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Short-term planning and policy interventions to promote cycling in urban centers: Findings from a commute mode choice analysis in Barcelona, Spain

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ABSTRACT

Background: Cycling for transportation has become an increasingly important component of strategies to address public health, climate change, and air quality concerns in urban centers. Within this context, planners and policy makers would benefit from an improved understanding of available interventions and their relative effectiveness for cycling promotion. We examined predictors of bicycle commuting that are relevant to planning and policy intervention, particularly those amenable to short- and medium-term action.

Methods: We estimated a travel mode choice model using data from a survey of 765 commuters who live and work within the municipality of Barcelona. We considered how the decision to commute by bicycle was associated with cycling infrastructure, bike share availability, travel demand incentives, and other environmental attributes (e.g., public transport availability). Self-reported and objective (GIS-based) measures were compared. Point elasticities and marginal effects were calculated to assess the relative explanatory power of the independent variables considered.

Results: While both self-reported and objective measures of access to cycling infrastructure were associated with bicycle commuting, self-reported measures had stronger associations. Bicycle commuting had positive associations with access to bike share stations but inverse associations with access to public transport stops. Point elasticities suggested that bicycle commuting has a mild negative correlation with public transport availability (−0.136), bike share availability is more important at the work location (0.077) than at home (0.034), and bicycle lane presence has a relatively small association with bicycle commuting (0.039). Marginal effects suggested that provision of an employer-based incentive not to commute by private vehicle would be associated with an 11.3% decrease in the probability of commuting by bicycle, likely reflecting the typical emphasis of such incentives on public transport.

Conclusions: The results provide evidence of modal competition between cycling and

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public transport, through the presence of public transport stops and the provision of public transport-oriented travel demand incentives. Education and awareness campaigns that influence perceptions of cycling infrastructure availability, travel demand incentives that encourage cycling, and policies that integrate public transport and cycling may be promising and cost-effective strategies to promote cycling in the short to medium term.

1. Introduction

The negative consequences of automobile dependency have become widely recognized in recent decades, prompting cities across the globe to invest in transportation alternatives with the potential to improve public health, reduce air pollution and carbon emissions, and relieve traffic congestion (Pucher et al., 2010b; de Nazelle et al., 2011; Deakin, 2001). As an active travel mode with physical activity benefits and no direct emissions, cycling has played an increasingly prominent role in these efforts to reduce automobile use and create more sustainable transportation networks in urban centers (Handy et al., 2014).

Cycling is often framed as a public health strategy, given growing evidence of its importance for physical activity and thus its potential to reduce associated chronic diseases. Ecological studies have found that countries with higher levels of active transportation (walking and cycling) have higher percentages of adults meeting minimum weekly physical activity recommendations and lower prevalence of obesity and diabetes (Pucher et al., 2010a; Bassett et al., 2008). These findings have been echoed in individual-level studies and systematic reviews, which have shown that active transportation is positively associated with physical activity and inversely associated with the risks of obesity, cardiovascular disease, and all-cause mortality (Wanner et al., 2012; Hamer and Chida, 2008; Andersen et al., 2000; Matthews et al., 2007). Importantly, recent work has suggested that bicycle commuting adds to overall physical activity, rather than replacing other forms of physical activity (Donaire-Gonzalez et al., 2015). Cycling in proximity to vehicles also entails certain health risks, including injuries and fatalities from crashes and increased exposure to air pollutants (Pucher and Dijkstra, 2003; Peden et al., 2004; Briggs et al., 2008; de Nazelle and Rodriguez, 2009). Although emerging research suggests that the benefits of increased physical activity may outweigh these risks (Mueller et al., 2015; Schepers et al., 2015; Rojas-Rueda et al., 2011; Hartog et al., 2010), these concerns persist and indicate a need for well-designed infrastructure that promotes safety, limits air pollution exposure, and thus maximizes the potential health benefits of cycling.

At the same time, cycling has become an important travel mode in strategies to promote low-carbon cities. Such strategies have been enacted in developed and developing countries, to varying degrees, in order to address the climate change challenges that result from fossil fuel consumption in the transportation sector. As a leading example, Copenhagen has incorporated cycling into its goal of becoming carbon neutral by 2025, with specific objectives including a 50% commute mode share for cycling and a 75% combined mode share of walking, cycling, and public transport for all trip purposes (City of Copenhagen, 2012). Rio de Janeiro has incorporated cycling into its Low-Carbon City Development Program (LCCDP), which includes plans to double the city's bicycle network and implement a bicycle sharing program in pursuit of reduced carbon emissions (The World Bank, 2013a). To encourage this type of growth in developing cities worldwide, the World Bank has published LCCDP plan preparation guidelines that include cycling recommendations (The World Bank, 2013b). As the World Bank's Low-Carbon Livable Cities (LC^2) initiative is enacted to support low-carbon strategies in 300 of the world's largest developing cities (The World Bank, 2013c), and as the mayors of 491 cities join together in a commitment to reduce greenhouse gas emissions as part of the recent Compact of Mayors (Compact of Mayors, 2015), the role of cycling in international climate change mitigation efforts is likely to become even more prominent.

The importance of cycling for public health and low-carbon mobility—coupled with the potential for non-motorized transportation to reduce congestion and generate corresponding gains in air quality (de Nazelle et al., 2011; Woodcock et al., 2009)—has prompted many cities to implement policies and invest in infrastructure to promote cycling. While bicycle lanes and separated paths are common interventions, cities have increasingly turned to policy and programmatic approaches such as bicycle sharing and travel demand management programs (Pucher et al., 2010b). The strategies available to planners and policy makers for encouraging cycling are diverse, with varying impacts, time horizons, and potential synergies. Within this context, decision makers would benefit from an enhanced understanding of the relative influence of various strategies on cycling and how they might be combined and prioritized in practice.

In this study, we examined how planning and policy interventions are associated with bicycle commuting in Barcelona, Spain. Compared to many Northern European cities, Barcelona has a relatively small cycling mode share equating to just 1.3% of trips in the metropolitan area (Autoritat del Transport Metropolitá, 2013). To reverse this trend, the city has pursued numerous policies over the past decade to be friendlier toward cyclists. Key changes include the addition of nearly 60 km of bicycle lanes between 2007 and 2012 (an increase of 44%), expansion of bicycle parking throughout the city, and the 2007 implementation of *Bicing*, a bicycle sharing program serving nearly 100,000 annual subscribers as of February 2016 (Bicing, 2016).

To evaluate these efforts and other potential cycling strategies, we estimated a travel mode choice model that explored factors associated with bicycle commuting among adults who both live and work in the municipality of Barcelona. The data