of urban expansion and high-polluting industries. The recent policy measures addressing industrial pollution have been to relocate these industries away from high-density urban areas [40, 41]. However, the effects of these measures are not obvious, as air pollution is caused by multiple factors. Our spatiotemporal framework can be used to understand and design effective relocation policies to ensure that environmental pollution problems and health impacts do not simply shift to new locations.

Since the launch of market-oriented reforms, China’s economy has expanded at a staggering pace over the last four decades. However, the consensus is prevailing that China was adopting the extensive pattern of growth, which is characterized by labour-intensive, investment-led and export-led. Concurrent with extensive growth of the economy, urbanization is taking place in a rapid and extensive way. The number of cities at prefecture level increased from 188 to 334 between 1990 and 2018, and the built-up area increased from $1.22 \times 10^4$ sq km in 1990 to $5.61 \times 10^4$ sq km in 2018. Within the cities, the land expansion, urban sprawl, and large-scale industrial parks are reshaping the spatial structure of the cities [42].

The spatial morphology of cities is extremely shaped by top-down planning, which aims at achieving short-term economic success, but lacks long-term
vision and sufficient argumentation from multiple parties. Since 1990, China has invested massively in industrial parks, which are usually located on the edges of the cities. Among around 1000 industrial parks in China, many are heavy industries and compose main sources of pollution. Industrialization particularly contributes to the growth of oil and chemical industry sectors, motor vehicle utilization and other anthropogenic activities, and consequently increases the amount of energy consumption, such as coal, natural gas, crude oil, petroleum oil and electricity (figure 2). Although many measures for protecting the environment have been adopted, industrial parks are still strong polluters, and some pollution can be carried by the local environment to residential areas. There are substantial evidences showing that persistent toxic substances concentrate in industrial parks, which would incur health risk.

Accompanying the rapid urbanization is land expansion. The conversion of Earth’s land surface to urban uses is one of the most irreversible human impacts on the global biosphere. It affects energy demand, alters the climate, modifies hydrologic and biogeochemical cycles, and reduces biodiversity [43]. Through numerical simulations, Wang et al., revealed that extensive urbanization decreased precipitation considerably over and downwind of Beijing [44]. Based on analysis of impacts of land-use changes on surface temperature in southeast China, it has been found that warming of mean surface temperature of 0.05 °C per decade can be attributed to urbanization, which is much larger than previous estimates for other periods and locations [45]. The environmental impacts of urban expansion reach far beyond urban areas themselves. In rapidly urbanizing areas, agriculture intensifies on remaining undeveloped land and is likely to expand to new areas, putting pressure on land resources [46].

In addition to the scattered large-scale industrial parks, there are large-scale residential neighborhoods emerging in the suburbs. To fully maximize corporate profits, real estate companies usually invest less financially and temporally in design and construction, resulting in low-quality housing, limited green spaces, limited access to health care facilities and other infrastructures important for residents’ wellbeing and health [25]. There has been an explosion of interest in neighborhood health effects, generating fruitful findings. Public buildings, open space, mixed land use, and pedestrian walkways are suggested to be incorporated into high-density neighborhoods to increase physical exercise and enhance civic life. Neighborhoods must be embedded in the existing urban infrastructure to provide larger cultural and business opportunities and reduce reliance on the automobile. Besides the physical environment, social capital in the neighborhood is stressed by Putnam [47]. Compelling evidences are presented that many illnesses, including colds, heart attacks, strokes, cancer, and depression are inversely related to social ties. Neighborhoods therefore need to re-configure to maximize contacts among residents. However, in the course of extensive urbanization as seen in the past decades, neighborhoods can hardly be built with high quality, which will have negative impacts on both mental and physical health of residents in the long run. Some of these negative impacts on citizens’ health and the relationship to urbanization trends are presented in the following section.

4. The evolution of urbanization and the related health outcomes

4.1. Time variation of urbanization

In the past decades, China witnessed a rapid development of urbanization (figure 3). In 2001, the urbanization rate was 37.66%, and reached 59.58% in 2018, with an approximate growth rate of 58.20%. China’s discrepant strategies for economic development in implementing reform and opening-up resulted in obvious region differences in socio-economic development, including urbanization. Early benefit from the reform and opening-up, the eastern coastal region is the most developed and the urbanization
rate is the highest, far higher than that in the central and western region. However, urbanization presented rapid development in all the three regions (figure 3).

The urban built-up area significantly increased during the process of urbanization. The urban built-up area more than doubled from 24,026.63 sq km in 2001 to 56,075.9 sq km in 2018 (figure 4). However, industry, as its important roles in driving economic and urbanization development, often favoured by local governments and also presented fast development (figure 4). For example, the industrial output was 4,385.56 (billion Yuan) in 2001 and reached to 30,216.02 (billion Yuan) in 2018. Undoubtedly, industrial development requires a lot of land and advantageous land and finance policies have promoted the huge number of industrial enterprises continually emerging, which increased pressure on land supply. Local governments had to amend urban planning and expropriate land from suburban rural people frequently to expand urban land [24].

4.2. Time variation of pollution emission and urbanization

However, Chinese cities have seen a dramatic growth in emissions of industrial waste gas, waste water and solid waste (see figure 5), all of which have contributed to worsening urban environments and negative health conditions in Chinese cities. In particular, both industrial waste gas emission and industrial solid wastes discharged are on a rapid upward trend, and the former has increased by 3.3 times in 15 years. While, the urbanization rate is increasing. Thus, there is an increasing population who are being exposed to a polluted, worsening, even poisonous environment. Inevitably, urban residents would suffer health risks related to environmental pollution.

4.3. Urban–rural and regional health outcomes

Serious health outcomes have emerged along with China’s rapid urbanization. Although the direct causal relationship between urbanization and health risks is ambiguous, the comparison of urban–rural
differences in health outcomes supports the argument, to some extent, that the development of urbanization has increased health risks and cities with high urbanization rate are facing more serious health challenges. Figure 6 shows the morbidity of all the chronic diseases and malignant tumors in 2008 according to the statistics of national authority. We can see that big cities have the highest morbidity rates in both chronic diseases and malignant tumors, followed by medium-sized cities. The morbidity was low in small cities and rural areas, where the urbanization rates were often lower than big cities and medium-sized cities.

Figure 7 shows regional and urban–rural differences in morbidity of chronic disease in 2013. The morbidity of chronic disease in urban areas presents a decreasing trend from the eastern region to the western region. The morbidity in rural areas in the eastern region was also higher than that in the central region. The physical environment was quite poor and the socio-economic conditions were backward in the western region, especially in the rural areas, which may contribute to the high morbidity of chronic disease in rural areas in the western region. However, combining figures 3 and 7, we can find that health risks are generally high in regions with high urbanization rate. Of course, a more detailed comparison of results also requires us to consider the differences between urban and rural realities such as diagnosis rates and life expectancy [48].

5. Healthy China based on healthy urbanization pathways—potentials for an approach of liveable cities

The success of the Healthy China strategy will depend on whether a healthy urbanization pathway can be achieved [49]. The past and current pattern of China’s urbanization has been government-driven, characterized by centralized planning for large-scale spatial extension and production, with lack of public participation in urban decision-making processes [50, 51]. The construction of many industrial parks at different levels is compounded by high-speed urban land expansion and large-scale rural migration into cities [40]. The originally scattered rural residential sites and farmland are transformed into highly-centralized
built-up areas. This also extended the range of pollution, making both rural and urban environments become a new carrier of pollutants.

Furthermore, high-impact consumption patterns and consumerist lifestyles are closely associated caused by urbanization, which results in increased domestic sewage, municipal waste and the pollution stress per unit of land. Lifestyles are increasingly recognized as a key determinant of human health [20]. The evidence shows that education on sustainable lifestyles is more important than ever to achieve sustainable urbanization with positive public health outcomes [52]. This is particularly relevant for urban mobility patterns. The increase in private car ownership in cities is not only directly associated with air pollution, but also contributes to unhealthy lifestyles and associated diseases such as obesity and cardiovascular disease, due to reduced physical activity and exercise [53, 54]. Our framework highlights the link between land expansion for road construction, leading to individual motorized transport choices and public health impacts. Again, time scales play an important role in understanding the causal relationship between urban road planning and construction (5–10 years), uptake of private vehicles and transformation of urban mobility patterns (10–30 years) and effects on urban lifestyles (30 years). Various negative health impacts occur across these different time scales.

We believe the concept and approaches of liveable cities can be a useful method to achieve healthier cities in China, complementing the current investment and infrastructure driven urbanization pathway. The concept has its origin in 1985 with the International Making Cities Liveable (IMCL) Conferences which ‘focused attention on the importance of making cities liveable for children first, the need for public transit, bicycle lanes, and traffic calmed streets, for human scale architecture and mixed-use urban fabric, for reviving the city centre and creating public places where people could gather for farmers markets, festivals, outdoor cafes and community social life’ [55]. Furthermore, measures to improve liveability of cities include a focus on wellbeing, a multi-dimensional concept that is receiving increased attention by sustainability researchers, health experts and urban planners to address health issues in high deprivation urban areas [56]. All these aspects of urbanization have received too little attention in recent Chinese urbanization planning and strategy.

There have been international studies on indicator systems such as liveability and public transport sustainability [57, 58]. The ‘Tsinghua Urban Health Index’ is designed to form an index system with five first-level indicators, 16 s-level indicators, and 53 third-level indicators, and tends to benchmark against the latest global concepts at the macro level [59]. However, the specific institutional background and functional mechanism of China’s urban development have not been fully reflected. People-oriented is the key connotation of new-type urbanization and healthy China. Below, we propose a set of liveable city indicators within four policy domains which can be combined with the spatiotemporal framework introduced above. These targeted and concise indicators can be used by policymakers and urban planners to understand the urbanization–health interactions and impacts on people’s wellbeing (see table 1).

The emerging literature on liveable cities confirms that the determinants of liveability, health and sustainability are closely related. To be able to measure liveability in specific urban contexts and in recognition of the interdependence between healthy and liveable urban environments and the sustainability of the natural environment, many liveability indices include environmental sustainability indicators (such as indicators of green space, water and air quality and climate) [58]. These liveable city indicators can support Chinese municipal policymakers to integrate health into urban policymaking set targets for achieving the Healthy China 2030 objectives in
Table 1. Liveable and healthy city indicators.

| Urban policy area                           | Possible set of indicators                                                                                                                                 |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Public open green space                     | Access to and quantity of public open space; variety and quality; frequency of use;                                                                         |
| Natural environment                         | Water and air quality; greenhouse gas emissions; water quantity and conservation; precipitation; climatic conditions; biodiversity;                       |
| Health and social services                  | The distance to and number of health care facilities for a given population; access to various services for older adults; provision of aged-care facilities; the number of hospital beds available; access to: public amenities, child and youth services, and emergency centres; |
| Energy services and public transport        | Population exposed to emissions from energy generation and transport; Disease burden related to energy generation and transport emissions; Quantity of energy/fuel consumed; Share of renewable energy supply/use; Mass of pollutants emitted (e.g. NOx, VOC, CO2); Cumulative opportunity (jobs/activity centres linked by public transport); Walkability in neighborhoods and communities. |

their cities, as recommended by the Tsinghua-Lancet Commission.

6. Conclusions

The most remarkable characteristic and achievement of China's urbanization has been the large-scale spatial expansion at a high speed, which accelerates the realization of the ‘Chinese Dream’ of national rejuvenation based on rapid economic growth in a relatively short period of time. However, what has largely been missing is a focus on health, citizens' wellbeing and liveability of Chinese cities. That is why heavy pollution and high health risks have been almost inevitable, especially in the medium term of urbanization. However, this pattern of urbanization based on land expansion and population agglomeration has proven to be unsustainable and unhealthy. 'Healthy China', as a new national strategy, should include a strong focus on healthy new-type urbanization and cities as cities hold the key to the solution. Meanwhile, if China can start pursuing healthy urbanization focused on physical and mental health and well-being, education, environment and community rather than just spatial and land expansion, healthy China will become an achievable dream for the Chinese people. We propose the above conceptual framework as a suitable framework to further analyse and understand the urbanization-health linkages in China and support implementation of policy decisions to address current imbalances in the urbanization processes and the Healthy China strategy. The indicators and design concept of this study can provide useful inspiration for effectively identifying the liveability or health level of cities in China and other similar developing countries.

Data availability statement

No new data were created or analysed in this study.

Acknowledgments

This work is supported jointly by Major Program of National Fund of Philosophy and Social Science of China (19ZDA086).

Contributors

All authors contributed to the overall paper structure and concepts, and provided input and expertise to all sections. C Y, P S, D Y, M C, C C, and L Z participated in the drafting of the manuscript. Coordination, strategic direction, and editorial support were provided by M C, and L Z.

Conflict of interests

All authors declare no competing interests.

ORCID iD

Liang Zhuang 凑 https://orcid.org/0000-0001-5824-3871

References

[1] Alirol E, Getaz L, Stoll B, Chappuis F and Loutan L 2011 Urbanisation and infectious diseases in a globalised world Lancet Infect. Dis. 11 131–41
[2] Ferreira C, Kalantari Z and Pereira P 2021 Liveable cities: current environmental challenges and paths to urban sustainability J. Environ. Manage. 277 111458
[3] Moore M, Gould P and Keary B S 2003 Global urbanization and impact on health Int. J. Hyg. Environ. Health 206 269–78
[4] Gong P, Liang S, Carlton E J, Jiang Q, Wu J, Wang L and Remais J V 2012 Urbanisation and health in China Lancet 379 843–52
[5] Liu M et al 2017 Spatial and temporal trends in the mortality burden of air pollution in China: 2004–2012 Environ. Int. 98 75–81
[6] Singh G K and Siahpush M 2014 Widening rural–urban disparities in all-cause mortality and mortality from major causes of death in the USA, 1969–2009 J. Urban Health 91 272–92
[51] Zhou S, Dai J and Bu J 2013 City size distributions in China 1949–2010 and the impacts of government policies Cities 32 S51–S57
[52] Li X, Song J, Lin T, Dixon J, Zhang G and Ye H 2016 Urbanization and health in China, thinking at the national, local and individual levels Environ. Health 15 32
[53] Douglas M J, Watkins S J, Gorman D R and Higgins M 2011 Are cars the new tobacco? J. Public Health 33 160–9
[54] Schuster C, Homold J, Lauf S and Lakes T 2017 Urban heat stress: novel survey suggests health and fitness as future avenue for research and adaptation strategies Environ. Res. Lett. 12 044021
[55] Homepage of Ottawa 2017 Ottawa to host International Making Cities Livable Conference in 2018 (available at: https://ottawa.ca/en/news/ottawa-host-international-making-cities-livable-conference-2018)
[56] Yang J, Wu T and Gong P 2017 Implementation of China’s new urbanization strategy requires new thinking Sci. Bull. 62 81–82
[57] De Gruyter C, Currie G and Rose G 2017 Sustainability measures of urban public transport in cities: a world review and focus on the Asia/Middle East Region Sustainability 9 43
[58] Lowe M, Whitzman C, Badland H, Davern M, Aye L, Hes D, Butterworth J and Giles-Corti B 2015 Planning healthy, liveable and sustainable cities: how can indicators inform policy Urban Policy Res. 33 131–44
[59] Vanke School of Public Health of Tsinghua University 2020 The first national urban health big data report ‘Tsinghua City Health Index’ was released (available at: https://vsph.tsinghua.edu.cn/info/1032/1275.htm)