



## Cycling willingness: Investigating distance as a dependent variable in cycling behavior among college students<sup>☆</sup>



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### ABSTRACT

We present a novel approach to understanding distance as a barrier to cycling and its use as a dependent variable in multinomial logistic regression. In doing so, this study explores distances in relation to spatially and relevant human factors such as gender and propensity to cycle among college students. College students ( $N = 949$ ) participated in a health survey and stated possible predictors of cycling based on their cycle usage and preferences in the previous 30 days. While utilizing GIS in a bicycle-friendly network, we created geo-statistical GIS-groupings and performed multinomial logistic regression analysis. We examined college students to discover how their demographic and personal characteristics may mediate the deterrent properties of distance when considered as a dependent variable in cycling to a college campus. Age and propensity for cycling for transportation mediate the negative effect of distance on the likelihood of cycling. The findings also suggest that infrastructure improvements could lessen the impact of distance as a barrier to cycling and increase the likelihood of cycling for commuting.

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### Introduction

The trend toward cycling as an important and healthy mode of transportation in larger cities has increased (League of American Bicyclists, 2013), and more and more communities are encouraging active transportation opportunities (Dujardin et al., 2012; Shan, 2014; Snizek, Nielsen, & Skov-Petersen, 2013). In the U.S., this trend is mostly seen in cities in the East and in Western states (League of American Bicyclists, 2013). Additional cities with the highest percentage of change in cycling between the years 2000 and 2011 have also established bike share programs (García-Palomares, Gutiérrez, & Latorre, 2012; Rybarczyk & Wu, 2010), initiated complete street programs (National Complete Streets Coalition, 2013), have a large campus population, or have shown an increased awareness of the need for sustainability in transportation (Schneider, 2013).

The physical built environment influences the degree of cycling for transportation and recreation (McGinn, Evenson, Herring,

Huston, & Rodriguez, 2007). Others have pointed out that the built environment, personal demographics, perceptions, and attitudes about physical activity can be barriers to or facilitators for cycling (Charreire et al., 2012). More detail on trip distribution, patterns and daily activities of college students is provided by Chen (2012). Utilizing trip diaries and surveys, Chen finds destinations with the highest frequency are labeled “home” and “academic activities”. Chen (2012) also notes that the surveys were geocoded but does not explain whether a bicycle-friendly network instead of a street-based network was explicitly used to compute biking and distances on dedicated bike paths. Khattak, Wang, Son, and Agnello (2011) and Nayar (2012) not only present a campus-oriented survey in their studies but also demonstrate the different behaviors among students living on-campus versus off-campus. This includes dissimilar statistical patterns found in transportation behavior in traveling to and from an urban campus compared to that occurring in the setting of a sub-urban campus in which personal vehicles, public transit, or bicycles were used. Both studies included mixed modes of transportation, and in Nayar's (2012) study it is not clear whether distance was considered.

The literature on cycling primarily provides studies (Buehler, 2012; Buehler & Pucher, 2011; Chen, 2012; Krizek & Johnson, 2006) which emphasize general population and function (i.e., distance to trailheads or bike facilities) and rarely specify targeted groups. Some studies present distance as an independent variable

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in their statistical models and as a supporting incentive in the larger process of deciding to bike or not to bike (Emond & Handy, 2012; Gatersleben & Appleton, 2007; Handy, Xing, & Buehler, 2010; Krizek & Johnson, 2006; Xing, Handy, & Mokhtarian, 2010). Heinen, van Wee, and Maat (2010) present an interesting observation that “most research into bicycle use identifies distance as a significant factor” (p. 61). Mullan also found in her studies on views of cycling for transportation (Mullan, 2013) and also cycling for recreation (Mullan, 2012) that distance, in terms of the length of the journey as well as trip purpose, are important in identifying willingness to cycle. For those who use cycling for transportation, the decision to do so was rarely based on health or environmental factors. Factors such as time, distance, and weather were more important drivers in the decision-making process (Mullan, 2013). These findings suggest distance creates a more significant barrier to some people than others. As such, we transpose the approach to studying distance as an independent variable to studying it as a dependent variable. We use spatial statistics to identify clusters of cyclist which in turn permits additional multinomial logistic regression analysis. We examine demographic and behavioral characteristics that may mediate different distances affecting college students' propensity toward cycling to campus. By knowing what specifically contributes to distance being an impediment to cycling, we hope to gain insights on how to influence policy that promotes cycling over a variety of distances and make such distances less of an impediment.

This study focuses on distance-relevant cycling behavior among college students at, “bicycle-friendly university” named by the *League of American Bicyclists* (2011b), and within the region of Boise, Idaho, where approximately 4% of its population regularly commute to work by bike (*League of American Bicyclists*, 2011a) and which has a richly-developed bike path network along a river. We examine several human factors that mediate distance as a barrier to or facilitator of engaging in cycling such as gender, age, biking usage, and car ownership, as well as spatial travel patterns to help explain the impact of distance on the decision of college students to bike. We use the application of bicycle-friendly networks in a GIS analysis to examine the patterns of cycling to the center of campus (the centrally located library) with statistical groupings in GIS and, thereafter, use multinomial logistic regression analysis to identify factors having significance for distance. We believe this combination of spatially-driven research along with a statistical analysis presents a novel approach and platform to study the cycling-based activity of college students.

## College students, human factors and distance

### *Cycling among college students*

Many studies examine choice of transportation as an integral focus among children in kindergarten, elementary school, and junior high schools (Evenson, Huston, McMillen, Bors, & Ward, 2003; Ewing, Schroeder, & Greene, 2004; Hoffman, Hayes, & Napolitano, 2014; Lang, Collins, & Kearns, 2011; McDonald, 2008; Schlossberg, Greene, Phillips, Johnson, & Parker, 2006). Faulkner, Buliung, Flora, and Fusco (2009) reviewed existing research finding students who walk, bike or use other non-motorized transportation to get to school tend to be overall more active than others. In regard to college-students, other scholars (Balsas, 2003; Bopp, Kaczynski, & Wittman, 2011; Chen, 2012; Kamruzzaman, Hine, Gunay, & Blair, 2011; Khattak et al., 2011; Nayar, 2012) present valuable insights into behavior, modal choice, and cycling activities on and in the immediate proximity of college campuses.

We focus on college students and their campuses to ascertain whether campus transportation policies might influence the behavior of students both within and outside those boundaries. Balsas develops the argument that communities in close proximity are affected by universities and their “parking, traffic, service access and off-campus housing” (Balsas, 2003, p. 36). With more insights into cycling behavior among college students which influences future campus policies, and can also ultimately transform neighboring communities. Schneider (2013) notes the efforts of communities to shift mode choice from automobiles to walking and bicycling as they frame a discussion on routine mode choice decisions. This discussion, on the steps needed to make such a shift happen, has value for larger college campuses and cities.

Our focus on a college population not only informs policy and decision makers but also provides insight into reorganizing, for example, college campus policies based on transportation and housing needs. Balsas (2003) explicitly states that college campuses are unique places whose population (students, staff, and faculty) turnover at a much higher frequency than the general population. This is generally supported by Bopp et al. (2011); however, in the context of active commuting, these researchers provide little knowledge about how a campus and its cycling environment influence student travel patterns and behaviors.

Campus cycling policies affect their population and adjacent communities, but there is little empirical work available on the subject of cycling among college students and their behavior when they live off-campus. Understanding these needs and then better addressing them might help to build more efficient and cost-effective transportation policy in the context of college campuses. It is also possible to imagine that the routines and behaviors adopted in college, such as cycling to work or school, can be carried on later in life, as Balsas (2003) suggests.

### *Factors of age, gender, cycling for recreation and car ownership*

Shahan (2007) found rates of cycling in both Maryland and the Netherlands are more often positively associated with age and negatively associated distance than with factors such as bike infrastructure and amenities. Pucher, Garrard, & Greaves, (2011) found that cyclists in the outer suburbs of Melbourne and Sydney tend to be under the age of 20 and primarily cycle for recreation on weekends. In the US, Pucher, Buehler, and Seinen (2011), found that the number of 40–64-year old cyclists increased the most of any age group they studied, more than doubling their share of bike trips between 2001 and 2009.

There is evidence that “women cycle shorter distances to work than men” (Heinen, Maat, & Wee, 2011, p. 62). This was also found to be the case in Copenhagen: persons commuting 8 km (approximately 5 miles) or more are more likely to be male. Additionally, long distance commuters in general are less likely to be women (Hansen & Nielsen, 2014). This is notable, since Copenhagen is well known for its extensive cycling infrastructure available to riders. Akar, Fischer, and Namgung (2013) cite many other studies that demonstrate women are likely to cycle less than men. Pucher, Buehler, et al. (2011) note that in the U.S. the share of women cyclists is 25% and the percent of trips women took by bike dropped from 33% to 22% between 2001 and 2009. Finally, Buehler (2012) specifically finds that men have a 2.56 greater likelihood of cycling to work than do women.

In the US, more than two-thirds of bike trips are taken for recreation (Pucher & Dijkstra, 2000). With such a large percentage of cycling for recreation purposes, it is reasonable to consider whether one's predilection toward cycling for recreation has an influence on one's decision to cycle for transportation. Stinson and Bhat (2004) found a relationship between cycling in general and cycling for

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