Gender gap generators for bicycle mode choice in Baltimore college campuses

Farhad Abasahl[a], Kaveh Bakhsh Kelarestaghi[b,*], Alireza Ermagun[c]

[a] Department of Civil and Environmental Engineering, University of Maryland, 1173 Glenn Martin Hall, College Park, MD 20742-2835, USA
[b] Charles Edward Via, Jr. Department of Civil and Environmental Engineering, Smart Urban Mobility Laboratory, National Capital Region, Virginia Tech University, 7054 Haycock Road, Room 425, Falls Church, VA 22043, USA
[c] Department of Civil and Environmental Engineering, Northwestern University, Technological Institute, 2145 Sheridan Rd, Evanston, IL 602088, USA

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ABSTRACT

This study explores the gender equity in bicycle mode choice and obstacles preventing women from bicycling to promote biking on major college campuses in the Baltimore metropolitan area. Socioeconomic data, travel preferences, mode accessibility, and individual factors of the surveyed population are used to identify generators of gender difference. To investigate gender equity, we develop a bivariate statistical analysis along with a two-level nested logit model. The results of the bivariate statistical analysis indicate females are about 30% less likely to bicycle from home to campus and are significantly more sensitive to environmental and infrastructural conditions. Complementary to the bivariate statistical analysis, the results of the two-level nested logit model demonstrate that distant trips, longer travel times, not having access to a bicycle, and an unsafe environment avert females from bicycling. We also find that undergraduate females are less likely to bike to campus than other group of students. The findings highlight that the integration of bicycle and transit services, advancing infrastructure to separate bicycle from motorized traffic, improving safety in bicycle facilities, and enhancing public knowledge about local bicycle routes promote bicycling among females.

1. Introduction

As an inexpensive, clean, and healthy mode (Handy, 2011), biking is a way of promoting environmentally sustainable transport. This, however, requires coping with multi-faceted challenges in mobility, safety, accessibility, economy, and equity. Transportation cannot be sustainable unless it assures equitable mobility across gender line (Hanson, 2010). Hence, as part of efforts to foster bicycling in communities, existing barriers and issues have to be identified and addressed for both genders. Baker (2009) asserts that women are "indicator species" for bicycle-friendly environments because of their aversion to risk. This means a higher percentage of female riders indicate safer infrastructure for bicycling.

The gender gap in commuting is partially attributed to the stay-at-home role some married women take on the household. Nevertheless, the dimension of this gap is continuously changing through mutual interchange with needs, policies, and planning (Crane, 2007). Women are more likely to use the bicycle for shopping and recreational purposes and less for commuting than men (Krizek et al., 2005). They show a different perception of risk (e.g. unsafe drivers' behavior) from men and prefer different bicycle facilities (e.g. bicycle lane) and

infrastructure. As a result, different bicycle facility designs can impact different audiences (Krizek et al., 2005).

This study augments the current literature of sustainable transportation and examines the gender gap in bicycle mode choice for regular travelers to college campuses located in the Baltimore metropolitan area, Maryland. Baltimore City with about 622,000 population is the busiest city in the State of Maryland and the female population is 52.9% of the total population (City-Data.com, 2016). More than dozen public and private universities are in the Baltimore Metropolitan area. University students are thought to welcome bicycling as a low-cost mode, which fulfills their multi-purpose trips. Universities are believed to be excellent environments for exploring influential factors on bicycling for several reasons including necessity of promoting new modes due to financial or environmental concerns, having suitable physical conditions for bicycling, direct aggregate effect by changing the mode choice in a large number of employees, and positive spill-over effects on communities through developing positive attitudes in students (Miller and Handy, 2012). To investigate gender equity, we develop a bivariate statistical analysis along with a two-level nested logit model. The results have the potential of contributing to identifying gender gap generators in college campuses, as well as identifying obstacles that keep

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females away from bicycling and ways to promote sustainable transport in the Baltimore metropolitan area.

The remainder of the paper is organized as follows. First, we review the related studies targeting the gender gap determinants, as well as factors that affect the transportation mode choice of educational settings' faculty, staff, and students. Second, we show the survey and the data gathering method along with a descriptive of the sample used for the analysis. Third, we juxtapose the travel behavior of females with males using a bivariate statistical analysis. This is then followed by developing two-level nested logit models to examine variables explaining the travel mode choice of females and males. We finally provide an in-depth discussion over the findings and conclude the paper with summarizing the key findings, representing the study implementations, and recommending future research avenues.

2. Background

A U.S. study (McDonald, 2012) showed boys between 8 and 13 years old bike to school 2–3 times more than girls. This gap is believed to be related to less independence mobility of girls than boys among schoolchildren. Trapp et al. (2011) indicated parents' confidence in their child's bicycling skills is a significant factor to encourage children to bicycle to school. The gender gap is then expected to diminish when schoolchildren get older and go to college, as they have higher independency and increased equal opportunities (Ermagun and Levinson, 2016; Ermagun and Samimi, 2015). In practice, however, results do not fully correspond to expectations.

Akar and Clifton (2009) conducted research on a target population of faculty, staff, and students at the University of Maryland. They determined that safety and travel time are major concerns for commuters. This study suggested that women are generally less likely to use bicycle for commuting. Incentives and disincentives such as planning of bicycle lane or bicycle routes, and proper traffic regulations in and around of campus were proposed to increase the share of biking.

Twaddle et al. (2010) indicated that facility preference is a similar concern between men and women, while women are often occasional bicyclists and more concerned about safety than men. This is consistent with the findings of another study conducted by Wang et al. (2015) at the Ohio State University, in which they emphasized on higher likelihood of commuters being male and a student. They also suggested that perceived safety, travel cost, and concern for the environment would impact bicycling.

Handy (2011) demonstrated fear of collision or being attacked (safety related factors) as primary factors that discourage women from bicycling. Matsuda et al. (2000) showed that women have different perceptions of risk and tend to avoid risky practices while bicycling than men.

Akar et al. (2013) conducted a study in the Ohio State University to explore factors affecting bicycling decisions for surveyed females including faculty, staff, and students. The results are consistent with previous studies as they revealed different risk perceptions between men and women in similar environments. The study indicated that women are more sensitive to being close to bicycle infrastructures. They suggested that changing policy and improving infrastructure encourage women to choose bicycling.

Gender differences in bicycling have not been limited to geography. Various studies found similar characteristics in different countries, which are associated with the gender gap in bicycling or are likely to propagate this gap. For example, Garrard et al. (2008) showed that female bicyclists in Melbourne, Australia prefer to use separate bicycle routes than shared paths. They proposed that separation between motorized and non-motorized traffic encourages more women to bike. Another study in China suggested that trip chains for female bicyclists are longer than men (Zhao et al., 2015).

In the U.S., female bicyclists in urbanized areas only compose 25% of users while in the Washington, D.C. region this ratio was more balanced and reached to 33% (Buehler, 2012). According to data presented by Capital Bicycle-share (CaBi), the bicycle-sharing system in the Washington metropolitan area, 52% of casual users in 2010 were female which is a significant departure from typical female bicyclists in the whole country (Buehler, 2012). For 2011, 2012, and 2014 the CaBi female user ratio was reported as 45%, 43%, and 41%, respectively. Almost 64% of female bicyclists specified their trip purpose as recreational as opposed to 56% of men. The majority of females were concerned with safety and bicycle facilities (LDA Consulting, 2013; LDA Consulting, 2015). Citi Bicycle is a bicycle-sharing system in New York launched in 2013. According to their 2015 report (Kaufman et al., 2015), 77.7% of users were male. A glimpse into this report shows that female user's ratio varies from 14% to 41% depending on location. Places with higher risk of crashes, heavier traffic, and lack of bicycle lanes seem to be less desirable for female bicyclists (Kaufman et al., 2015).

3. Bicycle-to-campus survey

The Bicycle-to-Campus Survey was designed and administered using in-person interviews and online questionnaire by a group of researchers at the Morgan State University (MSU). The purpose of the survey was to identify major issues of bicycling to campus for students, staff, and faculty, and finding ways to implement policies with the aim of promoting sustainable transport in college campuses. In addition to the sociodemographic related questions, participants were asked to respond to some other key questions in the survey. This includes items such as "access to personal motorized vehicle to commute", "access to a bicycle to bicycle-to-campus", "bicycle skill level", "frequency of bicycle-to-campus during a week", and "whether you encourage others to bicycle-to-campus", Participants were also asked to determine if obstacles such as "Darkness", "Physical need", "Condition of bicycle facilities", "Heavy traffic", "Risk of injury and theft", "Travel time", and "Air pollution", keep them from bicycling between home and campus. In the community and campus related section of the questionnaire, the participants were asked to rank campus and community-related changes to stimulate bicycle-to-campus commute. This includes items such as "Bike sharing programs for campus and/or community", "Incentive programs for bikers", "Increase enforcement and education", and "Improve bicycle facilities in campus".

The survey was initially conducted from November 6th, 2014 to November 26th, 2014 using both in-person interviews and web-based methods. In-person interviews were held at Johns Hopkins University (JHU), Towson University, and the University of Maryland – Baltimore County (UMBC). The on-line survey drew higher number of respondents and included Morgan State University (MSU), JHU-Homewood Campus (JHU-H), Towson University, UMBC, JHU-East Baltimore Campus (JHU-E), and few from other colleges. During the initial 20 days period, 268 responses were collected, of which 255 responses were valid. However, the web-based survey remained opened until June 6th, 2015 and the number of respondents spiked in the following months due to the better publicity. Overall, from November 6th, 2014 to June 6th, 2015, we received 780 completed questionnaires. Following the data processing and elimination of incorrect, or error data, the total number of valid inputs was reduced to 698, of which 50% are females.

3.1. Sample characteristics

An overview of the data statistics is depicted in Table 1. As shown, female undergrads are more underrepresented than male undergrads (37.8% versus 51.3%) whereas female staff has a bolder representation than their male coworkers (19.2% versus 8.9%). The majority of surveyed population for both genders comes from the University of Maryland, Baltimore County (41.8% male and 35.8% female). More female respondents live on campuses (10.6% versus 6.0%) while more males live 26 miles or farther away from campus (14.1% versus 7.7%).