Walking and Cycling

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Walking and cycling are not only frequently-utilized modes of transport but also a popular component of people's daily physical activity. As two alternatives to motorized travel modes such as private driving, walking and cycling can effectively reduce transport costs and, at the same time, mitigate traffic congestion induced by the explosion of motorized transport [1].

walking cycling active travel sustainable travel

1. Introduction

As environmentally friendly travel modes, walking and cycling are conducive to decreasing energy consumption and transportation-related air pollutants [2] and greenhouse gas [3]. In addition, walking and cycling involve moderate activity of skeletal muscles and can act as an efficient remedy for the sedentary lifestyle that is widespread in modern society, preventing a wide variety of non-communicable diseases such as obesity [4], cardiovascular diseases [5][6], hypertension [7], diabetes [8], and mental disorders [9][10] Moreover, walking and cycling are related to a higher level of social integration and interaction, thereby bringing about various social benefits [11]. In summary, walking and cycling have great potential for promoting economic, environmental, and social sustainability and public health.

However, despite the aforementioned multi-aspect benefits, walking and cycling are faced with marginalized or marginalizing status. The developed world has been witnessing a steadily low share of walking and cycling for decades. For example, in the USA, despite a mild rise from 9.6% in 2001, the combined mode share of walking and cycling was still as low as 12.9% in 2017 [12]. In the developing world, walking and cycling play a much more important role in people's daily life than it does in the West. However, they are experiencing a rapid decline due to the ever-increasing prevalence of private motor vehicles. In Beijing, China, the mode share of cycling dropped to 15% in 2014 from 62.7% in 1986 [13]. The latest travel survey of Shenzhen revealed that walking and cycling have steadily declined in Shenzhen in the last few years; and that walking has decreased from 50.0% in 2010 to 46.0% in 2019, while cycling dropped from 6.2% to 4.0% [14][15].

Against this backdrop, to promote walking and cycling or retard their decline, researchers from a variety of domains such as geography, urban planning, and public health have been devoted to examining the characteristics and built environment correlates/determinants of walking and cycling. The key to identifying the built environment correlates of walking and cycling is to accurately measure the built environment. The "3Ds" model proposed by Cervero and Kockelman [16], which delineates the built environment with the density of objects of interest (e.g., population, dwelling, and employment), diversity (i.e., land use mix), and design (often measured by street connectivity), is among the most influential and frequently-used methods of quantifying key elements of the built environment. Later, the “3Ds” model was expanded to “5Ds” by Ewing and Cervero [17], with “distance to transit” and “destination accessibility” added. Afterward, the “5Ds” model was further advanced to the “7Ds” model, with “demographic characteristics” and “demand management” involved.

However, despite the enormous research findings based on the application of the above-discussed “Ds” models, there are three critical issues correlated with walking and cycling studies. First, more often than not, the existing studies consider walking and cycling as similar or as an integral (i.e., active travel), and limited studies examine and compare the impacts of the built environment on walking and cycling simultaneously. As revealed by increasing studies, walking and cycling are essentially distinguished transport modes [18][19][20]. Hence, distinguishing between the built environment correlates of walking and cycling can enlighten the practitioners and policy-makers and help provide targeted interventions.

2. Socioeconomic Correlates and Built Environment Correlates

2.1. Socioeconomic Correlates

Individual- and household-level socioeconomic and demographic characteristics such as age, education, and household income can influence people’s walking and cycling propensity through affecting his/her transportation resources, time and money budget, physical fitness, etc. Arguably, there are generally two ways of dealing with socioeconomic variables in travel behavior studies [21]. First, researchers have divided the general population into different subgroups based on certain socioeconomic features (e.g., children and elderly, local and migrant, and female and male) and focused on one or more subgroup(s). The aim of doing so is to disclose the characteristics and correlates of a certain population subgroup or compare those between different subgroups. Such studies often derive diverse subgroup-specific findings on built environment-travel behavior associations, due to different travel demands, preferences, attitudes, and constraints of different population subgroups [22], which can usually moderate (exacerbate or attenuate) the effects of the built environment on travel behaviors. For example, through reviewing 17 academic articles, Adkins et al. [22] revealed that the impacts of the built environment on walking, cycling, and physical activity were stronger for the advantaged population groups (e.g., high-income and whites) than the socioeconomically disadvantaged. Similarly, Liu et al. [21] compared the trip frequency of four major transport modes of migrants and that of local residents and identified their built environment correlates. They corroborated that the built environment had less pronounced impacts on travel behaviors of migrants (who are socially and economically disadvantaged) and attributed the result to the process of “transportation assimilation” of migrants. A study conducted in the USA [23] found that the built environment surrounding both home and school (e.g., residential density) can significantly influence the probability of walking and cycling of adolescents. Whereas, also in the USA, the study by Nagel et al. [24] revealed that as for the elderly, the built environment had no effects on their propensity of walking whatsoever.

Second, more frequently, socioeconomic variables are incorporated in travel behavior studies and considered as control variables. In such studies, there are no specific population subgroups identified. More often than not, the incorporation of socioeconomic variables is for adjusting for confounders and singling out the effects of the built environment.

2.2. Built Environment Correlates

Basically, studies on the associations between the built environment and walking and/or cycling can be divided into three categories, according to whether the study examines built environment correlates/determinants of walking and cycling separately or simultaneously, or considers them as an integral.

The first category examines the effects of the built environment on walking and cycling separately. There are numerous such studies in the last few decades. Handy et al. [25] confirmed that after controlling for attitudes and residential preferences, the built environment still had a significant impact on walking. Saelens and Handy [26] reviewed and summarized 13 reviews and 29 original empirical studies and pointed out that density, land use mix, and non-residential destination proximity had significantly positive effects on walking; and that such effects were more pronounced for transportation walking than recreational walking. A recent empirical study [27] corroborated such findings. As for cycling, Fraser and Lock [28] conducted a comprehensive review and identified the positive environmental factors such as population density and proximity of amenities, and negative factors such as long trip distance. Despite the fruitful research findings, such studies focusing on walking and cycling separately failed to inform us whether and how the same built environment affects walking and cycling differently.

The second category combines walking and cycling into one as active travel, in consideration of the fact that the two modes share a variety of similarities, such as both being non-motorized transport modes and both involving moderate physical activity [29]. Freeman et al. [30] found that higher walkability (measured by density, land use mix, etc.) was significantly associated with a higher probability of active travel in New York. Similarly, the built environment was also found to be significantly associated with active travel in the UK, especially for obligatory/mandatory purposes [31], and in China, especially for the elderly [32]. However, it may be problematic to combine walking and cycling as one, which ignores the distinctions between features and correlates/determinants of the two transport modes. For example, in their international comparative study on the effects of the built environment on walking and cycling based on 17 cities in 12 countries, Kerr et al. [18] concluded that a highly walkable environment may not be suitable for transport cycling. Applying the stage-of-change approach, Biehl et al. [19] identified both shared and disparate determinants of walking and cycling. Moreover, based on the empirical study in the Netherlands, Ton et al. [20] identified different determinants for walking and cycling and stressed that walking and cycling should be considered two distinguished transport modes.

The third category examines the effects of the built environment on walking and cycling simultaneously and conducts comparisons wherever possible. Such studies are relatively limited in quantity. Table 1 presents a summarization of representatives of such studies, including their study areas, control variables (mainly socioeconomic characteristics), measurements they employed for “5Ds” variables, and most importantly, the associations between the “5Ds” variables and walking and cycling they revealed. Such studies are predominantly conducted in the developed world context, particularly the United States and Europe. Empirical examinations from the developing context are limited, for which the representatives include studies by Cervero et al. [33] in Colombia, Hino et al. [33] in Brazil, Munshi [34] in India, and Biehl et al. [19] and Liu et al. [21] in China. Moreover, inconsistencies exist between developed and developing contexts and between built environment correlates/determinants of walking and cycling. For example, most studies in the developed context found that density (typically measured by residential or employment density) has significant positive effects on walking and cycling [35][36][37], while a study in Colombia found no effects of density on either walking or cycling [38]. Hino et al. [33] found that land use mix had no significant impacts on walking but significant negative impacts on cycling, while Munshi [34] revealed that it was positively associated with walking and had no effects on cycling. Both studies derived different results from studies in the developed context (e.g., [39][40][41]). Discrepancies of associations between the built environment and walking and cycling exist in both developed and developing contexts. For instance, a Netherlands study [42] confirmed significant positive effects of density on walking but its negative effects on cycling. Liu et al. [21] found that in Xiamen, China, distance to the closest commercial center was significantly negatively related to walking and yet positively related with cycling. Such discrepancies between the built environment correlates of walking and cycling corroborate that walking and cycling are essentially distinguished transport modes.

All in all, researchers have predominantly identified the built environment correlates/determinants of walking and cycling separately or considered the two modes as one, and studies elucidating and comparing the impacts of the built environment on walking and cycling are relatively limited. On the other hand, among the studies focusing on walking and cycling simultaneously, inconsistencies still exist, both between developed and developing contexts and between the two modes themselves.

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