



Effects of street-level physical environment and zoning on walking activity in Seoul, Korea

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ARTICLE INFO

Article history:

Received 20 March 2014

Received in revised form 10 July 2015

Accepted 18 July 2015

Keywords:

Walking activity

Zoning

Street-level form

Mixed-use

Public health

ABSTRACT

Many studies in the public health and urban planning fields have suggested that zoning can promote an increase in physical activity by encouraging walking. New urbanists and smart growth advocates claim that Euclidian zoning results in spatial segregation of land use that actually works against walking activity. Few studies have identified empirically the effects of zoning on walking activity. Employing multiple regression modeling, this study identified the impacts of street-level physical environment and zoning regulations on street-level walking activity in Seoul, Korea. Our results demonstrate that areas zoned for mixed land use have greater potential for pedestrian activity than do other zoning types. In addition, we found that there are signs of interaction effects between street-level physical environment and zoning. This result demands further research to prove that efforts to improve walking-friendly, street-level physical environments should be combined with zoning regulations to promote walking.

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1. Introduction

Recent urban planning and public health research have shown an increasing interest in walking since walking activity is proposed to be significantly associated with sustainability, urban vitality, and improved public health (Barton, 2009). Jacobs (1961) observed that mixed high-density land use and pedestrian-friendly streets allow cities to encourage walking activity, thus maintaining their vitality. New urbanism and its successor, the smart growth movement, argue that the physical environment described by Jacobs will also prevent uncontrolled urban sprawl and reduce automobile dependency (Duany et al., 2010). The public health sector has also paid attention to walking's potential to prevent obesity and chronic diseases and has therefore advocated urban physical forms that are more conducive to physical activity (Frank and Engelke, 2001; Smith et al., 2008).

Euclidian-style zoning regulations, which are popular in North American cities, have been criticized because they prevent the formation of walking-friendly urban physical environments by

promoting single, exclusive land use (Hirschhorn, 2004; Schilling and Linton, 2005). Few empirical studies have thus far identified the effects of zoning regulations on walking activity in urban areas. Schilling and Linton (2005) emphasize that land use regulation through zoning is an important measure for promoting walking activity because it controls the physical forms of cities, including density, land use, and development scale.

This study empirically identifies how on-street walking activities are differentiated by zoning type in Seoul, Korea. We conducted a case study in Seoul, the capital city of South Korea, which has been the political, economic, and cultural nucleus of the country for the last 600 years and is now a global mega city with a population of 10 million living within its municipal boundary and another 10 million within its suburbs.

Our study makes two important contributions. First, we quantitatively examine the effects of different types of zoning, in combination with street-level physical environment, on walking activities. Street-level physical environment (micro-scale design measures implemented at the neighborhood level) is closely associated with walking activity on streets. The study employs multiple linear regression modeling to analyze the effect of zoning on walking activities. Second, another contribution of this study is that we empirically found interaction effects between on-street physical environment and zoning measures that determine the effect of land use patterns on walking activities.

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2. Literature review

2.1. Urban physical environment and walking activity

The urban physical environment has been measured and tested as one of the possible determinants influencing various aspects of walking activity. Kent and Thompson (2014) suggest that urban planning dealing with physical environment and urban form at the municipal level can support personal health through physical activity, including walking on the street. Many studies have identified a positive relationship between walking activities and the urban physical environment (Feng et al., 2010; Sallis et al., 2012), although the suggested relationship remains as an association pending further verification for causality by future research.

For example, Hirschhorn (2004) demonstrated that pedestrian-friendly urban design and transit-oriented development are closely related to a high level of walking activity. Based on the analysis of two regions in the U.S., Frank et al. (2010) concluded that people living within neighborhoods with high walkability actually “walked to work more often than those” in neighborhoods with low walkability. Based on a review of empirical studies verifying the possible connection between the physical environment and obesity, Sallis et al. (2012) suggested that walking, as both a leisure-based physical activity and a form of transportation, was positively related to physical environment. Zick et al. (2013) also found that a physical environment favorable for walking was likely to increase individual pedestrian activity, even though the effect was expected to be moderate. For neighborhood walkability, they measured attributes such as proximity to CBD and population density.

Sung et al. (2013) identified that the volume of pedestrian activity on the street was closely associated with the on-street physical environment, such as diversity and density of land use. For their study, various urban form variables were measured in five categories: street-level physical environment, mixed-use, small block, concentration, and accessibility. Coffee et al. (2013) demonstrated that walkability was related to reduced cardio-metabolic risks, which was a possible result of walking more. Intersection density, dwelling density, land use mix, and retail area were measured for the analysis. Park et al. (2015) found that micro-level urban design attributes, such as more windows on the second and third levels and ground-level façade transparency of nearby buildings, were associated with choosing walking over driving to the station.

2.2. Land use regulations and physical activity

Although previous empirical studies have focused on the connection between the urban physical environment and daily walking activities, few studies have empirically examined the relationship between land use regulations and physical activity. Zoning was originally introduced to improve public health (Frumkin et al., 2004; Schilling and Linton, 2005; ARHF and ARC, 2006; Talen, 2009; Institute for Local Government, 2010; Sung, 2011). Few studies have focused on its connection to physical activity. Because of the lack of such empirical studies, the integration between land-use planning through zoning and public health through walking remains unknown in Korea, as it does in the UK and other countries (Carmichael et al., 2013). A physical environment that supports physical activity can be attained through a convergent approach between urban planning and public health (Powell, 2005; Kochtitzky et al., 2006). In this respect, Powell (2005) emphasized the importance of land-use planning, including zoning and building design, for public health improvement. In addition, Green and Klein (2011) considered zoning an important method for connecting urban planning and public health.

There is an ongoing criticism over Euclidean zoning, which promotes the exclusive single use of land. Euclidean-style zoning

causes auto-dependency and a sedentary lifestyle, especially in single-use suburbs (Hirschhorn, 2004; Schilling and Linton, 2005). To achieve both livable and walkable neighborhoods enhancing public health, traditional neighborhood design with mixed-uses is encouraged. For example, investigating 168 mixed-use zoning ordinances across 22 California cities, Cannon and Thomas (2013) found that more mixed land-use for daily use activities has a higher potential for walking. The micro-scale land use approach considers and emphasizes individual buildings as basic units of local land use management. Katz (2004) suggested a new zoning paradigm that prioritizes micro-scale urban form controls first and land use and density controls second.

3. Korean zoning system

Zoning was first introduced in Korea in 1939. In 1962, Korea specified eight zoning districts. This number increased to 9 in 1971, 12 in 1988, and 16 in 2000, indicating an increasing diversity of land uses (Lee, 2000). Korea's zoning system is similar to that of those in North American countries, as it regulates building and land use, size, and density, including building coverage ratio, floor area ratio (FAR), and sometimes building height as well as stories. Zoning districts usually regulate the upper limit of land-use density regulations for the building coverage ratio and floor area ratio. The zoning law also stipulates allowable building uses in each zoning district. Table 1 shows the upper limit of land-use density by districts (building coverage ratio and floor area ratio).

Unlike North American countries, the Korean zoning system is primarily regulated by the central government, and local governments have limited authority to adjust density and building uses (Noh, 1998; Gallent and Kim, 2001). Local governments such as Seoul's municipal government can adjust these ratios and building uses by enacting ordinances. The same law also stipulates allowable building uses in each zoning district. The number of allowable buildings uses increases with up-zoning,¹ an accumulated up-zoning system (see Table 1 and Appendix 1).

The Korean zoning system does allow for relatively more diverse uses of land and building types in zones than that in the US (Min, 2007). Most residential, commercial, and industrial zones can take neighborhood-supporting commercial use buildings (hereafter, neighborhood uses). And, this neighborhood commercial use² is sometimes even allowed in exclusive residential and industrial zones (see Appendix 1). Residential and commercial districts that allow these neighborhood uses in Seoul comprise approximately 55% of total zoned areas, whereas exclusive residential zones are only approximately 1%.

One unique characteristic of zoning in Korea is quasi-zoning classification for residential and industrial areas. This practice is similar to overlay zoning in the US in that it allows for residential, commercial, and business uses in addition to the original primary use (Kim and Kang, 1998). These modifications have resulted in a higher level of land use mix than in North American cities.

4. Data and methodology

To understand zoning regulations' impact on walking activity, we compiled the data on Seoul, Korea, which has a zoning system.

¹ Up-zoned areas are categorized into the following: commercial is an up-zone for green and residential; and residential is an up-zone for green. Up-zones have more diverse uses and higher densities (Lee, 1991).

² There are two types of neighborhood commercial uses: the 1st-type and the 2nd-type. The neighborhood commercial uses cover shops, restaurants, offices, banks, workshops, and supermarkets within a certain size limit. Even a karaoke room without alcohol is considered the 2nd-type neighborhood use and is permitted in most zones in Seoul.

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