Research Paper

Research on high-density community renewal and design guidelines based on health promotion

a case study of Guangzhou, China

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Abstract

With the growth of population and the acceleration of urbanization, the contradiction between the scarcity of land resources and the demand for extensive space is becoming increasingly acute. The high-density construction of many big cities not only uses land intensively and provides convenient infrastructure, but also causes a series of new public health problems. As population gathering areas in the city, the renewal of high-density communities often encounter the balance between environmental quality and economic benefits. In the context of market economy, it is necessary to promote the implementation of renewal with a higher floor area ratio and construction volume. Therefore, how to achieve sustainable urban density and balance the relationship between population growth and sustainable development has become a crucial issue to be solved. By comparing and discriminating the concept of density, this paper indicates the public health problems caused by high-density development, compares the built environment factors concerned in the current urban design guidelines in the world, and concludes the path of integrating the concept of health promotion into urban planning and design. Finally, the paper puts forward the renewal strategy of high-density community and the optimization strategy of design guidelines to provide reference for the construction of healthy community.

Keywords

High-density communities, Health promotion, Design guidelines, Urban renewal, Guangzhou

1. Introduction

With the transformation of China's urban construction from high-speed development to high-quality development, under the guidance of the "Healthy China" strategy, establishing a sustainable public health system has become an urgent task in the new era (Wang, 2016; Tian, 2016). As early as the 19th century, urban planning was associated with public health. One of the main reasons for the advent of modern urban planning was to address public health issues brought about by rapid industrialization and urbanization, such as environmental deterioration and air pollution (Shi, 2023; Ewing, 2015). Countries around the world have participated in the construction of healthy cities, and through the Global Health Promotion Conference to promote the concept, method and practice of healthy city development (Zhang, 2017; Wang, 2015). In the context of China's rapid urbanization, the characteristics of high population density and high building density often lead to urban problems such as traffic congestion, environmental pollution, housing shortage, and space congestion. Consequently, how to achieve a more healthy living environment through urban planning has become an urgent challenge.

Community is the basic unit of residents' life and urban governance, and the main spatial carrier for residents' daily life, social interaction and access to various services. Community environment has various influences on health behaviors and health outcomes. However, in terms of theoretical research, the complex relationship between built environment and public health has been studied a lot, but its connection with the planning system is not clear. And it is not clear what strategies can be used in planning to produce health benefits. In terms of practical exploration, traditional spatial planning tools are often difficult to implement public health requirements and solve complex environmental health problems. Therefore, based on the current situation of high-density urban development in China, this paper discusses how to integrate the concept of healthy livable into planning, design and community renewal, achieve the balance between sustainable urban development and population growth, and build a healthy livable community environment.

2. Built environment and public health

2.1. Public health problems

The World Health Organization (WHO) has clearly stated that individual health is affected by a combination of many factors, including genetics, residential environment, lifestyle, health services and so on. Human living environment refers to the space where human beings live together, including natural ecology, built environment, social environment and other elements. According to the United Nations report, by 2030, more than 60% of the world's population will live in cities, and the number of megacities with a population of more than 10 million will increase to 43, of which the number of Chinese cities will account for about one-fifth (HABITATUN, 2015). High-density and intensive construction methods can improve urban land use efficiency, which is in line with the basic situation that most cities in China have more people and less land, but too high scale and density will inevitably lead to negative external effects and "urban diseases" (Liu, 2024). The risk of chronic diseases such as obesity, cardiovascular disease and diabetes is increasing year by year, which has seriously threatened people's health (Xiao, 2016). A great deal of empirical research has shown that the increased threat of these chronic diseases is associated to modern urban lifestyles. One of the reasons for the rapid increase in these chronic diseases is people's lack of physical exercise, working too long at desks, and relying on motor vehicles to travel (Liu, 2016).

2.2 Sustainable urban density and high-density communities

The term "Density" is derived from the concept in physics, which refers to the measure of mass within a specific volume, computed by dividing mass by volume. In the field of urban planning, density is often used as a concept to describe the efficiency of resource allocation and Morphological characteristics in the spatial environment (Wu,2014; Li, 2020). Density can help people identify and control the physical environment in the city, and plays an important role in the process of urban development. In addition, the conceptual connotation of density is quite rich, which can be divided into Physical density and Perceived density. Physical density refers to the quantitative description of the concentration degree of people or buildings in a specific geographical unit, which is an objective, quantitative and neutral spatial index. Perceived density refers to an individual's perception and estimation of the number of people, space and layout of an area, and is the result of the interaction between an individual and the external spatial environment (Wu, 2014).

People's understanding of the relationship between density and urban development has gone through a long process. In the mid-19th century, William Farr, the founder of British medical statistics, analyzed the impact of the cholera epidemic in London between 1853 and 1854. He proposed that the spread of

infectious diseases is closely related to population density, and defined high population density in parts of cities as a public health problem. His research was the first to establish a connection between urban density and urban environmental quality (Tian, 2016). At the end of the 19th century, density began to appear in various urban planning concepts as a concept to describe the relationship between people and their living environment. For example, Howard's Garden City concept advocates a decentralized urban layout and pointed to the public health problems that could be caused by the extremely crowded workers' quarters in British industrial cities. He proposed that the population should be diluted horizontally to improve the quality of urban environment, and the optimal population density was 7500 people /km² (HOWARD, 1902). Le Corbusier's Radiant City concept advocates a centralized urban layout, breaking the linear relationship between population density and residential patterns. He proposed that the city should develop in a vertical direction, envisiving a central area with a population density of 80,000 people /km² (LE CORBUSIER, 1967). In the 1990s, governments and scholars of various countries put forward a series of high-density urban development models based on the realistic conditions of suburban sprawl, ecological environment destruction and economic benefit consideration. For example, new urbanism, smart growth, compact city and other development concepts provide new ideas for urban construction. In conclusion, it can be found that the discussion of sustainable density has always been the focus of the built environment and public health. This paper combs the evolution of the concept of density and urban development (Table 1).

Table 1. Density and Urban Development. Source: Self-painted.

Period	Proposer	Planning Concept	Population Density	Main Content and Significance
Mid-19th Century	William Farr	Density and Public Health	Disease spread and population density	Analyzed the impact of the cholera epidemic in London, proposing that the spread of infectious diseases is closely related to population density.
Late 19th Century	Ebenezer Howard	Garden City	7,500 people/km^2	Population density and residential form have correspondence. Concentration implies crowding, decentralization implies livability.
1930s	Frank Lloyd Wright	Broadacre City	625people/km^2	Emphasized individuality in urban settings, opposed to collectivism, expressing dissatisfaction with the modern urban environment, and reflecting the harmony between people and the environment before the Industrial Revolution.
1930s	Le Corbusier	Radiant City	Central area: 80,000 people/km^2	High-density development in central areas using vertical expansion through tall buildings, breaking the linear relationship between population density and residential form.
1960s	Jane Jacobs	Urban Diversity	200 units/acre (173,000 people/km^2)	The vitality and diversity necessary for a livable neighborhood are built on high density. Diversity is the main feature that distinguishes cities from other living environments.
1990s	Andrés Duany	New Urbanism	Eliminate suburban sprawl	Advocated for the creation and redevelopment of rich, diverse, walkable, compact, and mixed-use communities.

The conceptual connotation and defining standards of high-density communities have not yet been unified in academia (Zhang, 2017; Liu, 2024). This is mainly because high density is subjective and relative, and different backgrounds and regions, as well as individuals, can lead to varying definitions of high density. For example, In the UK, if there are fewer than 20 homes per hectare, it's considered low-density development. If there are 30 to 40 homes per hectare, it's medium-density. And if there are more than 60 homes per hectare, it's high-density. In the United States, 25-40 homes per hectare are considered low-density, 40-60 homes per hectare are medium-density, and more than 110 homes per hectare are high-density. In Israel, 20-40 homes per hectare are considered low-density, while more than 290 homes per hectare are high-density (Wu,2014). The variation in judgments and evaluations of high density across different societies, cultures, and individuals creates difficulties in establishing definitive standards for high-density. Different scholars, employing various predictive methods and data, have put forward differing criteria. Finally, this paper argues that high-density communities should exhibit characteristics of spatially intensive construction, highly integrated functions, frequent social interactions among residents, and a compact and intensive design.

2.3. Action path exploring

The relationship between urban built environment and residents' public health is the main issue in the public health field of urban planning and design. A large number of studies have discussed the relationship between urban built environment and public health, and constructed urban built environment index system from qualitative and quantitative perspectives and analyzed its impact on public health. In 2008, Cervero et al. built a "3D" built environment quantification system, including three dimensions: density, diversity and design (Cervero, 2008). Subsequently, Ewing et al. added destination accessibility and distance to transit, and proposed a more complete “5D” built environment element (Ewing, 2010). In addition, many studies have identified pathways between built environmental factors and public health. For example, Wang summarized the role of urban planning elements on public health into three aspects: reducing health risks, providing health facilities and promoting social communication, and constructed a method of integrating public health into the urban planning system (Wang, 2021). In terms of coping strategies, relevant studies mainly focus on four levels: land use, spatial form, road traffic and open space. Based on existing studies and spatial characteristics of high-density communities, this paper summarizes the role path of built environmental factors on public health as follows (Figure 1).

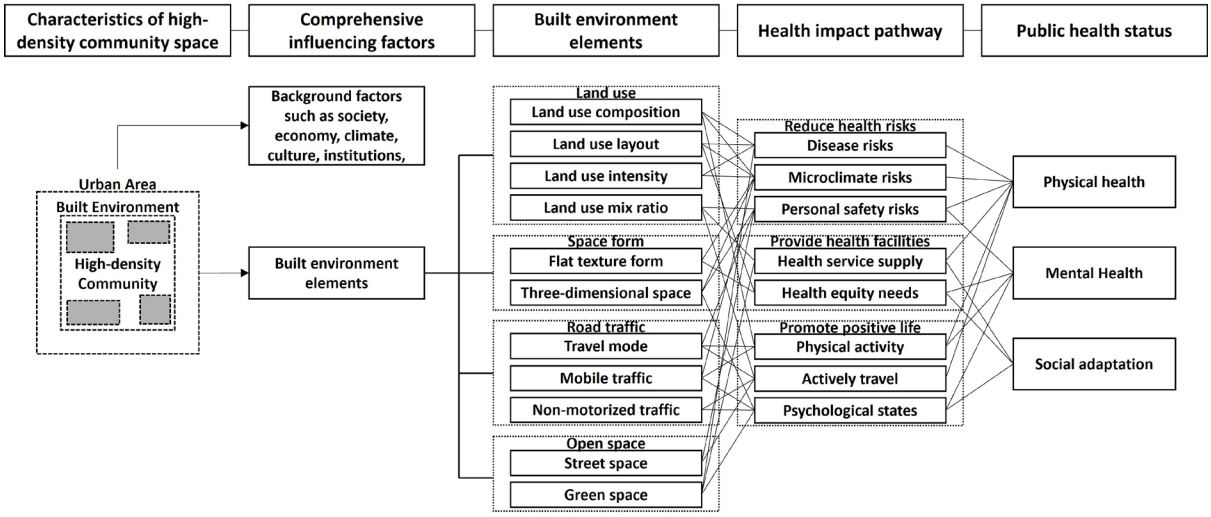


Figure 1. Pathways of built environment on public health. Source: Self-painted.

3. Design guidelines for community based on public health

3.1. Guidelines for the Design of Healthy Communities in the World

Since the 1990s, with the improvement of economic standards and the rapid advancement of urbanization, obesity and related chronic diseases have gradually emerged as significant threats to the health of urban citizens. The urban design guidelines and control indicators originally established were largely formulated based on the construction of new districts during the rapid urbanization phase, with inadequate consideration given to residents' public health (Zhang, 2017). For example, in road traffic planning, existing urban design guidelines do not adequately consider the continuity and convenience of slow mobility such as walking. In the process of planning implementation, when the ecological red line becomes a mandatory control requirement, some ventilation corridors in the city may be compromised for economic development. In this context, various countries and regions began to develop health-oriented urban design guidelines (Table 2), aiming to integrate health concepts into planning and design practices.

Table 2. Guidelines for the Design of Healthy Communities in the World. Source: Self-painted.

Country	Designation	Time	Institution	Content
America	WELL Community standard	2017	IWBI GBCI	Ten dimensions: air, water, nutrition, light, fitness, thermal comfort, sound environment, materials, spirit, and community. Emphasize the inclusiveness, integration, fairness, social interaction, and resident identity of the community.
America	LEED for Neighborhood Development	2018	USGBC	Five dimensions: community site selection and surrounding environment, community planning and layout, green buildings and facilities, innovation, and community superiority. Emphasis should be placed on people-oriented communities, mixed functions, etc.
America	Healthy Communities Policy Guide	2017	APA	It involves multiple dimensions such as healthy living, healthy environment, emergency disaster prevention, healthy food system, and social cohesion.
America	CDC's Healthy Communities Program	2008	CDC	Emphasis is placed on chronic disease prevention and community health promotion, including self-management of health, promotion of physical exercise, and provision of medical services.
Canada	Healthy Communities Practice Guide	2012	CIP	It includes several parts such as health services, social governance, economic development, community planning, ecosystem health, public space, infrastructure, architectural design, food health, healthy society, and health services.
Singapore	The Healthy Living Master Plan	2014	MOH	To achieve a healthy lifestyle by managing the relationship between people (a healthy and socially

				inclusive community), places (favorable environments for healthy living), and prices .
Australia	Victorian Public Health and Wellbeing Plan 2011–2015	2011	Department of Health	A healthy community should aim to promote residents' health and increase community resilience, and form a management system in the planning system that includes problem assessment, planning research, multi-party discussion and participation, planning formulation, and planning implementation.

3.2. The current urban design guidelines and control system in China

As China's urban construction changes from high-speed development to high-quality development, more and more regions compete in urban design competition. These areas hope to improve the quality of urban living environment through urban design. As the controlling and guiding result after planning, urban design guidelines play a guiding role in the subsequent planning implementation. This paper reviews the current urban design guidelines of some provinces and cities in China, and summarizes their index element system. We found that the compilation level of urban design guidelines in various provinces and cities in China is usually divided into 2-4 layers from the overall level to the local plot. For example, the design guidelines of Guangzhou, Shenzhen, Chongqing and Zhengzhou are divided into three layers of "overall urban design - district urban design - block urban design". In 2017, based on the current conditions of urban development in China, the Ministry of Housing and Urban-Rural Development formulated the “Technical Guidelines for Urban Design” on the basis of the “Measures for the Administration of Urban Design”. The document divides the urban design guidelines into three levels, providing a more authoritative reference for the preparation of various urban design. Moreover, Guangzhou's urban design guidelines system has formed a "1+5+N" compilation system. Among them, "1" is the general principles of Guangzhou Urban Design Guidelines, "5" is the sub-principles of street, architecture, traffic, landscape, and municipal administration, and "N" is the design manual and guideline of N items such as landscape design, road elements, and renovation of old residential areas. Based on the Technical Guidelines for Urban Design mentioned above and the control system of Guangzhou Urban Design Guidelines, this paper extracts the control content of existing guidelines. The management and control contents are sorted out according to the compilation levels of "overall urban design - district urban design - block urban design". Finally, this paper selects other recent and typical local guidelines from both domestic and international sources to integrate into this framework, exploring optimization strategies under the concept of public health (Table 3).

Table 3. The current urban design guidelines and control system in China. Source: Self-painted.

Locational level	Control elements		Design guidelines control content
Overall urban design	Ecological landscape resources	Mountains, water systems/ecological parks/basic farmland, etc.	Setback from surrounding buildings, building height control, reserved public corridors, etc.
	Overall urban spatial form	Urban space layout mode	Group type, strip type, etc.
		Special landscape corridors	Visual corridor zoning, visual corridor height control, etc.

Landscape features	Style division/axis/node	Architectural style guidance, building height control, skyline control, etc.
Public space	Open spaces	Open space system and its environmental quality.
	Slow-moving system/traffic organization	Road network form, layout, orientation, etc., traffic organization model.
	Scale and capacity	Development intensity, land use scale, environmental capacity control
Landscape style	Height zoning/skyline	Ventilation corridor section form, skyline form
Public space	Open space	Spatial scale, terrain shaping, plant planting, etc.
Slow-moving system	Walking system	Control and guidance of pedestrian density and average spacing in different urban areas
	Cycling system	Path design, cycling traffic network control and guidance
	Slow traffic facilities	Control and guidance of the number and scale of slow traffic facilities
Streets	Block scale	Propose block scale guidance for different functional plots
Architectural form	Group combination	Combination form, building volume control and guidance
	Urban interface	Continuous and neat urban interface, commercial street and main public space interface control

3.3. Comparative analysis and optimization strategies

3.3.1. Transform from Design to Control - Focus on the Implementation of Urban Design Guidelines

For a long time, due to the "non-statutory" nature of urban design and the lack of institutionalized technical tools, urban design projects have generally suffered from issues such as the "inadequate realization" of urban design intentions or the "diluted implementation" of urban design outcomes during the implementation process (Jin, 2018). This has resulted in the built environment failing to achieve the established urban design goals, and concepts such as public health cannot be implemented. In future urban design control, based on the existing statutory planning, urban design elements should be selectively and progressively integrated into statutory planning, for example, by incorporating them as additional diagrams into regulatory detailed planning, making them a direct additional condition for land transfer. This approach not only maintains the original order of statutory planning but also effectively leverages the role of urban design in planning and construction.

3.3.2. Integrate the Concept of Public Health into the Index Elements of Urban Design Guidelines

The original control indicators for urban design guidelines were largely formulated based on the construction of new districts during the rapid urbanization stage, and did not fully consider the public

health of residents. For example, in road traffic planning, there was little consideration given to pedestrian systems and bicycle lanes, and urban ventilation corridors often yielded to economic development during the planning implementation process when ecological red lines were being controlled. Therefore, based on a review of the current elements of urban design guidelines, this paper proposes to add, adjust, and optimize the control indicators. For instance, in the guidelines for the overall urban spatial form, content on urban spatial layout should be added to promote a compact land use layout and strictly control urban development boundaries. In the urban design of the key areas, the design guidelines should be added in favor of slow traffic. For example, traffic interchange points will be set up in densely populated areas, and pedestrian facilities will be arranged rhythmically along the street to enhance pedestrian safety.

4. A case of renewal design of a high-density community in Guangzhou

4.1. Site background

The western district of the Nanda main line is located in the northern gateway of Panyu District, Guangzhou, within the core area of Wanbo. The area bordered by Xingnan Avenue to the south, South China Expressway to the west, Jinxin Avenue to the east, and Sanzhixiang riverway to the north. It is also adjacent to the South China Expressway and Nansha Port Expressway, enjoying unique advantages in transportation hubs, industrial upgrading, and scientific research innovation. Consequently, it is necessary to conduct planning research and design to enhance the overall comprehensive quality of the areas along the Nanda main line. However, the current situation in the area is concentrated in many urban villages. There are problems such as insufficient public service facilities, poor urban appearance, and mismatch with the future development goals of the area. Therefore, the area is necessary to improve the living environment and urban appearance through urban renewal. At the same time, with the transformation of the positioning of the northern region of Panyu, it is also necessary to reverse the image of the "sleeping city" through the renovation of the gateway area. Finally, this paper aims to integrate the concept of public health into the planning and design practice to create a healthy and livable urban environment.

Based on an assessment of the current development status of the area and the surrounding development resources, this urban design positions the area as a healthy city that is innovative, ecological, and livable within the Greater Bay Area. The goal of this urban design is to create a future-oriented healthy community lifestyle. Design principles include eco-friendliness, smart innovation, safety and convenience, friendly neighborhood, green and low carbon, and then implement planning through urban design guidelines.

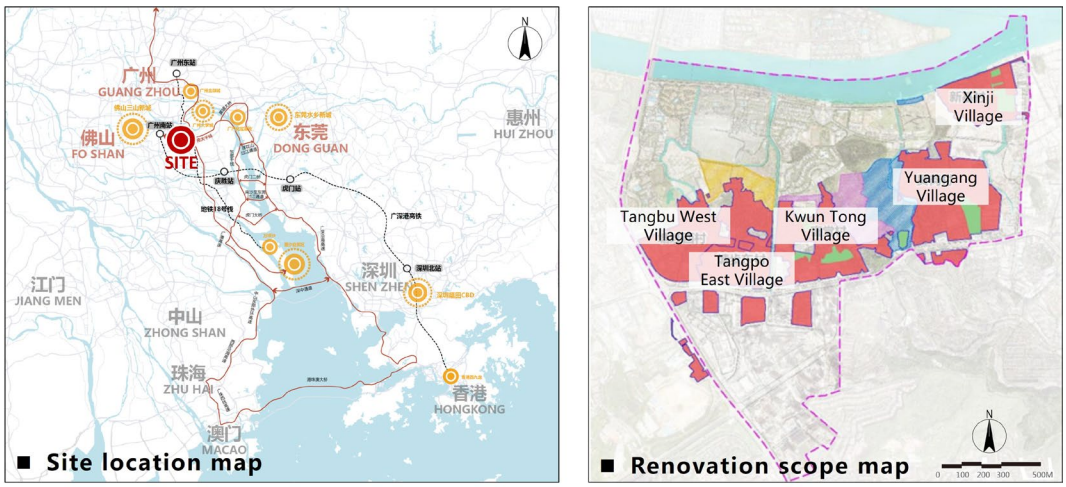


Figure 2. Analysis of the current site conditions. Source: Self-painted.

4.2 Urban Renewal Strategies and Design Guidelines under Health Orientation

4.2.1. Land use layout

The layout of land use mainly includes adjusting the nature of land use, balancing the relationship between occupation and housing and controlling the intensity of development. The current land use planning of the area mainly includes non-construction land such as garden and forest, which is inconsistent with the future development direction of this region. The design is based on the status quo controlled detailed plan to increase the residential and commercial land area. In addition, it is necessary to provide a complete set of public service facilities at different levels. The design will further optimize the land use of the existing control planning management units and promote the development of cities on both sides of the Nanda main line.

4.2.2. Road Traffic

Road transport mainly includes improving road connectivity, increasing road density and diversifying travel modes. This design combines the current construction situation and planning plot indicators, and improves the regional traffic level by opening branch roads, standardizing plots, and fine-tuning road networks to meet future development needs. We focus on creating a balanced, highly accessible, comfortable and leisurely slow transit system that ensures public living Spaces can be reached slowly within five minutes, thereby reducing the amount of motor vehicle traffic generated by daily urban life.

4.2.3. Public service facilities

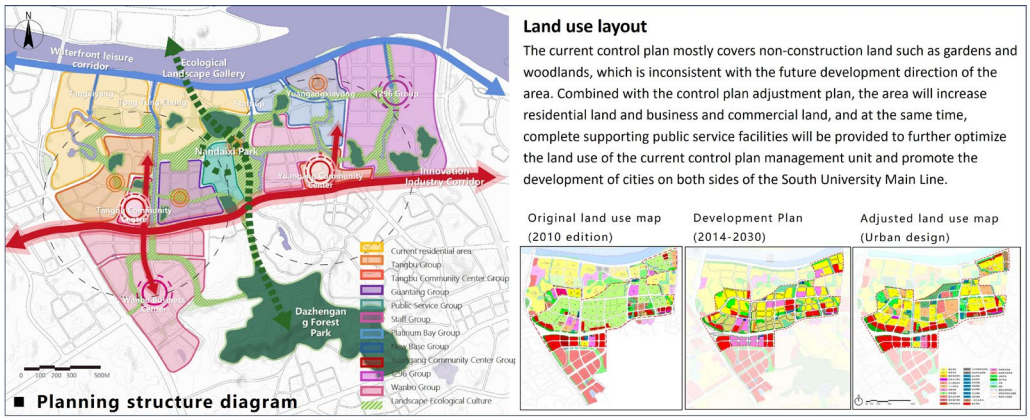
Public service facilities mainly include improving the layout concept of public service facilities supporting facilities, living circle and commuting circle, and hierarchical agglomeration layout. This design takes the 5-minute living circle and 15-minute commuting circle as the layout concept of public service facilities. And create “community (street level) - neighborhood (neighborhood committee level) - group center” three-level public service facility system. We wanted to create more compact, higher volume ratios, more mixed functions, clear boundaries and pedestrian-friendly residential units. In order to realize the public health concept of community environment construction.

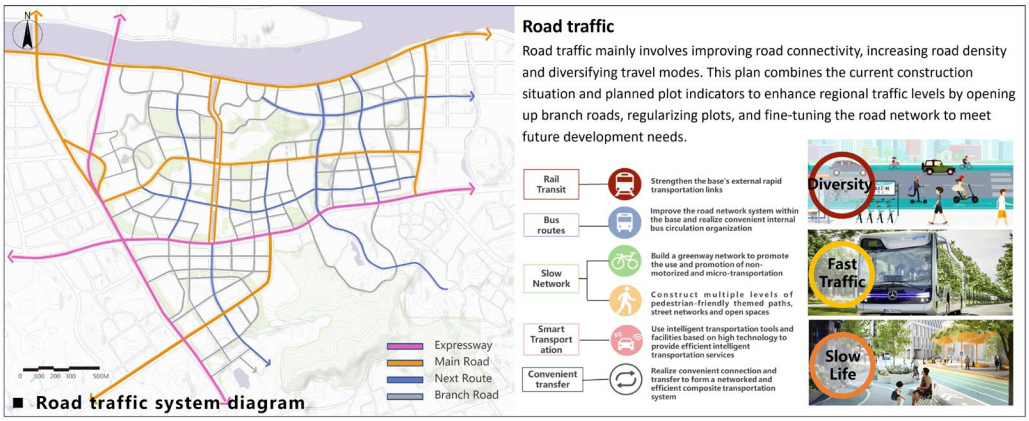
4.2.4. Ecological corridor

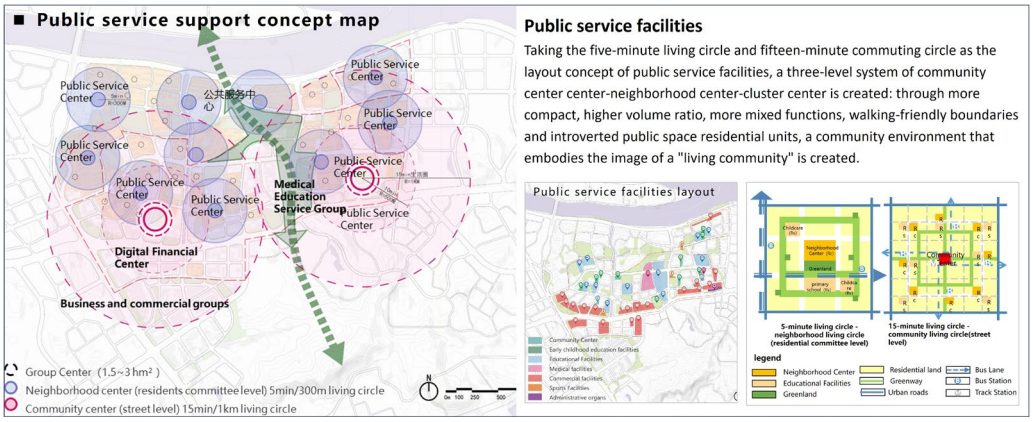
Ecological corridor mainly includes controlling the nature of land use to preserve the ecological corridor, building height on both sides of the corridor and interface control. The design is based on the regional open space of the North Pearl River and the central Forest Park. The scheme combines mountains, rivers, historical sites and other elements to create a permeable open space network of "three corridors, two belts and multiple gardens". In the design guidelines, the building height, slope and function on both sides of the corridor are controlled to ensure the implementation of the planning.

4.2.5. Block layout

The block layout mainly includes the function of the block, the microclimate environment and the building layout. The traditional block layout mode has some problems, such as monotonous form and single function. Therefore, the mixed block model is proposed to introduce diversified urban business forms into the block. Under the same development intensity background, mixed block mode introduces more commercial forms and community service facilities to increase community vitality. At the same time, considering the influence of block layout on microclimate, the multi-layer greening system is constructed. We wanted to optimize street space and roads by adjusting the layout of buildings within the block. This reduces the average temperature within the block and brings wind into the city through the wind gallery.







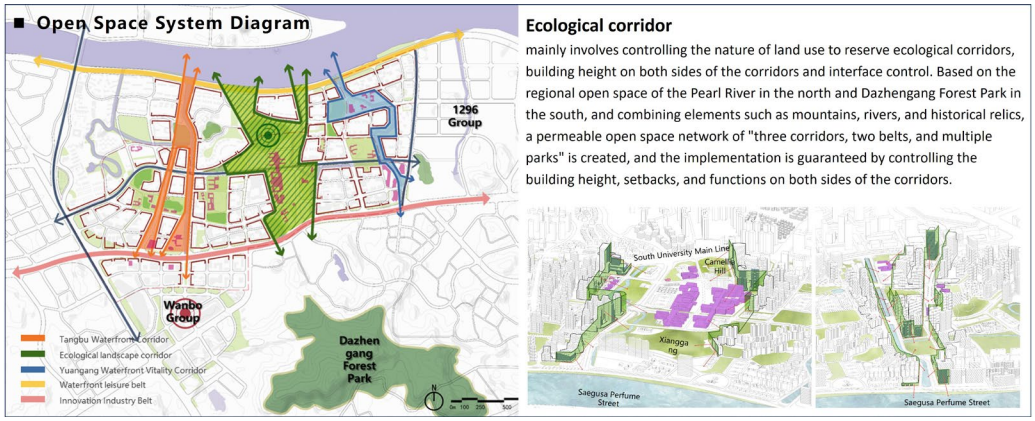


Figure 3. Urban Renewal Strategies and Design Guidelines under Health Orientation. Source: Self-painted.

5.Conclusion

As the urbanization process in our country continues to advance, health issues related to the urban environment are becoming increasingly prominent. The COVID-19 pandemic, floods, haze weather, chronic diseases, etc., all pose threats to people's public health. Traditional medical services can no longer meet the demands of public health. It is necessary to commence with improving the urban built environment and control it through the urban design guidelines indicator system to achieve the aim of reducing health risks, providing health facilities, and promoting activities and exchanges. Only in this manner can we prevent problems before they arise and achieve the transition from "treating existing diseases" to "preventing diseases before they occur". However, the current urban design guidelines still have issues such as insufficient feasibility and less attention paid to public health. It is still necessary to transform urban design from design-oriented to control-oriented to ensure the implementation and accurate realization of design intentions. At the same time, the concept of public health should be integrated into the design guidelines indicator elements, and the indicator elements should be augmented, adjusted and optimized on the basis of the existing guidelines system to construct a path for achieving public health through urban design guidelines, so as to enhance the public health level of residents.

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