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Objective correlates and determinants of bicycle commuting propensity in an urban environment

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ABSTRACT

Objective: Bicycle use for commuting is being encouraged not only to address physical inactivity, but also vehicular congestion, air pollution and climate change. The current study aimed to ascertain the urban environmental correlates and determinants of bicycle use for commuting (bicycle commuting) among the working or studying population in Barcelona, Spain.

Methods: Adults ($n = 769$; 52% females) recruited whilst commuting within Barcelona (Spain) responded to a comprehensive telephone survey concerning their travel behaviour. Based upon responses collected from June 2011 to May 2012, participants were categorised into four groups: frequent bicyclists, infrequent bicyclists, willing non-bicyclists, and unwilling non-bicyclists. The determinants of frequency and willingness (propensity) to commute by bicycle were assessed by multinomial logistic regression models adjusted for potential confounders and covariates.

Results: The number of public bicycle stations surrounding the home address and amount of greenness surrounding the work/study address were significant positive determinants of bicycle commuting propensity. On the other hand, the number of public transport stations surrounding the home address and elevation of the work/study address were significant negative determinants of bicycle commuting propensity. Individual age, education level, gender, nationality, physical activity level and commute distance significantly affected this propensity.

Conclusion: Greater availability of public bicycle stations and higher levels of urban greenness may increase bicycle use by adults commuting within a city such as Barcelona, Spain. Electrically-assisted public bicycles may address the challenge of elevation, making this system a more competitive mode against traditional motorised public transport.

Abbreviations: dB(A), A-weighted decibels; GIS, geographic information system; NDVI, Normalized Difference Vegetation Index; NO_2, nitrogen dioxide; RBA, route-by-area.

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Introduction

Physical activity is associated with myriad mental and physical health benefits (Haskell et al., 2007; U.S. Department of Health and Human Services, 1996). Insufficient physical activity may result in cardio-metabolic conditions such as obesity, diabetes, and high blood pressure (Furie and Desai, 2012) which rank as leading causes of death and disability globally (Lim et al., 2012). An urban environment can facilitate the incorporation of regular physical activity into daily routines (Brown et al., 2013), such as with active transport (Pucher et al., 2010), increasing physical activity levels. Moreover, a substantial population shift from motorised to active transport modes may reduce emissions and improve air quality, while also reducing traffic accidents, bringing greater environmental and public health benefits (De Nazelle et al., 2011).

Most cities have only a very small proportion of commuting trips by bicycle (Pucher et al., 2010), and our study site of Barcelona is no exception with only 1.3% of the trips being made by bicycle (Autoritat del Transport Metropolità, 2013). However, other cities have a much higher bicycle share. For example, Copenhagen has approximately a third of all commuting trips by bicycle (City of Copenhagen, 2012). While recently more studies are being conducted in non-exceptional cities, the majority of previous studies have focused on exceptional cities like Copenhagen, and arguably, determinants of bicycling may vary at different levels of participation in the population. For example, high levels of participation in bicycling may reduce the individual risk of bicyclists by heightening awareness of their presence and thereby mitigating interaction with motorised traffic (Bhatia and Wier, 2011). While participation rates are still low, however, bicycle infrastructure such as separated bike lanes on major roads may reduce the risks for bicyclists and encourage participation by offsetting the negative effects of higher traffic volumes (Broach et al., 2012; Wegman et al., 2012; Winters et al., 2010) and by enhancing connectivity and travel times (Winters et al., 2011). The vast majority of studies examining the determinants of bicycling commuting have focused on infrastructure features such as this in different cultures and geographies (Panter and Jones, 2010; Molina-García et al., 2010; Rodríguez and Joo, 2004; Titze et al., 2008; Troped et al., 2001). One potential reason for this focus is the prevailing framework for understanding travel behaviour. Bicycling infrastructure and other built environment attributes can be thought as influencing travel behaviour by affecting the relative utility of different travel modes (Boarnet and Crane, 2001; Cervero, 2002; Crane, 1996). The utility of a given mode is related to the perceived cost and difficulty of using that mode (Boarnet and Crane, 2001; Cervero, 2002; Handy and Boarnet, 2002). By influencing travel times, convenience, safety, pleasantness, and so on, infrastructure features have a direct influence on the choice of different travel modes.

Despite the emerging importance of the built environment for bicycling, several measurement improvements are necessary. For one, a broader set of environmental measures is required. Some built environment attributes have been less consistently covered than others in the existing literature, such as greenness and noise, which are features of a typical urban environment that warrant consideration. Based on the travel behaviour framework, greenness and noise likely affect the utility of bicycling by influencing the overall pleasantness and enjoyability of it. While noise may directly influence utility in this way (Winters et al., 2011; Panter et al., 2008), greenness may generally promote physical activity (James et al., 2015; Lee et al., 1999; Rodriguez et al., 2014; Frank et al., 2007; Ewing et al., 2008). In fact, greenness has been observed as one of the most stimulating perceived (subjective) environmental determinants to bicycle commute (Wahlgren and Schantz, 2012). In addition to a broader set of environmental measures being required, the context in which built environment measures are made deserves attention. Most studies have focused on the environment around where trips begin. Yet, the attributes of destinations and of the route in-between are also likely to impact the utility of a given mode. For example, Winters and associates (Winters et al., 2011) find that features of the origin, route, and destination environments are all significant determinants of bicycling and in different ways (e.g., some determinants are more important in one spatial zone than the others). Not only can the attributes of the built environment be important for mode choice, but the perception of travellers about these attributes can be too. In the end, the utility of a given mode for a person is a melding of the actual attributes, the traveller's perceptions of those attributes, and the traveller's valuation of the importance of those attributes. Indeed, studies have considered both objective and perceived measures of bicycling infrastructure, with interesting comparisons. Previously, perceptions have been found to be more important predictors of travel behaviour than objective measures of the same environmental characteristics (Dill and Voros, 2007; Hoehner et al., 2005). McGinn and associates (McGinn et al., 2007) found both to be significant, but varying in magnitude. Both objective and perceived measures of the built environment are likely to factor into the valuation of travel modes and resulting decisions about how to travel.

While attitudes and perceptions of an individual are known to be important theoretical considerations for travel planning (Dill et al., 2014; Sener et al., 2009a,b), a review on the determinants of bicycle commuting highlighted gaps in the literature and the need to gather more evidence on objective and built environmental determinants (Heinen et al., 2010). In this paper we address this call by focusing on an expanded set of built environment measures calculated in different contexts (around home, around work/study, and along the route). Specifically, we aim to (1) describe the urban environmental characteristics (including greenness and noise) of three different spatial zones (home, work/study, and commute route areas) according to a participant's propensity to bicycle commute; and (2) evaluate the strength of the relationship between multiple yet specific urban environmental determinants of bicycle commuting (including greenness and noise) and the propensity to bicycle commute.