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Walking, obesity and urban design in Chinese neighborhoods

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ABSTRACT

Objective: We examined the connections (1) between the design of the built environment and walking, (2) between the design of the built environment and obesity, and (3) between walking and obesity and income in urban settings in China.

Methods: Six neighborhoods with different built environment characteristics, located in the Chinese cities of Shanghai and Hangzhou, were studied. Data on walking and other physical activity and obesity levels from 1070 residents were collected through a street intercept survey conducted in 2013. Built environment features of 527 street segments were documented using the Irvine–Minnesota Inventory-China (IMI-C) environmental audit. Data were analyzed using the State of Place™ Index.

Results: Walking rates, household income and Body Mass Index (BMI) were related; neighborhoods with a higher State of Place™ Index were associated with higher rates of walking.

Conclusion: This study began to establish an evidence base for the association of built environment features with walking in the context of Chinese urban design. Findings confirmed that the associations between "walkable" built environment features and walking established in existing research in other countries, also held true in the case of Chinese neighborhoods.

Introduction

China faces growing problems with obesity and chronic disease (Wang et al., 2005; Wang et al., 2007). A recent survey in ten Chinese provinces found that 34% of adults between the ages of 20 and 69 are overweight (Xiaochen and Lei, 2013). In fact, one-fifth of all overweight or obese people in the world are Chinese. Obesity and chronic diseases cause 80% of deaths in China, costing billions in lost productivity (Bekedam, 2006). Existing research links obesity to affluent populations and to urban areas in China (Wu et al., 2005). The association of obesity and income has typically been assumed to be a direct one: higher income has been associated with greater obesity and has been explained by shifts to Western diet, sedentary work, and motor transportation (Wang et al., 2007). The association of obesity with urban residence is particularly concerning given China's rapid urbanization. By 2025, China will have 221 cities with one million+ people (The State of China's Cities, 2010). There is a pressing need to reduce obesity in China's growing urban population. We also need to better understand the link between income and obesity, especially given China's increasing middle class, to effectively target interventions.

Obesity and chronic disease in China have been linked to decreasing physical activity and to other factors, especially changing diets and environmental pollution (Wang et al., 2005; World Health Organization, 2008). In the last two decades, physical activity declined by over 30% among Chinese adults, including reduced walking and bicycling (Ng et al., 2009). For men, self-reported occupational, domestic, transportation, and leisure physical activity, fell from 350 MET (metabolic equivalent) hours per week in 1997 to 253 MET hours per week in 2006.[1] Women's physical activity declined from 390 MET hours per week in 1996 to 246 MET hours in 2006. Few studies of physical activity in China have distinguished between walking and other forms of physical activity. At the same time, the odds of being obese were found to be 80% higher for Chinese adults who own a motorized vehicle, compared to those who did not; this discrepancy is linked to differences in travel behavior, including walking or bicycling versus motorized travel (Bell et al., 2012). Declining walking in China has been exacerbated by Chinese development patterns that encourage sprawl and impede active modes of travel (Day et al., 2013a; Quan and Sun, 2011; Shi et al., 2011; Xu et al., 2011). China's urbanization goals are expected to spur massive additional development, including an estimated 170 mass-transit systems, 5 billion square meters of road and 40 billion square meters

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[1] A MET unit is the ratio of a person's working metabolic rate relative to his/her resting metabolic rate (Sallis et al., 1998).

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of floor space (The State of China's Cities, 2010). The urban development patterns these new cities adopt are likely to impact future rates of walking and bicycling for transportation and for recreation. While rapid urbanization in its current form poses a threat to the health of Chinese cities, it also presents an important opportunity to adopt new, more sustainable, urban development patterns that include urban design that supports active living (i.e., being physically active as a part of everyday life, including increased walking for recreation and for travel).

Chinese cities differ significantly from many Western cities in terms of their urban design (Day et al., 2013a,b). Chinese cities are extremely dense compared to cities in the USA or other Western countries; for example, the density of Shanghai suburbs exceeds that of many urban neighborhoods in Western cities. Also, inward-facing or gated communities are very common in China; a majority of residential buildings are oriented around internal courtyards or lanes, surrounded by gates that create blank or inactive street facades. This design feature reflects historical patterns in which daily life—including some forms of physical activity—was conducted "inside" the community. It is unclear whether findings on the association between built environment features and walking and other physical activity from Western cities can be directly applied to China.

Research on the links between walking and the built environment in Chinese cities is thin. The few empirical studies conducted have produced some counterintuitive findings: in the Chinese context, high density has been associated with reduced recreational physical activity (Xu et al., 2009) and increased overweight (Xu et al., 2010). Extremely high density may limit open space and parks, leaving little space for walking or other physical activity. Extremely high density may also cause severe traffic nuisances and safety and pollution concerns, which could further discourage walking and other outdoor physical activity.

Existing research on these issues in Chinese cities have measured built environment features somewhat crudely. For example, in the studies noted above, the density measure was based on the aggregate of 13 districts within a city of 8 million people (Xu et al., 2009). At this level, the density measure may be capturing confounding effects from some unobserved or unmeasured built environment factors. Supplementing density measures with measures of micro-scale built environment features like urban form and pedestrian amenities, assessed at the neighborhood or segment (street block) level, may support a more nuanced understanding of the relationship between the built environment, walking and obesity.

Finally, existing literature may oversimplify the relationship between overweight and income. Some studies have focused on differences in overweight and obesity between urban and rural residents, finding that residents of the former were more likely to be overweight or obese than the latter, and then have drawn a parallel divide between lower income and higher income residents (Xu et al., 2005; Wang et al., 2007). In studies that observed the impact of income directly and found a positive association relationship between income and BMI, samples were still drawn from urban and rural residents, making it difficult to separate out the impact of income from that of the urban rural divide on BMI, especially as these two factors are positively related (Popkin et al., 1995; Reynolds et al., 2007).

This paper aimed to expand the fledgling evidence base on the association between built environment features and walking and obesity in China, using a more inclusive definition of walking (for both travel and recreation) and employing micro-scale measurements of built environment features at the segment level. The study also attempted to increase our understanding of the relationship between income and obesity by examining income in more detail within urban areas.

Methods

Neighborhood selection

This study was based in Shanghai, the largest city in China, and Hangzhou, the provincial capital city of Zhejiang Province, which have urban populations of more than 22 million and 6 million respectively (http://www.demographia.com/db-worldua.pdf). Both cities are located in the Yangtze River Delta region. These cities were selected because of their varied size and density levels and because they each included a wide range of neighborhood types. These cities were also proximate to East China Normal University, where student research assistants for this study were based. Within these cities, we identified six distinct neighborhoods with different development patterns—three in Shanghai and three in Hangzhou.

Neighborhood selection was based upon a typology we developed based on three information sources: existing literature on urban design in Chinese cities, systematic field observations in several Chinese cities, and interviews with several Chinese urban development experts (Table 1) (Day et al., 2013b). The typology characterized Chinese neighborhoods according to primary and secondary urban design elements that strongly differentiate various development types and that were hypothesized to impact walking and other forms of physical activity. The typology was not mutually exclusive; many neighborhoods displayed elements of more than one type.

Three neighborhood types were selected for inclusion in this study: (1) the "urban center" neighborhood developed before the 20th century; (2) the "inner suburban" neighborhood located right outside the urban center, primarily developed in the 1980s and 1990s; and (3) the "outer suburban" neighborhood based in the suburbs and developed primarily after 2000. Selected neighborhoods in Shanghai were all located within a 10 to 15 minute walking distance from a subway station. This criterion was intended to control for the effect of access to transit, which has been associated with walking in existing research (c.f., Saelens and Handy, 2008). Hangzhou did not have an operating subway system at the time of our data collection and so subway access was not considered in selecting neighborhoods. (Note that all of the Hangzhou neighborhoods in the study now have a subway station under construction.) See Table 2 for the names, typology, and location of the six neighborhoods. We assigned each neighborhood a typology code: S-UC = Shanghai Urban Center, S-IS = Shanghai Inner Suburban, S-OS = Shanghai Outer Suburban, H-UC = Hangzhou Urban Center, H-IS = Hangzhou Inner Suburban, and H-OS = Hangzhou Outer Suburban. We used these codes throughout the paper when referring to the six neighborhoods.

Independent variables: built environment

Environmental audits were conducted to collect data on built environment features. The audit used in this study was a revised and expanded version of the Irvine–Minnesota Inventory (IMI) (Day et al., 2006), which was a tool designed to objectively measure "micro-scale" built environment features, such as sidewalks, street trees, benches, street width, curbcuts, or building facades. The IMI was originally developed by members of the research team to measure built environment features tied to walking and bicycling in the USA and other Western cities. Based on several sources of information (including a literature review, Day et al., 2013a; observations of built environments in Shanghai, Guangzhou, and Beijing; and interviews with several experts on Chinese urban development), the IMI was expanded from 162 to a total of 286 items. The new audit tool was called the Irvine–Minnesota Inventory-China (IMI-C). Examples of new items added to the IMI-C included measures of obstruction of sidewalks by vendors or parked cars (common in high-density Chinese cities), visible air pollution, presence of overhead pedestrian bridges (which require more effort for street crossing), barriers in bicycle lanes, and others. The IMI-C is available from the authors as an iPad application.

Built environment data collection

Research assistants audited all segments (or street blocks) in each of the six neighborhoods for a total of 527 segments, including 286 in Shanghai (129 segments in S-UC, 60 segments in S-IS, and 97 segments in S-OS) and 243 in Hangzhou (95 segments in H-UC, 18 segments[2] in H-IS, and 127 segments in H-OS).

State of Place™ Index

IMI-C data were analyzed using the State of Place™ Index, a proprietary algorithm that was developed by one of the members of the research team (Leinberger and Alfonzo, 2012). The State of Place Index™ is a score composed of eleven sub-scores (Table 3) that measure urban design dimensions

[2] See note in the Built Environment Characteristics sub-section within the Results section for an explanation on why the number of segments in the H-IS was lower than that of the other neighborhoods.