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The relationship between the neighborhood built environment and physical activity

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Chapter 1

Introduction

“Together for a fairer, healthier world” was the theme of World Health Day on April 7, 2021. The World Health Organization (WHO) urged governments to take action and realize one of its primary goals: “Health for all.” Rapid urbanization has brought the populations of countries into the cities and, today, more than half the world’s population (55%) live in urban or suburban areas. Creating a health-promoting urban environment is therefore essential. Although public health conditions in the rural countryside often lag behind those in urban areas, the latter deserve special attention since they are expected to absorb a substantial number of those who leave the countryside. Urban areas are prone to health hazards. Noncommunicable diseases – which are usually related to unhealthy lifestyles, such as inadequate physical activity and unhealthy diets – are common problems in cities. A decade ago, World Health Day was themed “Urbanization and health,” emphasizing the importance of health in urban policies. Instead of promoting medical solutions, WHO stressed the need for prevention and health promotion. In response, this thesis explores the impact of the urban environment on people’s lifestyle choices. Comparing neighborhoods in the Netherlands and China, it takes a historical and social-ecological perspective in an in-depth analysis of the way the physical and spatial environment promotes or frustrates healthy lifestyles.

1.1 Urbanization and health

1.1.1 Urbanization as a global trend

Urbanization is considered a global trend in the twenty-first century. The year 2008 marked a special moment in the rapid process of urbanization: for the first time in history, the urban population equaled the rural population of the world. In 2021, more than 55% of the world's population lived in non-rural areas, and by 2050, more than two-thirds of the world's population is expected to live in urban areas (WHO, 2019a).

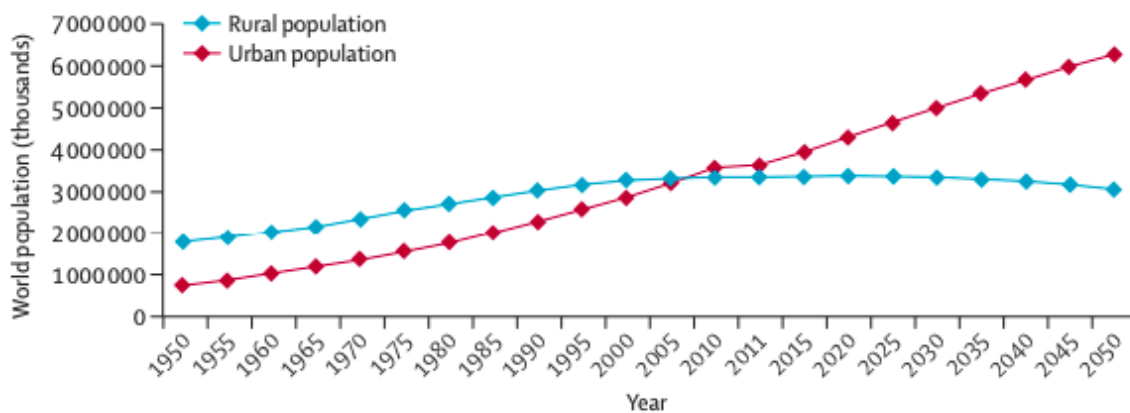


Figure 1-1 World population growth, 1950-2050

(Source: Rydin et al., 2012)

Northern America, Latin America, and Europe have already become highly urbanized. For example, the urbanization rate for Northern America is 83% (Statista Research Department, 2022). Other continents are relatively less urbanized – in 2022 the urbanization rate for Asia and Africa was 52% and 44%, respectively. However, countries in Asia and Africa are rapidly catching up. After political reform in 1978, when China opened its borders and adopted semi-capitalist economic development practices, the country began to urbanize at an unprecedented pace. From 1978 to 2020, the number of Chinese urban residents increased from 170 million to 831 million (National Bureau of Statistics, 2021). Today, almost four times more residents live in urban areas than just a few decades ago. The urbanization rate in China has surpassed the average urbanization rate of the world – which has increased from 17.9% to 60.6% over this period (National Bureau of Statistics, 2021).

This rapidly urbanizing world has changed people's lifestyles and behaviors. The urban population has experienced great economic and social progress and citizens now have access to better health care, but they are also confronted with health problems that are associated with living in urban areas. Car dependency, sedentary lifestyles, inadequate physical activity, and non-healthy diets are seen as urban problems (Wang et al., 2020). Considering the continuously increasing number of urban inhabitants, addressing this problem is perhaps the most important global health challenge of this century.

1.1.2 Noncommunicable diseases as the primary threat to public health

Although noncommunicable diseases (NCDs) lack the spectacular qualities of contagious diseases which occasionally result in epidemics and pandemics, they represent by far the biggest threat to public health. Diabetes, together with cardiovascular diseases, cancers, and chronic respiratory diseases are known as NCDs, and they have become the dominant diseases today. According to a document released by WHO, in 2016, 41 million deaths were caused by NCDs, equivalent to 71% of all deaths globally (WHO, 2018b). To be more specific, cardiovascular diseases account for most NCD deaths, with 17.9 million people annually, followed by cancers (9 million), respiratory diseases (3.9 million), and diabetes (1.6 million) (WHO, 2018b). The health challenge associated with NCDs can be found in both developed and developing countries. In the Netherlands, for example, NCDs are estimated to have accounted for 90% of all deaths in 2016, while in the developing country of China, the number is similarly high – at 89% of all causes (WHO, 2018b). In the opening remarks at the First Global Ministerial Conference on Healthy Lifestyles and Noncommunicable Disease Control (WHO, 2011), Director-General of the World Health Organization (WHO), Margaret Chan, mentioned: 'In a sense, the threat of NCDs is a slow-motion catastrophe, as most of these diseases develop slowly. But unhealthy lifestyles that fuel the epidemic are spreading with a stunning speed and sweep.'

While urbanization can be harmful to public health (Kuddus, 2020; WHO, 2021b), it can also be considered a great opportunity to tackle the problem and enhance the health of urban inhabitants. Whereas communicable diseases are hard to prevent simply by discouraging unhealthy lifestyles and promoting healthy ones, preventive and health promotion strategies can result in a substantial reduction in NCDs (WHO, 2017b). Diabetes, for example, is a widespread disease in many countries and its numbers are still rapidly increasing (WHO, 2018b). At the same time, diabetes is also

a largely preventable and treatable NCD. People with unhealthy lifestyles tend to suffer from diabetes, and simple lifestyle changes have been shown to be effective in preventing or delaying the onset of type 2 diabetes, including maintaining normal body weight, engaging in regular physical activity and eating a healthy diet (Carbone et al., 2019). Like diabetes, many other NCDs are preventable through a change in behavior. In addition, in relation to the health care costs, preventive interventions in people's daily behaviors are simple and cost-effective. Many risk factors in urban lives can be addressed by applying such interventions, which include urban and architectural measures that can play a substantial role in facilitating healthier ways of living.

1.2 Policies to reduce the risk of NCDs in cities

1.2.1 Agenda for tackling NCDs by prevention

WHO has called for action regarding the current situation with NCDs. In 2013, it released a document entitled, *Global action plan for the prevention and control of NCDs 2013-2020* (WHO, 2013), which provides a roadmap and a menu of policy options for all Member States and other stakeholders to take coordinated and coherent action, at all levels – local to global – to attain global targets. The action plan mainly focuses on four types of NCDs – cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes – which make the largest contribution to morbidity and mortality, as well as four shared behavioral risk factors – tobacco use, unhealthy diet, physical inactivity and harmful use of alcohol (WHO, 2013). It thus addresses the conditions in which people live and work and how their lifestyles influence their health and quality of life.

In addition to the guiding global agenda, regions and countries have also developed their own policies to better address the problem of NCDs at a more local level. For Europe, the *Action plan for the prevention and control of noncommunicable diseases in the WHO European Region 2016-2025* (WHO, 2015) was developed, which envisages a health-promoting Europe, free of preventable NCDs, premature death, and avoidable disability. Combined with the United Nations (UN) Agenda 2030 and the WHO Action Plan, these are three key policy agendas for the European Region that can guide its contribution to the global NCD agenda (WHO, 2019a).

Asian countries have also joined this global action. In 2016, the Chinese government published the *Guideline for Healthy China 2030* (GOCCPCC, 2016) and, with the main principle of “co-creating, co-sharing, and health for all,” the guideline puts prevention first and promotes healthy lifestyles for all populations to decrease the prevalence of these diseases. Based on this, the *Healthy China Action (2019-2030)* was planned three years later, aiming at 15 targets, including health literacy improvement, better dietary habits, more physical activity, and less smoking. Another movement of note is the China Healthy Lifestyle for All campaign (China CDC, 2014), which started in 2007, aiming at promoting a healthy lifestyle for all, the action mainly promotes the idea of “Health 1 2 1,” which means 10,000 steps per day and balanced eating, and – motivating these two things – being healthy for one lifetime.

1.2.2 Health promotion via urban strategy

Urban planning plays an essential role in prevention and health promotion. Two well-received and projected agendas from a prevention perspective are WHO’s “Healthy Cities” and “Healthy Urban Planning” initiatives. Healthy Cities was a strategy developed by the WHO in response to the twenty-first-century urbanization challenges to human health (WHO, 1994). It was first put forward in the 1980s (McKeown, 1979; WHO, 1994). And in 1986, the WHO Regional Office for Europe decided to launch an urban health promotion program and implement the Healthy Cities Project (HCP), which has been joined by many European countries and cities. In the early 1990s, the concept of Healthy Cities was first introduced to China (Yang et al., 2018). In 2016, the construction of healthy Chinese cities entered a large-scale development stage after the release of the *Guideline for Healthy China 2030* (GOCCPCC, 2016).

1.3 Planning healthy cities

The urban environment is an urban artifact: it is human-made, the result of deliberate decisions made by inhabitants, architects, and urban planners. Almost without exception, those involved have applied urban models that, when put into practice, represent accumulated contemporary knowledge on how the built environment impacts public health. Without the ambition to promote public health, urban planning would never have developed (and the same is true for public housing). Cities can be seen as conglomerations of neighborhoods that date from different periods and are

exemplary outcomes of different health-promotion strategies. In the healthy cities concept, neighborhoods play a vital role – they are seen as spatial containers with distinct borders that separate them from other neighborhoods. Their social make-up, their urban and architectural qualities, and the characteristics of their housing stock, set them apart from neighborhoods dating from other periods. The way they evolve over time adds specific qualities that help to define their identity.

The social characteristics of neighborhoods – living conditions, working circumstances, and the way space is used for travel and other purposes – and many other aspects are bound to change over time. These changes impact lifestyles, and lifestyles impact health. These are partly defined by the original urban plan and architectural qualities, and partly by later changes.

Urban planning interventions can redesign neighborhoods in order to address contemporary problems and promote healthy lifestyles. To be effective, the relationship between the urban environment and lifestyles needs to be clarified. This thesis takes the healthy cities matrix used by the Expertise Center Architecture, Urbanism and Health at Groningen as a starting point (AUH, 2022). This center distinguishes three domains: the physical domain, lifestyles, and sustainability.

The *physical* comprises:

- > the outdoor and indoor climate, as well as addressing issues of pollution

The most important domain focuses on *lifestyles*, and includes:

- > food, greenery

- > inclusivity (prevention of social isolation)

- > mobility

- > placemaking (the use of public space for other purposes than traffic)

Finally, the domain of *sustainability* comprises:

- > ecology

- > energy transition

- > circularity

- > global issues related to the production and distribution of food

All the items listed under these three domains are directly related to the urban layout of cities and neighborhoods.

1.4 Research questions and hypotheses

From the urban planning perspective, one way to tackle the health problem of NCDs is by planning health-promoting urban environments to help people shape healthier lifestyles. The layout of neighborhoods has direct and indirect impacts on the daily living choices of individuals, thus leading to distinct health effects.

In the last decades, many efforts have been made to identify the associations between the urban built environment and healthier lifestyles in terms of physical activity. Several built environment characteristics have been explored for their relationship with physical activity, such as density, diversity, design (Cervero&Kockelman, 1997), safety (Fonseca et al., 2021), aesthetics (Saelens et al., 2003), and integrated indexes such as the walkability index (Clary et al., 2020; Frank et al., 2010). Despite many promising findings, however, sometimes inconsistent impacts of the built environment on physical activity were found across studies and reviews. This suggests the causal relationship behind the mechanisms at work is complex and needs to be further explored.

These built environment characteristics can all be operationalized in many parameters. However, many of these have never been studied, or a certain indicator that may be suboptimal has been chosen, keeping the true relationship between the built environment and physical activity hidden. For example, the existing research often uses generically available GIS data for measuring the built environment, neglecting the fact that these built environment characteristics influence people's physical activity in a much more nuanced and complex way than a GIS layer or computations can show. Notoriously absent in the studies are drawings, maps and diagrams that are indispensable to address the built environment characteristics at the level of precision that is a condition sine qua non for any study on the built environment. Moreover, many studies assume that the availability of the built environment characteristics they measured are unaffected in any manner. But in real life, the characteristics that show on a GIS layer, such as green spaces, can be not available for the public because of fences, parked vehicles, poor maintenance, etc.

We believe that the effect (activity and consequently health) will be inadequate if the built environment attributes are not operationalized correctly and are not integrated with other circumstances that promote activity. Thus, they still need to be studied better and differently. The aim of this thesis, therefore, is to enrich the understanding of the relationship between urban environments and public health and contribute to the knowledge of the impact of the former on the latter by bringing in holistic urban analysis in assessing the neighborhood. The findings of this research should provide policymakers and urban planners with the means to propose urban interventions that contribute to improving public health. The main questions are:

How do the built environments of different neighborhood types relate to the physical activity of individuals? And what changes to the built environment can effectively improve physical activity?

And the sub-questions are formulated as follows:

- 1) *Which built environment parameters have been explored so far, and how do they relate to health-related outcomes?*
- 2) *Which aspects of the built environment have been insufficiently studied and measured in terms of their impact on physical activity?*
- 3) *Which specific urban interventions promote physical activity (evidence from the existing literature)?*

These questions are answered accordingly in the following chapters.

1.5 Main theories and concepts

This thesis aims to determine how the built environment influences people's lifestyle behaviors through historical and social-ecological perspectives. The social-ecology frameworks (Whitehead&Dahlgren, 1991; Barton et al., 2005; Sallis et al., 2006) are applied to analyze people's surrounding environment. In relation to spatial units or specific settlements, the focus is on human activity as a part of ecosystems. In addition, key notions are borrowed from planning history to better understand the "biography" of the spatial units studied.

The research framework is derived from the Healthy Cities concept as outlined above, with the main focus on mobility, and physical activity specifically. An evidence-based approach is used to first critically review the existing literature on the relationship

between the built environment and physical activity. Later on, neighborhoods in China and the Netherlands are investigated to test the raised hypotheses built by the reviews. Finally, urban intervention suggestions are put forward for neighborhoods in China learning from the Dutch experiences. The mentioned theories and concepts are further introduced in Chapter 2.

1.6 Research methodology

1.6.1 Case studies

Cases studies were employed to test hypotheses built upon the literature reviews. Case studies is the most appropriate approach for this thesis because, first, we raised a *how* research question and the case study approach is well suited to answer (Yin, 2009). Second, deeper investigations and greater available details of the built environment are required for this research, which are supported by the approach of case studies (Rowley, 2002). Moreover, case studies are most useful for current events when it is impossible to modify relevant behaviors (Rowley, 2002), and that is the case for this research.

This thesis aims to deeply explore the relationship between the built environment and people's daily living patterns (physical activity behaviors). It was decided that the research question could be better answered by conduction study cases of neighborhoods in both China and the Netherlands.

Five neighborhoods in China and the Netherlands are selected as the study cases. Three of the neighborhoods are located in Beijing, China, and two in Groningen, the Netherlands. These two countries are different in many ways: the Netherlands is a developed country and China is a developing country; one is embedded in European or Western culture, while the other is immersed in Chinese or Eastern culture. These differences will be taken into account.

In addition, Groningen and Beijing both contain most types of local neighborhoods, and they are both international urban areas with many university students. The resulting diverse demography was also a reason that case studies were chosen from the two cities. While it could be argued that, in terms of city size and population, the differences are too great, our research choices took this into account. Furthermore, this thesis has a focus on the neighborhood level, which abates the concern of the city size differences. The selected neighborhoods are of similar size.

Two neighborhoods in Groningen were selected, each representing a typical Dutch neighborhood model from the twentieth century. An urban analysis of the two neighborhoods and the way they shape people's living patterns results in data that are considered representative of the respective urban models of these neighborhoods. The same is true for the Chinese case selection.

1.6.2 Research methods

Three research methods are used in this research. We employed the literature review method to establish the nature of the relationship between the built environment and physical activity and people's health. Critical reviews built up a hypothesis for upcoming empirical studies. For instance, our review of urban green spaces revealed the one-sided approach used in recent studies (more focus on the physical presence of green spaces while overlooking their interaction with people), which resulted in the relationship between green spaces and health were not comprehensively captured. Following this, we brought a people-centered approach to assess the built environment in the case studies.

A detailed urban analysis of the five case study neighborhoods is demonstrated to assess the built environment of those neighborhoods. The built environment parameters that have been widely used in the literature, in terms of density, land-use mix, street connectivity, green ratio, and public transit availability, were chosen but assessed in a more nuanced way - we conducted field observation and applied map analysis to map people's real-use experience of the spaces and facilities in their residential neighborhoods. The results are shown as urban analysis maps. This analysis is supplemented by literature research on the history of the neighborhoods selected.

People's physical activity, self-rated health, and perceptions of their neighborhood environments are collected by means of a questionnaire survey. This choice was made because we wanted to focus on the context and people's daily experiences, which "may be much more local and experiential in nature" (Fitzgerald et al., 1999). Surveys in Beijing were conducted in March and April 2020. And one year later, in March 2021, I conducted surveys in the studied Groningen neighborhoods. The collecting time was chosen intentionally to minimize the impacts of national holidays on people's physical activity levels (it was the Chinese spring festival holiday in January 2020 in China, and the Christmas holiday in December 2021 in the Netherlands. And the survey times were two to three months after these national holidays), and to control the influences

caused by COVID-19 - at the time, there were relatively few restriction measures implemented in the two cities. The surveys were conducted according to internationally recognized standards to protect the research participants, and approved by the Research Ethics Committee Faculty of Arts (CETO) of the University of Groningen for both Beijing cases (number: 75890231, issued in October 2020) and Groningen cases (number 85452141, issued in February 2022). How the questionnaires were collected in the neighborhoods can be found in Chapters 4 and 5.

1.7 Contribution of the thesis

This thesis adds evidence to the causal chain from the built environment to physical activity and health. An overview of what aspects of the built environment has been studied so far for their impacts on physical activity was presented, such as density, land use mix, street connectivity and walkability. Additionally, what urban interventions are effective in improving physical activity were summarized, in terms of park and playground interventions, interventions aimed at walking and cycling, and community-based interventions. Moreover, more perspectives are brought into the relationship between the built environment and physical activity. For example, physical activity is found that its frequency is better associated with a healthier environment, rather than the often-used indicator duration of physical activity.

Many explorations of the built environment and its impacts on people's behaviors have been undertaken in transportation, mobility, and health studies. The evidence has accumulated and resulted in planning theories, in the development of new concepts, or it has been used in guiding practical projects. However, studies on "neighborhood and health" from an urban perspective seldom use the term "neighborhood type." While this line of research has been neglected, different models of neighborhood types can present varied details concerning spatial distribution and design, and indicate the design principles behind such a "neighborhood type" and how it can have health consequences for its inhabitants. In this thesis, we categorize the neighborhood into types from a planning history point of view, which reflects the mainstream planning theories and sometimes health policies prevalent at that time. Certain types could be representative in one or more countries, thus the results from one or more case studies could be applied to other similar neighborhoods, which could be beneficial to neighborhood renewal or intervention projects.

Also, we view each neighborhood in a more people-centered holistic way, and we use urban analysis maps to precisely present the built environment characteristics. Current studies on associations between the built environment and people's behaviors mostly focus on the parameters of residential density, land-use diversity and street connectivity, which originated in transportation studies. What is missing in the studies are urban analysis maps, which provide a certain level of precision for assessing the built environment. This research adds the missing part to the research field.

This thesis also contributes to the construction of health-promoting environments practically. The findings and conclusions this thesis has arrived at can be applied to neighborhood (re)design practice, and can guide urban planners and policy-makers to create physical activity-enabling environments, in the Chinese and broader context. In addition, the case study in China can address the problem of insufficient studies in Asian countries in this field (Pontin et al., 2022).

1.8 Outline of the thesis

This thesis is structured into eight chapters in four parts. The first part contains two chapters that introduce the background, research questions, perspectives and methods of this research, and the thesis outline is presented.

	Chapters	Contents
PART I	Chapter 1	Introduction
	Chapter 2	Theoretical Perspectives
PART II	Chapter 3	Green places and health
	Chapter 4	Case study in China
	Chapter 5	Case study in the Netherlands
PART III	Chapter 6	Urban interventions and physical activity
	Chapter 7	Studies both in China and the Netherlands
PART IV	Chapter 8	Conclusion

Figure 1-2 The structure of the thesis (by author)

By detailing the theories and perspectives used in this thesis, Chapter 2 creates a pathway from planning history to people's lifestyles/health, through the neighborhoods' built environment. This chapter provides a theoretical basis for this thesis, emphasizing that the study is conducted in light of both social-ecological and historical considerations. First, the origin and development of the Healthy Cities are outlined, which shows a trail of connection-disconnection-reconnection development history between the city and health. Following this, how to better understand health in settings is illustrated by using social-ecological models, which holistically view health determinants and suggest that people's health and lifestyle behaviors are affected by multiple factors. Additionally, we critically reviewed the existing literature to investigate the current evidence of the relationship between the built environment and lifestyle/health. Most often used parameters for the built environment and physical activity and how they are operationalized are discovered. Next to the social-ecological perspective, the section on the development history of the Chinese and Dutch neighborhoods added historical considerations, and representative neighborhood types from both countries are introduced with examples. Finally, based on a great body of studies, we develop a framework for assessing the built environment more comprehensively and precisely.

The second part consists of Chapters 3, 4 and 5, which deeply explore the relationship between the built environment and health outcomes in terms of physical activity. The hidden aspects of the built environment are investigated, the overlooked physical activity dimension is identified, and the assessing methods are finetuned.

In Chapter 3, we investigate possible causal relationships between green spaces and health outcomes by conducting a scoping review, to address whether the mere material presence of green spaces contributes to people's health or the health-promoting qualities of green spaces (that people can actually see, access, and enjoy) attributed to the ability? The latter view highlights the relational dimension of places, and it entails personal relationships with places that are imbued with psychological meaning and significance for those who visit and experience them. Based on the 189 papers identified, we find both (the material presence and qualities of green spaces) are crucial for better health outcomes. The relational measures of green spaces (quality and characteristics) demonstrated statistically greater positive impacts on health. Nonetheless, the material aspects (abundance and proximity to residences) received much more attention in studies. Therefore, we advocate a greater focus on the

relational perspective of green place-thinking on green spaces and health research to optimize the green spaces' positive effects and thus to create healthy and livable cities. Chapters 4 and 5 are empirical case studies that test hypotheses generated by literature reviews. Chapter 4 presents an empirical study in Beijing, China, where emerges insightful results (which have been largely overlooked by quantitative analysis of previous studies). Adopting an urban analysis method, we assessed the built environment of three Beijing neighborhoods more holistically. And relating the assessment to residents' physical activity results collected by questionnaires, the results of this chapter argue that regardless of the effectiveness of some largely-used built environment indicators, such as land-use diversity and green ratio, in evaluating how likely the built environment is to encourage physical activity, it is essential to look at the environment from an integrated urban design perspective, otherwise useful information can be neglected and lead to misinterpretations or false conclusions. This chapter suggests that physical activity level is not simply related to residential density or road section crossings; indicators have to reflect the complex way in which the built environment impacts physical activity.

In Chapter 5, we focus on the physical activity, and explore if, and if so how, a healthier neighborhood can stimulate people's physical activity both in terms of duration and frequency. This empirical study conducted in the Netherlands reveals that a higher frequency of physical activity, rather than a longer duration, is more associated with a health-promoting environment. Even though the duration are the more often used indicator for physical activity. Two Dutch neighborhoods in Groningen (one built before the Second World War and one after), which are similar in their social-economics but with different health levels were selected as study cases, and questionnaires were used to gather data on physical activity and health in the two neighborhoods. Results show that the residents' perceptions of the environment and health are better in the healthier neighborhood, also the frequency of physical activity was consistently higher in the healthier neighborhood, but no substantial differences could be found for the duration. This suggests that the frequency might be a better indicator of physical activity in creating a healthy neighborhood than the duration. And accordingly, we suggest shedding further light on the frequency of physical activity in creating a healthy neighborhood.

Following the evidence found in the relationship between the built environment and physical activity in the second part of the thesis, the third part further discusses, in the

existing settings, what changes to the built environment (urban interventions) we can make to enhance the physical activity level effectively. This part, unlike the preceding one, has focus on the practical micro-scale. And here, we emphasize the *change*. Several effective urban interventions have been identified by reviewing the literature, and several practical design strategies for creating healthy Chinese neighborhoods are proposed based on case studies. This part comprises Chapters 6 and 7.

Chapter 6 presents an umbrella review of literature produced in the last decade on the relationship between specific urban interventions and physical activity, which finds several specific urban interventions that can promote physical activity. In this chapter, we follow the PRISMA 2020 and the JBI umbrella review protocol guidelines and conduct the search using keywords relating to the built environment, health, physical activity and interventions. As a result, seven reviews are identified. The results show that physical activity can be promoted by urban interventions of three categories (park and playground interventions, interventions aimed at walking and cycling and community-based interventions). Specifically, park renovations, adding exercise equipment, introducing a (new) pocket park, improvement of cycling environments, improvement of walking and cycling environments, multi-component initiatives for active travel and the availability and accessibility of destinations. The findings can directly guide practitioners and policy-makers in making health-promoting urban intervention plans. Furthermore, it reduces the gap between academia and practice, and thereby contributes to guiding urban designers and policy-makers in building healthier cities. Adding to the findings, we suggest tailoring urban interventions based on local contexts and people's needs. And we call for more longitudinal research with a pre and post-measurement to get a better understanding of the causal relationship between urban interventions and physical activity.

Next, regarding the lack of experience and evidence of constructing healthy cities in China, in Chapter 7, we adopt the Netherlands as the model to propose urban design suggestions for creating healthier Chinese neighborhoods. This chapter identifies characteristics of a healthy neighborhood regarding promoting physical activity and health, which are: safe and attractive residential environments, good access to local facilities such as shops and bus stops within walking distance, safe and nice pedestrian and cycling environments with good connectivity, and well-designed and managed open spaces. We deeply analyze the built environment of four representative Dutch and Chinese neighborhoods at a streetscape level, and propose several practical design

strategies for creating healthy Chinese neighborhoods, in terms of prioritizing walking and cycling, enhancing the micro-environment, removing obstacles/barriers, planning and also managing, designing for different groups, and tailoring to the local context.

The last part of Chapter 8 presents the conclusions of this thesis. We revisit the research questions and summarize the findings from the preceding chapters. This further sparks discussion on the studies in this research field from a broader view, and accordingly, recommendations are provided for future research. Finally, the theoretical and practical contributions complete this thesis as final words.

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