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An Examination of the Socio-Demographic Characteristics and Perceptions of Cycling among Students at Georgia State University

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ABSTRACT

An Examination of Socio-demographic Characteristics and Perceptions of Cycling among Students at Georgia State University
(Under the direction of Christine Stauber, Faculty Member)

Background: Bicycling as a form of transportation is important to public health and the improvement of the environment by way of sustainable transportation. Active transportation is inversely related to all-cause mortality, obesity, and levels of ozone and greenhouse gases. University communities have been shown to bicycle more than big cities. However, downtown setting of the Georgia State University (GSU) campus poses unique barriers to bicycling.

Methods: A cross-sectional study was conducted in fall, 2009 at GSU. To determine perceptions and barriers to bicycling, the sample was divided into cyclists and non-cyclists. Chi square analysis, odds ratios, and multivariate logistic regression were used to compare the socio-demographic characteristics and perceptions surrounding bicycling between the groups.

Results: The survey included 314 students; 60% female, 11.1% bicyclists, and mean age of 23. Of the socio-demographic characteristics examined, gender was the only factor significantly associated with bicycling, with males being 6.82 times more likely to cycle. Independent t-tests found that bicyclists viewed the built environment, social support, and future bicycling support more favorably than non-cyclists. Of the built environment factors, distance was the most important barrier to bicycling (OR=2.156, 95% CI= 1.484-3.133). Cyclists and non-cyclists were in agreement that bicycling was unsafe due to motor vehicle traffic, roadway conditions, and theft risk

Conclusions: Overall, the findings were consistent with current knowledge about bicycling. The findings show that distance appears to be the most significant barrier to bicycling. Although safety due to roadway conditions and motor vehicle traffic and risk of bicycle theft did not produce significant results, these factors should be addressed in future studies and/or programs. Further investigation into how to alter these perceptions and create safer environments for the community would be beneficial.

Keywords: bicycle, built environment, social support, barriers to bicycling

An Examination of the socio-demographic characteristics and perceptions of cycling among students at Georgia State University

By Nancy Braxton Pope

B.S., University of Georgia, 2004

A Thesis Submitted to the Graduate Faculty of Georgia State University in Partial Fulfillment of the Requirements for the Degree

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QUALIFICATIONS SUMMARY

Proficient in MS Word, PowerPoint and Excel. Graduate course work and masters thesis required the use of EpiInfo and SPSS for data analysis. Exposure to a variety of cultures through extensive international travel. Proficient in spoken Spanish.

EDUCATION

Master of Public Health **January 2009-May 2010**
Georgia State University, Atlanta, Georgia
GPA: 4.0

- *Student Lead:* Biking for Transportation at Georgia State University
  P3 Award: A National Student Design Competition for Sustainability Focusing on People, Prosperity and the Planet; EPA-G2009-P3-Q6 – Built Environment and EPA-G2009-P3-Q3 – Energy
  Principal Investigator: John A. Steward, MPH
- *Masters Thesis:* "An examination of the socio-demographic characteristics and perceptions surrounding bicycling among students at Georgia State University."
- Completed coursework in Biostatistics, Environmental Health, Human Toxicology, Epidemiology, Chronic Disease Epidemiology, Intermediate Epidemiology, Health Research Methods, Principals of Tobacco Control, Social and Behavioral Aspects of Public Health, and Health Care Systems.

Bachelor of Science in Biology **August 2000-December 2004**
University of Georgia, Athens, Georgia
GPA: 3.8

- *Honors:* HOPE Scholarship recipient and National Deans List

EXPERIENCE

Student Guest Researcher **November 2009-present**
Centers for Disease Control and Prevention: Community Measures Task Force: Science Unit, Atlanta, Georgia

- Worked with team to build situational awareness and formal surveillance of community activities for preparedness and response to H1N1 influenza
- Assisted in initiating, implementing and analyzing scientific investigations
- Completed daily tasks including: survey data entry, data coding, management and analysis, literature reviews, and telephone interviews for specific studies.
- *Oral Presentation*: "Don't get caught with your preparedness pants down," Annual American Camp Association Conference, Denver, CO., February 2010.

Administrative Assistant/Accounting Support **May 2006-September 2009**
Brunning and Stang Construction Management, Inc., Atlanta, Georgia

- Managed phone system, office supplies, shipping, and physical and electronic filing system
- Wrote and executed contracts between project owners and subcontractors

Sales Associate **October 2005-May 2006**
Swoozies, Dallas, Texas /Atlanta, Georgia

- Personalized and designed products for customers at 10 different stores in the southeast

Privileging Coordinator **March 2005-October 2005**
Staff Care, Inc., Dallas, Texas

- Coordinated with clients and providers to obtain privileges at hospitals, clinics and other venues
- Maintained constant communication with my production team, clients, and providers

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Chapter I

Introduction

1.1 Background

The use of bicycling as a form of transportation is important to public health and to the improvement of the environment by way of sustainable transportation. Obesity and physical inactivity are serious public health concerns in the United States. Over two thirds of the adult population in the U.S. do not engage in the recommended amount of physical activity per week and 40% do not participate in any physical activity (U.S. Department of Health and Human Services, 2000). In addition to physical inactivity, outdoor urban air pollution is associated with negative health outcomes and both are part of the top 15 global causes of health impairment (Marshall, Brauer, & Frank, 2009).

The mode of transportation that individuals use has great potential to either promote or hinder public and environmental health. Active modes of transportation are inversely related to all-cause mortality and obesity, with bicycling generally producing a stronger relationship than walking (Barengo et al., 2004; Matthews et al., 2007; Tin Tin, Woodward, Thornley, & Ameratunga, 2009; Wen & Rissel, 2008) Models have shown that active transportation can help to reduce the levels of ozone and greenhouse gases in the air (Maibach, Steg, & Anable, 2009; Woodcock et al., 2009).

Utilitarian bicycling levels in the United States lag behind other developed nations, with only 0.9% of all trips being made by bicycle (Liss, McGuckin, Moore, & Reuscher, 2001;

Pucher & Renne, 2003). In the U.S., bicycling for transportation rates are higher in urban, mixed-use environment settings (Steele, 2010). Research has shown that physical and social environments along with personal factors and perceptions are associated with bicycling for transportation (Dill, 2009; Frank, Kerr, Sallis, Miles, & Jim Chapman, 2008; de Geus, De Bourdeaudhuij, Jannes, & Meeusen, 2008; Moudon et al., 2005; Pikora, Giles-Corti, Bull, Jamrozik, & Donovan, 2003). A national survey found that university communities are more likely to use bicycles to commute than city dwellers and, on average, 10% of the population in university towns cycle for their commute, compared to only 1% in big cities. (Federal Highway Administration, 1992).

Traditionally, university campuses have a unique environmental design which often discourages motorized vehicles by relegating parking to the periphery and concentrates a dense network of destinations that are easily negotiable by bicycle (Sisson, McClain, & Tudor-Locke, 2008; Balsas, 2003). However, Georgia State University (GSU) is not a traditional campus. GSU is the second largest university in the state and is unique because of its downtown location in a big city. The non-traditional, downtown setting of the campus poses barriers such as perceptions that downtown streets and traffic are dangerous, lack of locations to store or park bicycles, and bicycle theft to potential bicycle riders.

GSU plans to significantly expand residential housing leading to an increase of students, which poses a need for more efficient transportation around the campus as downtown Atlanta is already highly congested with traffic. Bicycling for transportation is a viable alternative to driving and successful bicycle programs have been implemented at Emory University and Agnes Scott University in Atlanta, Georgia. However, there is very

little research addressing bicycling on college campuses, specifically urban, non-traditional campuses.

1.2 Purpose of Study

This study aimed to add to the knowledge of bicycling on non-traditional college campuses through an investigation of the bicycling community at GSU. The purpose of this study is to describe the perceptions and attitudes surrounding bicycling to, from and around campus at GSU. Negative perceptions often surround bicycling for transportation especially in a congested downtown campus area. This project will explain the students' ideas, perceptions and knowledge about bicycling to campus in order to examine ways to effectively encourage bicycling to campus. This project will determine what the major barriers are to bicycling at GSU and provide more information about how to increase the likelihood of active transportation at GSU. This has both environmental and public health implications as it is tied to pollution reduction and to physical health.

1.3 Research Questions

1 How do the socio-demographic characteristics and perceptions about bicycling differ between cyclists and non-cyclists?

2 What are the most important barriers to bicycling for transportation at GSU?

Chapter II

Literature Review

2.1 Physical Activity, Environmental and Public Health

According to the Surgeon General's 2010 Vision for a Healthy and Fit Nation, significant health benefits can be obtained by including moderate amounts of physical activity on most, if not all, days of the week. Physical activity not only reduces the risk of all-cause mortality but also improves mental health. Adults should participate in at least 150 minutes of moderate physical activity per week or 30 minutes most days of the week in order to obtain these benefits ("2008 Physical Activity Guidelines for Americans: Chapter 4," 2008). Despite the proven benefits of physical activity, 40% of Americans do not participate in any regular physical activity and over two thirds of adults do not engage in the recommended amount of physical activity (U.S. Department of Health and Human Services, 2000). An estimated two thirds of adults in the U.S. are overweight or obese (Flegal, Carroll, Ogden, & Curtin, 2010).

Along with physical inactivity, outdoor urban air pollution is associated with negative health outcomes and both are part of the top 15 global causes of health impairment (Marshall et al., 2009). Daily motor vehicle transportation contributes to air pollution and global warming through the release of volatile organic compounds (VOCs), nitrogen oxides (NO_x), and carbon dioxide (CO_2) into the air. CO_2 accounts for 80% of greenhouse gas emissions in the U.S. and transportation accounts for approximately one third of that total (*The 'Carbon Footprint' of Daily Travel: NHTS Brief*, 2009). The U.S.

Department of Energy estimated that per capita greenhouse gas emissions are close to 20 tons per person per year, which accounts for one fifth of the total global CO_2 (2008). VOCs and NO_x s interact with sunlight to form ozone. Ozone is a lung irritant and is the most significant contributor to Atlanta, Georgia's air quality problem (Goldberg, Jim Chapman, Frank, Kavage, & McCann, 2007). Solutions surrounding the growing pollution and obesity problems can converge to achieve multiple benefits through active transportation.

2.2 Active Transportation: Public and Environmental Health Benefits

Transportation mode has the potential to promote or hinder public health and environmental health goals simultaneously. The schematic below gives an overview of how active transportation can benefit health and the environment.

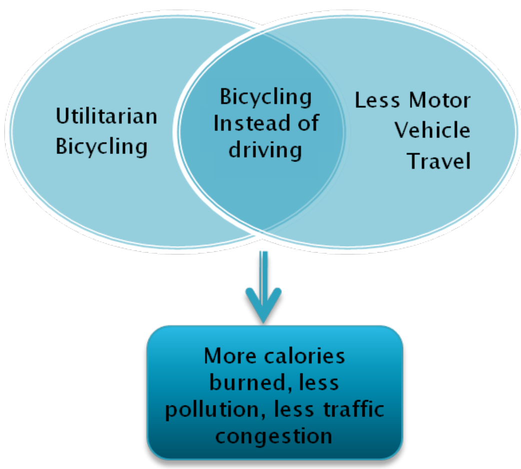

Figure 1. The environmental and public health benefits of active transportation.

Public Health Benefits

Healthy People 2010's physical activity and fitness goal was to improve health, fitness, and quality of life through daily physical activity (U.S. Department of Health and Human Services, 2000). In order to achieve higher levels of physical activity, emphasis has been placed on active living, which incorporates less structured, moderate-intensity

physical activity into daily activities. Active commuting fits well with these recommendations as it is an easy way to increase physical activity levels and may be more likely to be adopted and sustained than other exercise programs (Tin Tin et al., 2009; Troped, Saunders, Pate, Reininger, & Addy, 2003). It has been shown that bicycle commuting is an activity that does meet these physical activity recommendations (Dill, 2009; Moudon et al., 2005). A study conducted on bicyclists in Portland, Oregon found that a majority of the participants met the recommended levels of physical activity per week through bicycling (Dill, 2009). In another U.S. study, Moudon et al (2005) found that cyclists were more likely to engage in a sufficient amount of vigorous physical activity per week than non-cyclists. Healthy People 2010's section 22.15 specifies the goal to increase the proportion of trips made by bicycling from 0.6% in 1995 to 2.0% in 2010 for adults and from 2.4-5.0% for children (5-15) (U.S. Department of Health and Human Services, 2000).

Multiple studies have shown the positive health impacts associated with bicycling (Frank, Greenwald, Winkelman, James Chapman, & Kavage, 2010; Shephard, 2008; Tin Tin et al., 2009; Wen & Rissel, 2008). A review of active commuting and cardiovascular event risk literature found that, on average, active commuting was associated with an 11% reduction in cardiovascular event rates (Tin Tin et al., 2009). Studies in Finland and China concluded that active commuting was associated with reduced all-cause mortality in women (Barengo et al., 2004; Matthews et al., 2007). Similarly, a study in Copenhagen found that those who cycled to work experienced a 28% lower risk of mortality (Shephard, 2008).

Active transportation has also been shown to help combat the obesity epidemic. In Australia, a population based study found that men who cycled to work were significantly

less likely to be overweight and obese than those who drove to work (OR=0.49; 95% CI: 0.31-0.76) (Wen & Rissel, 2008). Wen et al (2008) also found that of active transportation modes, bicycling in particular showed a strong inverse relationship with obesity. The Alliance for Biking and Walking produced a recent report including a comparison of the distribution of obesity levels across the states to the distribution of bicycle/walking trips to work across the states. The maps are shown in Figure 2. The comparison found that states with the lowest levels of bicycling and walking to work had the highest levels of obesity (Steele, 2010).

Obesity and physical inactivity are increasing global problems that already cost the U.S. health care system more than $147 billion a year (Frank et al., 2010). To understand the health benefits in different terms, they can be expressed in terms of health care cost savings. Multiple studies assessing healthcare savings were reviewed to compile a portion of the "Guidelines for Analysis of Investments in Bicycle Facilities". Although the values varied due to differing study designs, they all showed a positive association. The health savings resulting from physical activity, measured in 10 different studies, ranged up to $1,175 per person, per year. The median annual per capita value of the ten studies was $128 (Transportation Research Board, 2006). Additionally, increasing active commuting has great potential to reduce the many environmental burdens caused by the transport sector.

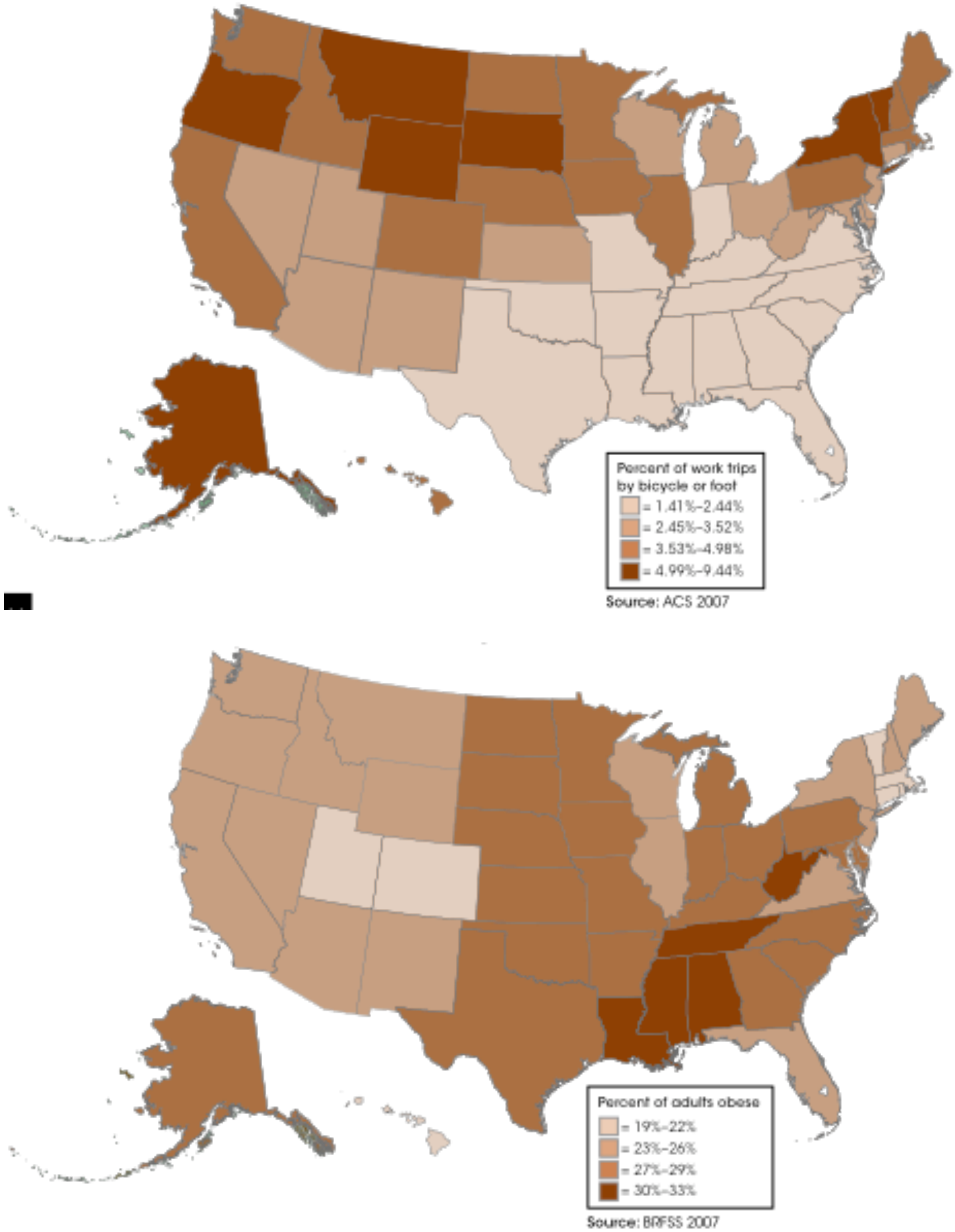

Figure 2. Maps showing the distribution of bicycle/walking trips (top) and the distribution of adult obesity (bottom).

(Maps used with permission from Steele, 2010)

Environmental Health Benefits

Active transportation has the potential to save fuel and reduce noise and air pollution. In most U.S. cities, motor vehicles are the main sources of noise and air pollution. The Urban Land Institute conducted a comprehensive review of multiple studies and projected that in the US, transportation related CO_2 emissions will continue to rise due to present trends in driving, despite any gains resulting from technological advances such as changes in fuel type and hybrid vehicles (Ewing, Bartholomew, Winkelman, Walters, & Chen, 2008). A study by Woodcock, et al (2009) estimated the health effects of alternative urban land transport scenarios for two settings: London, UK, and Delhi, India. They considered lower-emission motor vehicles, increased active travel, and a combination of the two scenarios. It was found that reduction in carbon dioxide emissions through an increase in active travel and less use of motor vehicles had larger health benefits per million populations in one year in both cities than from increased use of lower-emission motor vehicles. With motor vehicles contributing considerably to global warming, alternate forms of transportation are highlighted and being promoted as viable resources to help curb the increase in pollution. Approximately one half of the car trips in the U.S. are less than five miles so there is considerable capacity to replace these trips with active transport (Maibach et al., 2009).

Replacing trips to school and work via motor vehicle with active transportation could help to reduce the levels of ozone and greenhouse gasses in the air so that cities can meet the federal air quality standards more consistently. For example, a study in the U.S. predicted that a 38% reduction in oil consumption could be realized if recommended daily

exercise was swapped for transportation. Specifically for bicycling, an 11.9% reduction of the U.S.'s 1990 net emissions could be observed (Higgins, 2005). The United States has great potential to experience noticeable benefits from a transition to alternative transportation, as the United States is currently a highly motor vehicle dependent country.

2.3 Bicycling In United States

The United States Department of Transportation Federal Highway Administration (FHWA) houses the Bicycle and Pedestrian Program. The program's goals are to promote bicycle and pedestrian transportation use, safety, and accessibility. Each state is responsible for administering its own program and the FHWA provides guidance and federal funding when proposed state programs meet the federal surface transportation funding requirements ("Bicycle and Pedestrian Program - Planning and Environment - FHWA," 2010). While the potential for bicycling as a mode of transportation has been recognized, overall, the United States has fallen behind other developed countries when comparing the amount of individuals regularly bicycling for transportation (Dill, 2009; Pucher, Dill, & Handy, 2010). Figure 3 demonstrates this scenario by showing the share of bicycle trips for select countries. Even the minimal amount of bicycle use reported in the U.S. is for recreation for the most part, not transportation (Liss et al., 2001).

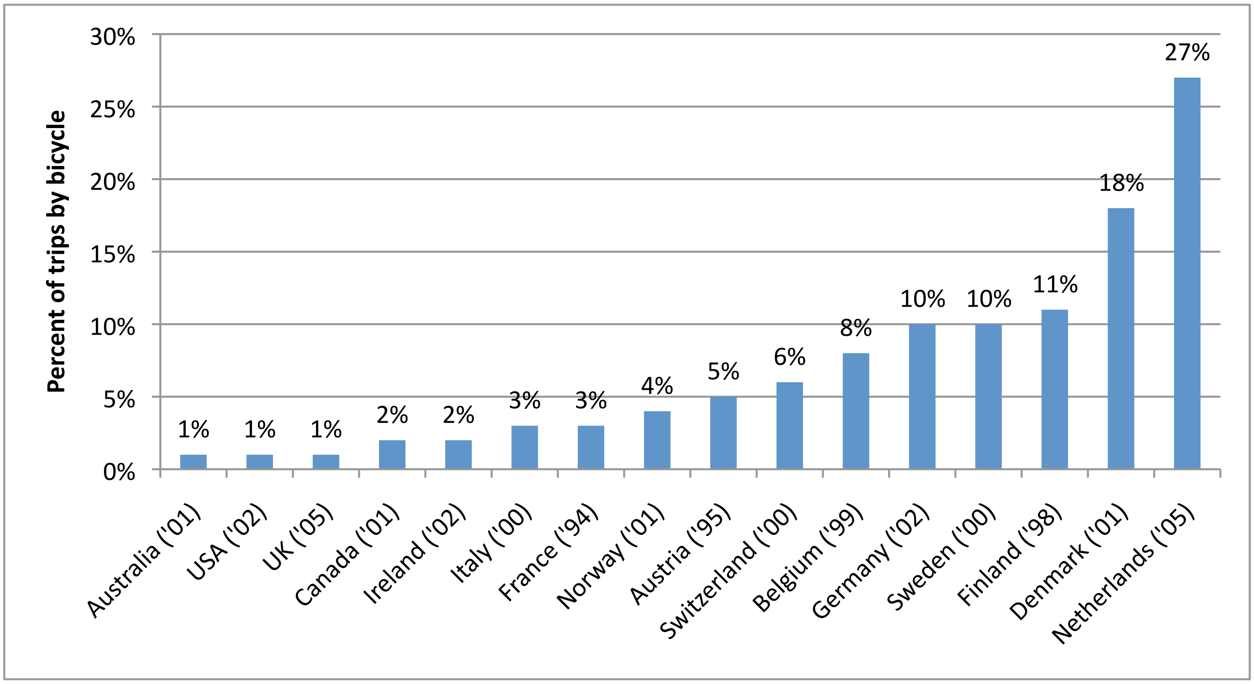

Figure 3. Bicycle Trips by Country

(Graph used with permission from Pucher, et al, 2008)

The 2001 National Household Travel Survey (NHTS) reported that there are nine million bike trips for all purposes in the United States every day. However, that only accounts for 0.9% of daily trips for all purposes and all modes of transportation. Of the nine million bicycle trips, approximately 50% were for social/recreational purposes and only 16% of the bicycle trips were for commuting to work. According to the 2000 census, only 0.4% of adult workers in the United States traveled to work via bicycle (Reschovsky, 2004). The average bicycle trip to work was 2.9 miles one-way (Liss et al., 2001; Pucher & Renne, 2003). The pie chart in Figure 4 shows the distribution of transport modes used by workers in the U.S. according to the 2007 American Community Survey (Steele, 2010). Bicycling rates also vary by region of the country, with the Pacific region (Alaska, California, Hawaii, Oregon, and Washington) having the highest percentage (1.1%) of trips made by bicycle. The East South Central region (Alabama, Kentucky, Mississippi, and Tennessee)

had the lowest level of bicycling (0.4%) while the rest of the country had roughly the same levels of bicycling (0.7% to 0.9%) (P. Hu & Reuscher, 2004; Pucher & Renne, 2003). These regional variations are depicted in Figure 5.

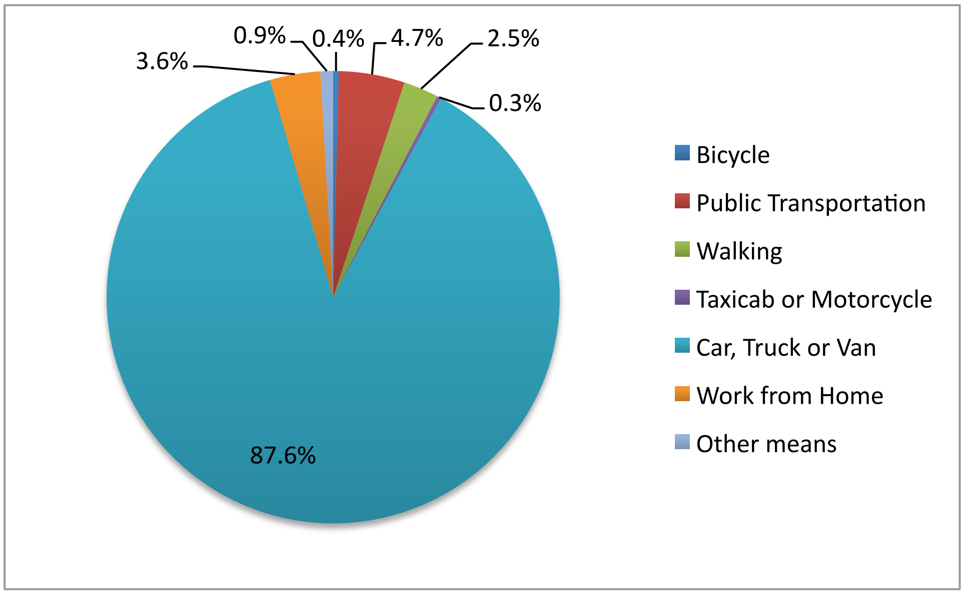

Figure 4. Mode of Transportation for U.S. workers.

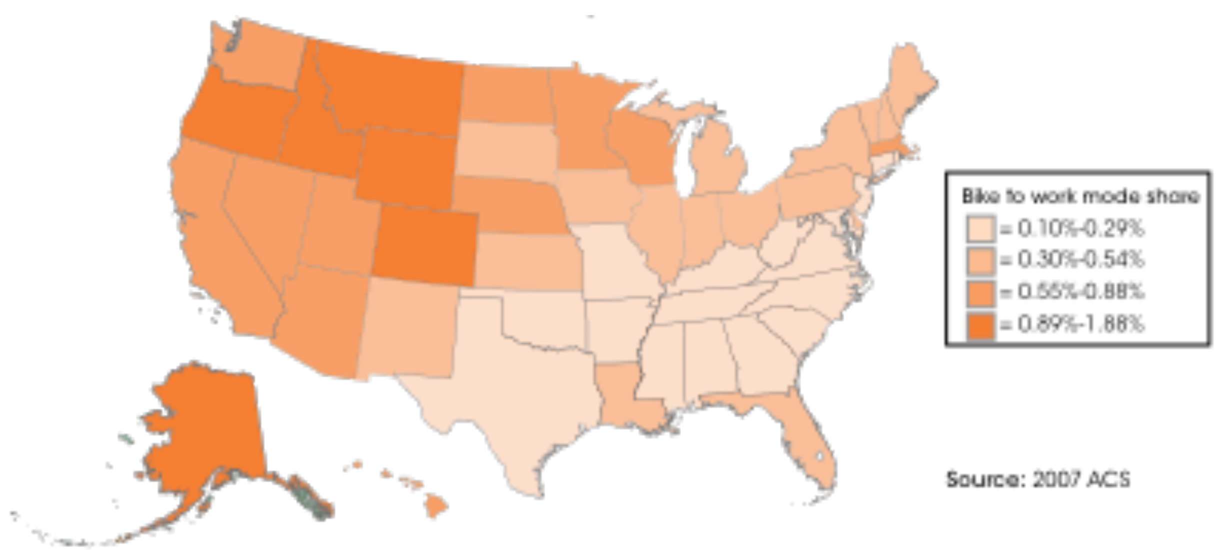

Figure 5. Distribution of Bicycle Trips across the United States.

(Map used with the permission of Steele, 2010)

Multiple demographic factors have been examined with respect to active transportation in the United States. Gender has the greatest impact on the modal split for bicycling than for any other transportation choice (Pucher & Renne, 2003). Trips by bicycle made up 1.2% of total trips made by males and only 0.5% of trips made by females (P. Hu & Reuscher, 2004; Pucher & Renne, 2003). Figure 6 shows bicycling trips split by gender according to the 2007 American Community Survey (Steele, 2010). In 2005, a U.S. study found that 66% of the 128 respondents reporting cycling at least once a week were male (Moudon et al., 2005). These findings are consistent with international studies from Canada and Australia, which generally find that cyclists are significantly more likely to be male (Wood, Lacherez, Marszalek, & King, 2009; Garrard, Rose, & Lo, 2008). However, Pucher et al (2008) showed that cycling is fairly gender neutral in countries with high utilitarian bicycling levels such as the Netherlands, Denmark, and Germany.

Age is also an important indicator of bicycling for transportation. The age distribution found in the 2001 NHTS is shown in Figure 7. In 2002 the National Survey of Bicyclist and Pedestrian Attitudes and Behaviors found that people age 16 to 20 rode bicycles more often in the past 30 days than any of the older age groups (Royal & Miller-Steiger, 2008). A U.S. study found that middle-aged and young adults tend to bicycle more than older adults (Moudon et al., 2005). An active transportation study in Canada found that the youngest age brackets (15-29 years old) were significantly more likely to cycle than middle aged and older adults (Butler, Orpana, & Wiens, 2007).

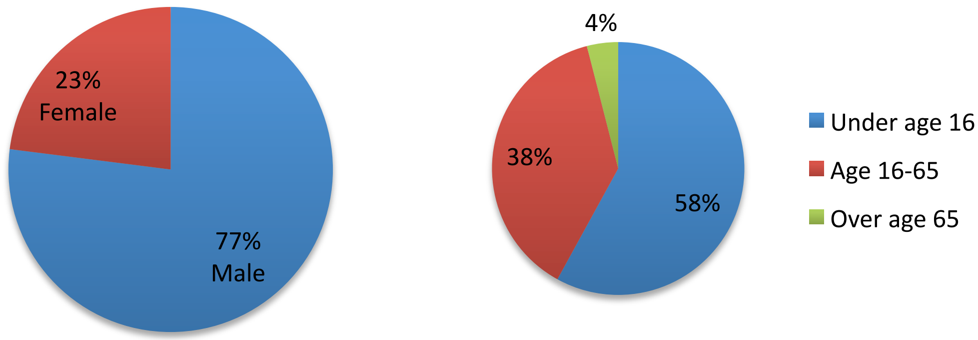

Figure 6 . Bicycle trips to work by gender and for transportation by age in the United States.

The American Community Survey found that ethnicity was evenly distributed among cyclists as shown in Figure 8. The ethnic breakdown in the U.S. according to the same survey was 66% White, 15% Hispanic, 12% Black, 4% Asian, and 3% other (Steele, 2010). The distribution of bicycle trips across all income levels was found to be roughly equal showing that the bicycle mode share was 0.9% for all income classes, (P. Hu & Reuscher, 2004; Pucher & Renne, 2003).

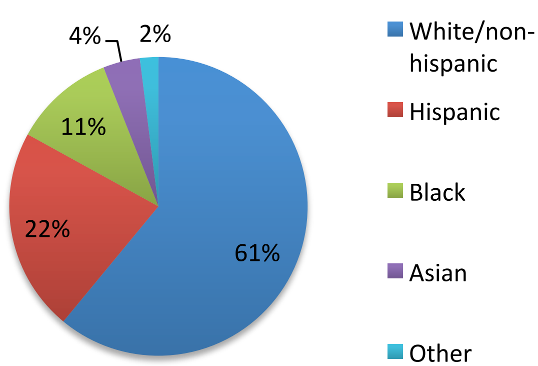

Figure 7. Distribution of bicycle trips by ethnicity in the U.S.

(Source: Steele, 2010)

Car ownership and location have also been shown to be indicators of bicycling for transportation. Reports from the 2007 American Community Survey support this finding showing that cities with the highest levels of bicycling and walking have the lowest car ownership rates. Similarly, a study in Atlanta, Georgia found households with more vehicles to be associated with significantly less energy expended from walking (Frank et al., 2010). A different study based in Atlanta, Georgia found that all identified subgroups were more likely to participate in active transportation if they lived in neighborhoods with greater residential density, street connectivity, and greater land use mix (Frank, Andresen, & Schmid, 2004).

2.4 Individual, and Physical and Social Environmental Factors

In addition to demographic characteristics, numerous studies have shown the importance of attitudes, motives, perceived benefits and barriers, self-efficacy and social influence for the participation in physical activity (Hoehner, Brennan Ramirez, Elliott, Handy, & Brownson, 2005; Suminski, Poston, Petosa, Stevens, & Katzenmoyer, 2005; Troped et al., 2001). Multiple studies use social-ecological models to assess physical activity (Giles-Corti, 2006; Pikora et al., 2003; Titze, Stronegger, Janschitz, & Oja, 2007). Giles-Corti (2006) used an ecological model to examine the relative influence of individual, social environment, and physical environment factors on a range of physical activities. Odds ratios adjusted for demographic factors showed that respondents with favorable scores for the three categories (positive cognitions, and supportive social and physical environments) were at least twice as likely to walk as those with low scores. Pikora, et al (2003) identified four areas of the physical environment that potentially influence bicycling for transportation: functionality, safety, aesthetics and destination. These items can all be

considered part of the built environment as safety here refers to things such as streetlights and crossing aids.

Physical Environment

Urban designers have described bikeable neighborhoods as those characterized by high population density, mixed land use, high connectivity, and design features such as sidewalks and bicycle lanes (Saelens, Sallis, & Frank, 2003). Findings from the transportation, urban design, and planning fields support the hypothesis that the built environment is associated with physical activity (Saelens et al., 2003). Many studies have investigated the role of the built environment in physical activity and have shown that characteristics of the built environment influence bicycling for transportation both objectively and subjectively (Dill, 2009; Moudon et al., 2005; Reynolds, Harris, Teschke, Cripton, & Winters, 2009; Titze et al., 2007, 2008; Troped et al., 2003). A study of bicyclists in Portland, Oregon investigated the role that infrastructure plays in encouraging bicycling for transportation and indicated that a supportive environment with bicycle infrastructure that addresses people's concerns about safety is necessary to encourage bicycling for everyday travel (Dill, 2009). The most common facilities used by bicyclists according to the 2002 National Survey of Pedestrian and Bicyclist Attitudes and Behaviors are shown in Figure 9 with paved roads being the most popular.

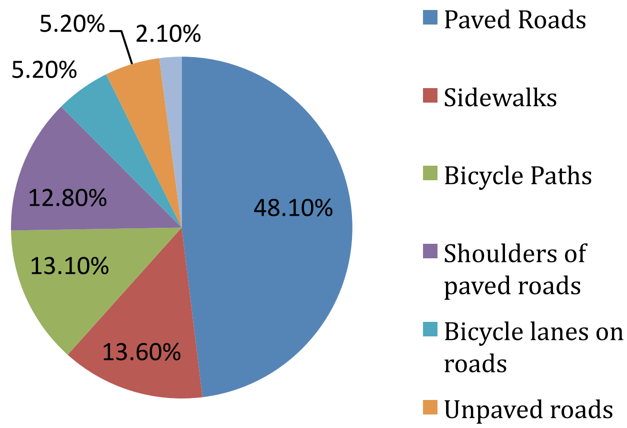

Figure 8. Bicycle Facilities used by Bicyclists: Findings from the 2002 National Survey of Pedestrian and Bicyclist Attitudes and Behaviors.

(Source: Royal & Miller-Steiger, 2008)

With respect to functionality and safety of facilities supporting physical activity and more specifically bicycle facilities such as paths and trails, better access to or creation of places for physical activity, such as bicycling facilities will increase physical activity levels (Librett, Yore, & Schmid, 2006). Similarly, individuals with access to bicycle trails are more likely to report physical activity (Dill, 2009). A study of 33 large U.S. cities showed that each additional mile of bicycle lane is associated with an approximate one-percent increase in the share of bike-to-work trips (Dill & Carr, 2003). Among Austrian city dwellers the presence of bike lane connectivity was positively associated with bicycling for transportation (Titze et al., 2008). A review of the impact of transportation infrastructure on bicycling found that the presence of bicycle facilities such as on-road bicycle routes and lanes and off-road bicycle paths was associated with the lowest risk of injuries (Reynolds et al., 2009).

Preferences and actual behaviors of bicyclists have shown that bicycle facilities are preferable. Simple stated preference studies generally find that people prefer bicycle paths

and lanes or indicate that this infrastructure would encourage them to bicycle (Dill, 2009). Bicyclists have also been shown to choose a longer travel time in order to use a bicycle lane or off-street path (Dill, 2009; Stinson & Bhat, 2003; Tilahun, Levinson, & Krizek, 2007). Two studies in Minneapolis, MN found that cyclists were willing to travel significantly out of their way to use bicycle facilities. The first study concluded that bicyclists would choose a longer route if it included a bicycle lane 85% of the time and they were willing to add an additional 16.3 minutes to a 20 minute commute in order to use an on-street bicycle lane (Krizek, 2006). The second study found that bicyclists were willing to travel, on average, 2.6 miles out of their way to use a high-quality off-street bicycle facility (Krizek, El-Geneidy, & K. Thompson, 2007).

Aesthetics and built environment features other than bicycle trails have can also effect levels of utilitarian bicycling. Researchers found that presence of streetlights, enjoyable scenery, and neighborhood sidewalks were significantly positively associated with increased minutes of transportation physical activity (p=0.05, 0.03, and 0.04 respectively) (Troped et al., 2003). A comparison of non-cyclists to cyclists in the U.S. found that more bike lanes and trails, good lighting at night, and bicycle racks at destinations would help them bicycle more (Moudon et al., 2005). Girls who agreed that it was safe to walk or jog in their neighborhood and who reported more trees and interesting things to look at were more likely to report higher levels of physical activity than those who disagreed. Additionally, girls who reported bicycling and walking trails in their neighborhood were more likely to report active transport to school (Evenson, Herring, & Huston, 2005).

Commute distance is another physical environmental factor effecting bicycling. Troped et al (2003) found that increasing distance from a respondents' home to an access point of a trail was negatively associated with active transportation. A cross-sectional study of adolescents age 15-17 in Ireland found that distance is also a perceived barrier to actively commuting to school, showing that distances within 2.5 miles are achievable for adolescent walker and cyclist (Nelson, Foley, O'Gorman, Moyna, & Woods, 2008). de Geus et al (2008) found that when estimating the time they would spend going to destinations by bicycle, non-cyclists generally always estimated the time as longer than the cyclists. This finding could imply that non-cyclists have an exaggerated perception of the time it would take to make every day trips by bicycle and therefore creating a barrier to bicycling for transportation.

In addition to facilities and distance, weather is often considered when bicycling for transportation. A Canadian study found that increased precipitation and days of freezing temperatures were significantly associated with decreased utilitarian cycling. Interestingly, utilitarian cycling among students was not significantly associated with increased precipitation and was only slightly significantly associated with increased days with freezing temperatures (Winters, Friesen, Koehoorn, & Teschke, 2007). However, these results were confined to Canada. Pucher, et al (2006) compared Canadian bicycling to bicycling in the U.S. and found that bicycling rates in Canada are higher despite their lower year-round temperatures. Also, when investigating average temperatures across the states compared to state bicycling rates, Montana and Alaska were among the states with the lowest temperatures, yet were also among the states with the highest levels of bicycling (Steele, 2010).

Social Environment

The association between social environments and physical activity has been studied and shown to be significant (de Geus et al., 2008; Titze et al., 2007; Troped et al., 2003; Wendel-Vos, Droomers, Kremers, Brug, & van Lenthe, 2007). A recent review of 47 publications found social support to be convincingly associated with physical activity (Wendel-Vos et al., 2007). Social environment factors may include items such as:

- Presence of peers bicycling
- Presence of a bicycling partner
- Encouragement from close friends or family
- Support from close friends or family through bicycling together (Accompaniment)
- Support from close friends or family through bicycling separately (Modeling)

A study of university students in Austria found that students who reported having friends who cycle to the university were more than twice as likely to cycle than those who did not have friends cycling to the university (Titze et al., 2007). In 2008, Titze et al found that social support, specifically encouragement, modeling, and peer bicycling, was significantly positively related to bicycling for transportation among adults. de Geus et al (2008) reported similar findings with those reporting accompaniment being roughly twice as likely to bicycle for transportation than those not reporting accompaniment.

Risks associated with Active Transportation

Bicycling for transportation does introduce health risks through injuries and exposure to pollution. These risks are a major barrier to bicycling for transportation, especially in motor vehicle dependent developed countries (Shephard, 2008). Statistics show that the United States is far less safe for bicyclists than other developed countries.

Between 2002 and 2005 in the US, the average of bicyclist fatalities was 5.8 per 100 million kilometers bicycled versus 1.7 in Germany, 1.5 in Denmark, and 1.1 in the Netherlands indicating that bicycling is over five times more dangerous in the U.S. (Pucher & Buehler, 2008). The Netherlands, Germany, and Denmark have much higher levels of utilitarian bicycling (27%, 10%, and 18% respectively) when compared to the U.S. (1%), making the above comparison much more dramatic (Pucher & Buehler, 2008).

Perceived safety should not be overlooked, as it is equally important as actual safety documented by items such as crash incident reports. Cho, et al (2009) found that low density and non-mixed land use increased individuals perception of crash risk. When comparing the perceived crash risk levels to the actual crash rates, this study found that the increased perception of risk and unfriendly environment reduced the actual crash rates as a result of behavioral changes.

Other studies (Frank et al., 2010; Jacobsen, 2003; Steele, 2010) have consistently indicated negative correlations between levels of transportation physical activity and bicycle/pedestrian fatality rates. These studies consistently show that cities with higher levels of utilitarian bicycle use generally have lower levels of bicycle fatality rates. This could signify that with bicycling, there is safety in numbers.

Bicycle parking safety is also a concern. Over 1.5 million bicycles are stolen in the U.S. each year according to the stolen bicycle registry (Steele, 2010). In 2006, a survey of approximately 1,800 bicyclists in San Francisco found that the number one reason for no bicycling more was the fear of bicycle theft (San Francisco Bicycle Coalition, 2006). Consistent results were shown in an Austrian study conducted by Titze, et al. (2007) that

found that students who were not concerned with bicycle theft were more than twice as likely to bicycle regularly to campus than those who considered bicycle theft as a danger.

2.5 Bicycling and Physical Activity among College Students

Physical Activity

Overall, most college students fail to participate in the recommended amount of physical activity and females tend to be less active than males (Reed & Ainsworth, 2007). According to the spring 2008 National College Health Assessment, roughly 50% of male and 57% of female college students reported that they did not participate in vigorous or moderate exercise on at least three of the previous seven days (American College Health Association, 2008). Supportive results have been consistently reported (Keating, Guan, Piñero, & Bridges, 2005; Reed & Ainsworth, 2007). While these numbers have been slightly reduced since 2000 (57%: men and 61%: women), students are still not meeting the recommended 30 minutes of moderate physical activity most days of the week. A meta-analysis of college students' physical activity highlighted that college students were more active on weekdays as opposed to other adult populations who were more active on the weekends (Keating et al., 2005). This finding differentiates the physical activity patterns of college students from those in other adult populations, indicating that interventions to increase or advocate physical activity should differ between these groups (Keating et al., 2005). Bicycling on campus could help to decrease the levels of inactivity among college students.

College Campuses and Bicycling

College campuses are traditionally very distinct, self-contained communities. Traditionally university campuses have a unique environmental design that often discourages motorized vehicles by relegating parking to the periphery and concentrating a dense network of destinations that are easily negotiable by bicycle (Sisson et al., 2008; Balsas, 2003). Rural campuses tend to exhibit horizontal connectivity, meaning that these campuses are generally large and spread out. Whereas, urban campuses tend to exhibit vertical connectivity, meaning that the college is housed in fewer buildings and is not as spread out as rural campuses (Balsas, 2003). Promotion of sustainable transportation on college campuses has the potential not only to benefit the campus and its surroundings but also to have widespread, long term affects on transportation habits and environmental awareness as students move from college to other areas of society (Balsas, 2003).

University communities are more likely to ride bicycles for transportation and in university towns, over 10% of the residents cycle for their commute, compared to 1% in big cities (Federal Highway Administration, 1992). College students cycle at much higher rates than the general population (Pucher, Komanoff, & Schimek, 1999). In 2003, a Canadian study using the Canadian Community Health Survey to investigate individual and city level factors influencing utilitarian bicycling rates in urban settings discovered that 7.9% of the urban population reported bicycling in a typical week and students were more likely to cycle (17.2%) than non-students (6.0%). Evidence from another Canadian study found that respondents who were currently enrolled in school were significantly more likely to bicycle for transportation (Butler et al., 2007).

Urban campuses have been shown to be successfully bicycle friendly including the University of Wisconsin, Madison; University of Boulder, Colorado; Stanford University; University of California, Davis; University of Oregon, Eugene; and University of Washington, Seattle (Balsas, 2003). Through modest investments, the University of California-Santa Barbara and Davis campuses have increased non-motorized modes of transportation to over 50% (Toor & Havlick, 2004). Emory University and Agnes Scott University in Atlanta, Georgia have recently implemented bicycle programs that offer bicycles at deeply discounted rates, incorporate bicycle share availability, bicycle repair facilities, and bicycle information.

Georgia State University Campus

Georgia State University, founded in 1913, is the Southeast's leading urban research institution, located in downtown Atlanta. It is on the list of the top 100 public universities for doctoral degrees awarded. More than 250 fields of study are offered through some 55 accredited degree programs at the bachelor's, master's, specialist and doctoral levels. As of fall 2009, approximately 30,000 undergraduate and graduate students were enrolled at GSU.

The downtown GSU campus is the second largest campus in the state. While university communities are more likely to commute by bicycle than city dwellers, the downtown location of GSU poses unique challenges for those who bicycle for transportation and to promoting bicycling for transportation (Pucher et al., 1999). GSU plans to significantly expand residential housing leading to an increase of students, which poses a need for more efficient transportation around the campus.

2.6 Summary

Bicycling for transportation has been highlighted in recent research as a viable alternate form of transportation. This has become an important research topic because active transport has been shown to significantly improve the health of individuals as well as the environment. With physical inactivity, obesity and pollution on the rise, researchers worldwide have been investigating alternate forms of transportation. Many developed countries such as Denmark and the Netherlands have been successful in replacing car trips with bicycle trips. While it is imperative for cities around the U.S. to look to foreign countries as a resource on increasing bicycling for transportation, more national investigations are needed, specifically addressing bicycling on college campuses. It has been shown that those living in urban areas are more likely to cycle than those living in suburban or rural areas. It has also been shown that college communities are more likely to cycle than cities. Very little research has addressed the combination of these scenarios; a college campus located in the center of an urban city environment. This study aimed to add to the knowledge of bicycling on non-traditional college campuses through an investigation of the bicycling community at GSU.

Chapter III

Methodology

3.1 Data Sources

Study Background and Explanation

A cross-sectional study was conducted in the fall of 2009 at Georgia State University. The survey was created and administered as part of the Biking for Transportation at GSU research project. The United States Environmental Protection Agency (EPA), through the 7th Annual P3 Awards: A National Student Design Competition for Sustainability, provided support for the survey. Surveys were conducted as part of a larger overall bicycling awareness campaign on the campus. The goal of the survey was to investigate student perceptions and attitudes surrounding utilitarian bicycle use. The survey was approved by the Institutional Review Board of GSU (H10127).

Survey Development

The questionnaire used by Titze, et al (2007) in the "Environmental, Social, and Personal Correlates of Cycling for Transportation in a Student Population" study was adapted to better suit GSU's location and population. The survey was originally generated from a list of potentially important built environment, social environment, and personal items for cycling based on a review of bicycling studies and behavior change models (Titze et al., 2007). The final instrument included questions concerning socio-demographic characteristics, perceived health, transportation behavior, perceived physical environment

for bicycling, bicycle parking facilities at GSU, perceived social environment, general perception of the neighborhood, and perceived barriers to bicycling for transportation. These items were measured on a four-point, Likert-type scale ranging from strongly disagree to strongly agree. In the previous study, the test-retest reliability of items was examined and showed acceptable agreement with Spearman's correlation coefficients ranging from 0.37-0.91 (Titze et al., 2007). The survey can be found in Appendix A.

3.2 Study Population

Non-random cluster sampling of course sections at GSU identified participants for this survey. Instructors of the undergraduate perspectives courses and select graduate courses were asked to volunteer to have his or her classes participate in the survey. Interviews were carried out in all classes where the instructor volunteered. A group administration strategy was used to administer the surveys in lectures. Additionally, grab sampling of cyclists at bicycle racks around campus was used to identify a small portion of the sample. All students voluntarily participated in the survey. The data were collected in hard copy and entered into data entry forms created in EpiInfo.

3.3 Study Measures

Table 1 lists the socio-demographic variables used, their final coding, and type. The four-point Likert-type scale that the perception variables were measured on was converted to a five-point scale to incorporate the "I don't know" option (previously coded to 77). This option was treated as a neutral option and was recoded to fall between the disagree and agree choices. Additionally, due to question wording, the scale for eight of these variables

was reversed so that bicycling was favorable. These variables are shown in Table 2. Specific coding information is detailed in Appendix B.

3.4 Statistical Analysis

All collected data was manually entered into EpiInfo, exported to Microsoft Excel, and then transferred to SPSS 17.0 for analysis. Descriptive statistics of the variables gender, major, and age were calculated for the study population and used to determine its representativeness of the entire GSU population. Two groups were identified, cyclist and non-cyclist, using the response to the outcome variable, "Since the beginning of the current semester, have you used a bicycle for transportation to, from, or around the GSU campus at least once?". Those who answered yes (1) were grouped as cyclist and those who answered no (0) were grouped as non-cyclist. The remainder of the data analysis compares these two groups.

Descriptive statistics of the cyclist vs. non-cyclist groups were examined for the variables: age, gender, major, health status, exercise level, mode of transportation, bicycle access, and bicycling behavior. Chi-squared tests were carried out to determine if there were significant differences between non-cyclists and cyclists for these variables. An independent samples t-test assuming equal variances using a pooled estimate of the variance was performed to determine whether the mean ages of the two groups were equal.

Bicycling behavior characteristics of the cyclist group were described in order to quantify the frequencies and duration of bicycle commutes. Descriptive statistics of cyclists by interview location (lecture vs. bicycle rack) were also generated for the variables: age, gender, major, health status, exercise level, mode of transportation, and bicycling behavior.

Odds ratios were generated using univariate logistic regression to examine the association between socio-demographic variables (gender, major, health status, and exercise level) and bicycling. Multivariate logistic regression was used to examine multiple variables together and the relationship with bicycling.

Cronbach's alpha reliability coefficients were calculated from each set of variables making up the four perception categories (Built Environment, Facilities/Support at GSU, Social Support, and Future Support at GSU) to determine how reliably these items measure their categories. Alpha values range from zero to one and the closer the value is to one, the more reliable the scale. The following is the generally accepted rule of thumb when interpreting Cronbach's Alpha (George & Mallery, 2002):

- > 0.9 – Excellent
- > 0.8 – Good
- > 0.7 – Acceptable
- > 0.6 – Questionable
- > 0.5 – Poor
- < 0.5 – Unacceptable

Mode responses of cyclists and non-cyclists for each perception variable were examined. Additionally, chi square analysis was carried out to determine if the distribution of response frequencies along the five-point Likert scale varied significantly between the two groups. Bonferroni-adjusted p-value cutoffs were used to maintain $\alpha=0.05$ (Built Environment: $p\leq0.0039$, Facilities/Support at GSU and Future Support for Bicycling: $p\leq0.0083$, and Social Support: $p\leq0.013$).

In addition, using all responses for cyclist and non-cyclist groups, arithmetic mean scores were calculated for each perception category; built environment, facilities/support at GSU, social support, and future bicycling support. They were then compared between the groups. Independent samples t-tests were performed to determine whether the overall mean scores were significantly different between non-cyclists and cyclists. Additionally, gender adjusted odds ratios were calculated using multivariate binary logistic regression analysis to predict bicycling for each individual perception variable.

Bar charts were generated as examples to visualize the distribution differences between cyclists and non-cyclists for selected variables:

- Distance is reasonable for bicycling
- Bicycling is a pleasant experience
- Bicycle might be stolen even when properly secured
- Better safety and security for bicycle parking on GSU's campus

Additionally, response distributions for safety variables (unsafe due to roadway conditions, unsafe due to motor vehicle traffic, and bicycle might be stolen even when properly secured) were visualized on bar charts by gender. This step was carried out due to the extensive literature showing males to be more likely to bicycle than females and females to be more concerned with safety than males.

Table 1. Socio-demographic variables, code, and type.

Variable	Coding	Type
Gender	1 = Male 2 = Female	Categorical
Age		Continuous
Major	1 = College of Arts and Sciences 2 = College of Education 3 = College of Health and Human Services 4 = Business/Policy related disciplines 5 = Uncertain	Categorical
Health Status	1 = Excellent/Very Good 2 = Good/Fair/Poor	Categorical
Exercise Level	0 = Not Active 1 = Moderately Active 2 = Active	Categorical
Forms of transportation to and from GSU: Motor Vehicle Motorcycle/Scooter Bicycle Public Transportation GSU Panther Shuttle Bus Foot/wheelchair	0 = no 1 = yes	Categorical
Access to a Bicycle	0 = no 1 = yes	Nominal
Bicycle for fun – Fall, 2009	0 = no 1 = yes	Nominal
Bicycle for transportation – Fall, 2009	0 = no 1 = yes	Nominal
Bicycle for transportation on GSU campus – Fall, 2009*	0 = no 1 = yes	Nominal
During past 7 days, how many did you bicycle for transportation on GSU campus?	1 = 0 days 2 = 1-2 days 3 = 3-7 days	Categorical
Average time spent bicycling on those days?	1 = 0-20 minutes 2 = 21=40 minutes 3 = 41-60 minutes 4 = >60 minutes	Categorical
Live in GSU housing	0 = no 1 = yes	Nominal

*Outcome variable

Table 2. Perception variables by category and coding.

Built Environment	Code
1. Distance is reasonable	1 = strongly disagree
2. Pollution level is low	2 = somewhat disagree
3. There are lots of trees, gardens, parks, or interesting features	3 = I don't know
4. Bicycling is a pleasant experience	4 = somewhat agree
Where I live now:	5 = strongly agree
5. There is a bus stop or train within a reasonable bicycling distance	
6. Is a good neighborhood for riding a bicycle	
7. Route is hilly	1 = strongly agree
8. Unsafe due to motor vehicle traffic	2 = somewhat agree
9. Unsafe due to roadway conditions	3 = I don't know
10. Have to take detours from most direct route in order to use bike paths, lanes, or streets more suited for bicycles	4 = somewhat disagree 5 = strongly disagree
11. Noise level is high	
12. Many houses, buildings or other properties in disrepair or vacant	
13. Weather often makes bicycling difficult or unpleasant	
Facilities/Support at GSU	
1. There are enough bicycle racks	1 = strongly disagree
2. Bicycle racks are in convenient locations	2 = somewhat disagree
3. Bicycle racks are easy to find	3 = I don't know
4. I can find information about bicycling (safety, repairs, properly securing, and parking)	4 = somewhat agree 5 = strongly agree
5. I can find a place to repair my bicycle	
6. Bicycle might be stolen even if properly secured	1 = strongly agree 2 = somewhat agree 3 = I don't know 4 = somewhat disagree 5 = strongly disagree
Social Environment at GSU	
1. My GSU friends ride bicycles	1 = strongly disagree
2. Bicycling for transportation is considered cool among my friends	2 = somewhat disagree
3. I know the name of one bicycle organization in Atlanta	3 = I don't know
4. I know where to get information about bicycle routes around Atlanta	4 = somewhat agree 5 = strongly agree
Future support for bicycling	**Code**
1. Bicycle racks on campus that allow parking in locations that are more convenient	1 = strongly disagree
2. Education programs about bicycling to and from GSU campus	2 = somewhat disagree
3. Information about routes for bicycling to and from GSU	3 = I don't know
4. Facility on the GSU campus to get help with minor bicycle repairs	4 = somewhat agree
5. Better safety and security for bicycle parking and storage areas on GSU campus	5 = strongly agree
6. Bicycles available to use by students, staff, or faculty at little or no cost	

Chapter IV

Results

4.1 Socio-demographic Variables

The survey was administered from October 21, 2009 to November 23, 2009 and included 314 students after those who did not sign the consent form were removed from the data set. The group was 60% (n=189) female and an overwhelming majority (n=163, 52.6%) of the students reported majors offered in the College of Arts and Sciences. The sample consisted of 32 students who were cyclists as defined in the methods section, making up 11.1% of the sample. According to data from the fall of 2009, 30,431 students were enrolled at GSU. Like the study sample, roughly 60% were female, the mean age was 23, and a majority of the students (43.4%) were enrolled in the College of Arts and Sciences. When looking at these demographics, the study sample appears to be somewhat representative of the general population. Initial demographics of the group as well as some demographics from the general population are shown in Table 3.

In order to better understand differences between the populations that did and did not bicycle to GSU for transportation, associations were assessed and compared between the two groups. Shown in Table 4 are the results of the comparison including statistical analysis for each factor. The cyclist group was overwhelmingly male (81.3%) while the non-cyclist group was only 35% male. A chi-squared test showed a significant difference in gender between cyclist and non-cyclists (χ^2=25.59, p=<0.001). The mean ages of cyclists

and non-cyclists were also significantly different with cyclists being on average, 3 years older. The distribution of reported health statuses and exercise levels were significantly different between non-cyclists and cyclists. A significant difference was also observed for the variables mode of transportation, access to bicycle, bicycle for fun, and bicycle for transportation. While these observations were expected, it is important to note that of non-cyclists, 2.5% reported using a bicycle as a form of transportation to and from GSU; however, this question was not specific to riding a bicycle in the fall of 2009. Additionally, 44% reported having access to a bicycle, 20.7% reported bicycling for fun in fall of 2009 and 6.2% reported bicycling for transportation in fall of 2009. However, here, bicycling for transportation was not specific to the GSU campus.

In order to quantify the bicycling behaviors of the cyclists, descriptive statistics were calculated and are shown in Table 5. Cyclists were asked to recall how many days out of the previous seven days they bicycled to, from, or around GSU. A majority (61.3%) reported bicycling three to seven days. Most of the cyclists (73.3%) reported bicycle commutes of 40 minutes or less. Only one cyclist reported having a round-trip commute of greater than 60 minutes.

Due to differing sample strategies to capture cyclists as discussed in the methods, demographic characteristics of the cyclists by interview location (bicycle rack and lecture) were assessed as shown in Table 6. Fifteen of the cyclists were interviewed at bicycle racks and seventeen were captured through the lecture interviews. The mean age of those interviewed at bicycle racks (m=30) was greater than that of those interviewed in lectures (m=23). Cyclists interviewed in the classrooms were distributed more evenly among the colleges than those interviewed at bicycle racks.

Univariate binary logistic regression models were used to examine the effect of the independent descriptive characteristics (gender, major, health status, and exercise level) on bicycling. The results for this analysis are shown in Table 7. The analysis showed that males were significantly more likely to be cyclists than females (OR=8.04, 95% CI: 3.20-20.2). Students reporting excellent/very good health status were approximately three times more likely to be cyclists than those reporting a good/fair/poor health status (95% CI: 1.05-9.11).

Adjusted odds ratios were then calculated for the independent variables (gender, major, health status, and exercise level) using multivariate binary logistic regression and are shown in Table 8. This analysis showed that after adjusting for all other variables in the model, gender was the only demographic variable that remained significantly associated with bicycling (OR=6.819, 95% CI: 2.545-18.272).

4.2 Perception Variables

This section details the analysis of perceptions of GSU and the surrounding built environment.

Reliability

Table 10 shows the results from the reliability tests. As discussed in the methods section, Cronbach's alpha, a measure of reliability, was used to analyze the reliability of the student responses. Two of the categories, built environment and facilities/support on GSU campus, had questionable reliability coefficients, 0.61 and 0.63 respectively. All of the other categories rated at or above 0.7 suggesting reasonable reliability. Although the individual categories did not all report a score of 0.70 (standard) or greater; collectively,

the overall scale, composed of 29 items, was found to have an acceptable reliability coefficient of α=0.74.

Mode response and Chi-square analysis

Mode responses of cyclists and non-cyclists for each perception variable are shown in Table 9. Additionally, chi square analysis was carried out to determine if the distribution of responses varied significantly between the two groups. In order to compare the mode response for four of the perception variables between cyclists and non-cyclists, frequencies of responses were graphed. The following variables were graphed: “the distance is reasonable for bicycling,” “bicycling is a pleasant experience,” “my bicycle might be stolen on the GSU campus,” and “better safety and security for bicycle parking and storage.” These variables were selected from the variables that had significantly different distributions of responses based on the chi square analysis.

The analysis of response frequencies, including modes, show that cyclists and non-cyclists had similar response frequencies with respect to the built environment factors except with their perceptions of distance, bicycling as a pleasant experience, and houses and/or buildings in disrepair. The response distribution of the distance variable is shown in Figure 9. A majority of the non-cyclists perceive that their commute is too great to use cycling as a form of transportation. Chi-square analysis results show that the distribution of responses for each item in this category was significantly different between the two groups. While non-cyclists somewhat agreed and cyclists strongly agreed that bicycling was a pleasant experience, the distribution of the reported responses was significantly different, χ^2=22.022, p=<0.001 as seen in Figure 10. Both groups had the same mode response, somewhat agree, for the variable “there are many houses, buildings, or other

properties in disrepair or vacant on the route to GSU." However, the distribution of responses between the groups was significantly different, χ^2=10.725, p=0.030.

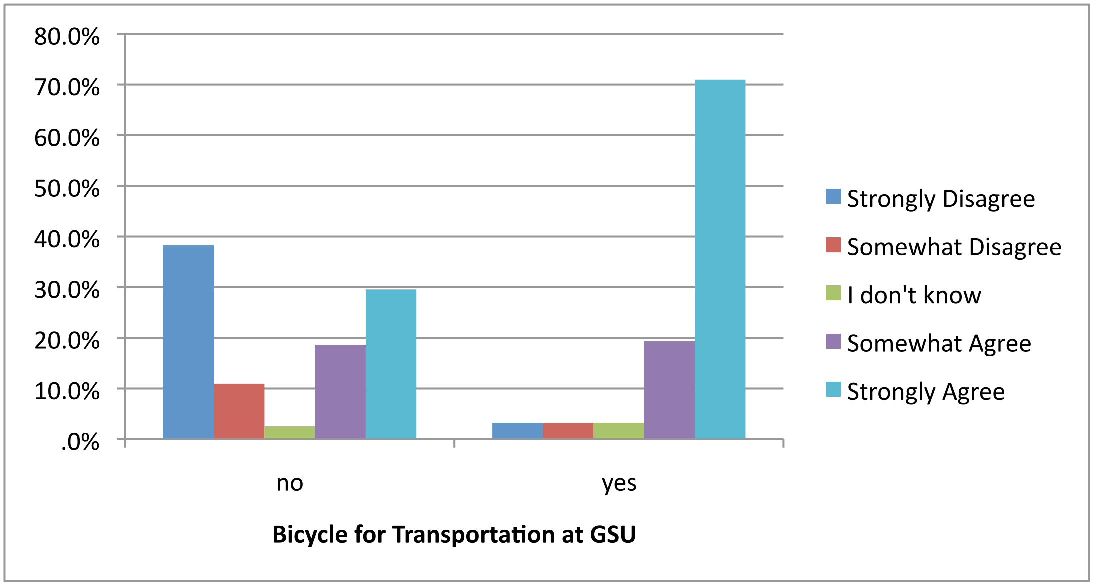

Figure 9. Distribution of responses to the variable "distance is reasonable for bicycling" stratified by bicycling behavior.

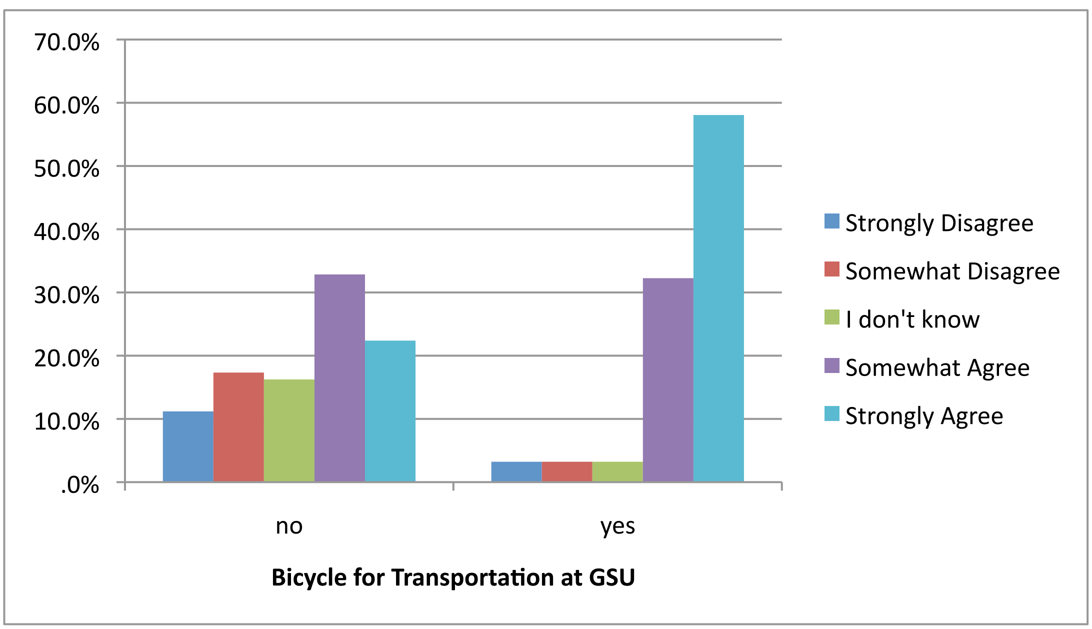

Figure 10. Distribution of responses to the variable "bicycling is a pleasant experience" stratified by bicycling behavior.

Non-cyclists reported not knowing about the majority of the items in the facilities/support on GSU campus category; however, they did somewhat agree that their bicycle would be stolen, as did cyclists. Although the mode response with respect to bicycle theft was somewhat agree for each group, the distribution of responses was significantly different as shown in Figure 11.

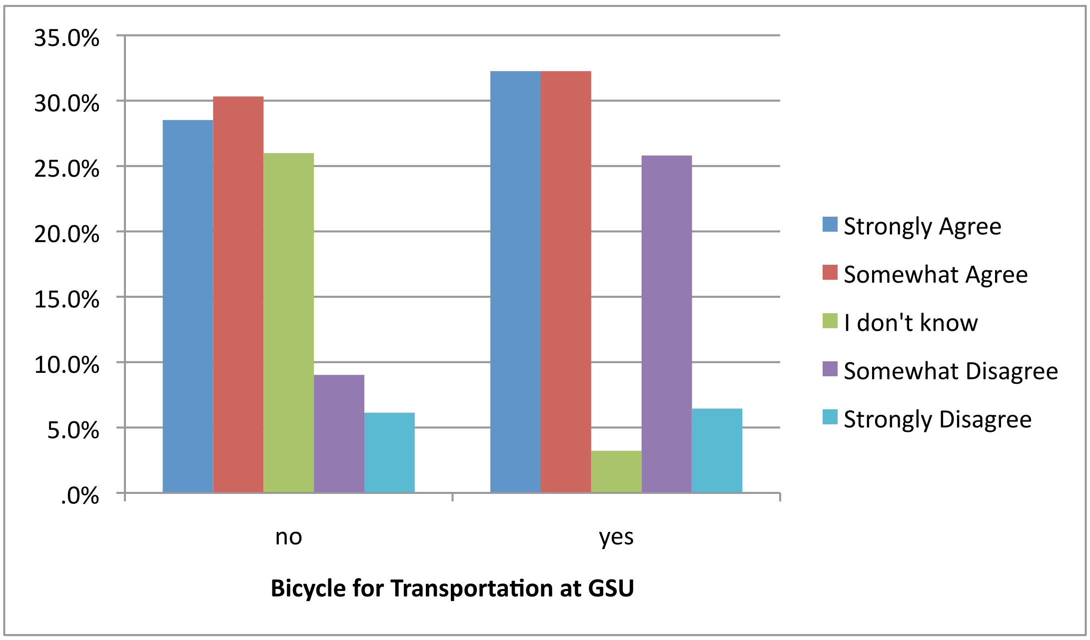

Figure 11. Distribution of responses to the variable "my bicycle might be stolen on the GSU campus even when properly secured" stratified by bicycling behavior.

Perceptions of social support at GSU were opposite between cyclists and non-cyclists with cyclists being in agreement with all of the social support factors as shown in Table 9. Additionally, the distributions of responses were significantly different between the two groups for each item in this category.

Cyclists and non-cyclists had similar mode responses, somewhat or strongly agree, throughout the future bicycle support at GSU category. However, the distributions of

responses for the variables: "more convenient bicycle racks," "facility on campus to get minor repairs," and "better safety and security for bicycle parking and storage," were significantly different between the two groups (Table 9). Figure 12 displays the distribution of responses related to better safety and security for bicycle parking. Over 80% of the cyclist strongly agreed that this would make cycling more likely while roughly 45% of non-cyclists strongly agreed that this would make it more likely that he or she bicycle for transportation.

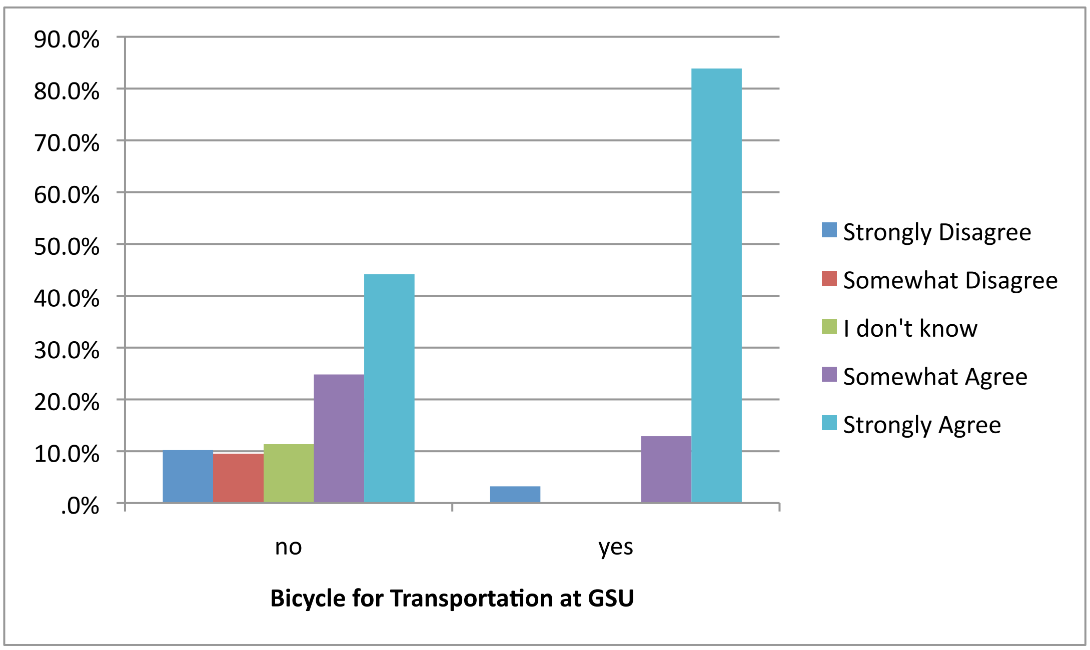

Figure 12. Distribution of the responses to the future support variable "better safety and security for bicycle parking and storage" stratified by bicycling behavior.

Mode response by gender: safety

In order to investigate differences in safety perceptions by gender, the distribution of mode responses were graphed and are shown in Figures 13-15. The three perception variables assessed were: bicycle theft, unsafe motor vehicle traffic, and unsafe roadway

conditions. Chi-square analysis shows that the distribution of these responses were significantly different (χ^2=21.727, p=<0.001; χ^2=10.194, p=0.037; χ^2=13.649, p=0.009, respectively). The graphs show that, on average, females perceived higher risk surrounding bicycling with respect to motor vehicle traffic, roadway conditions, and bicycle theft than males.

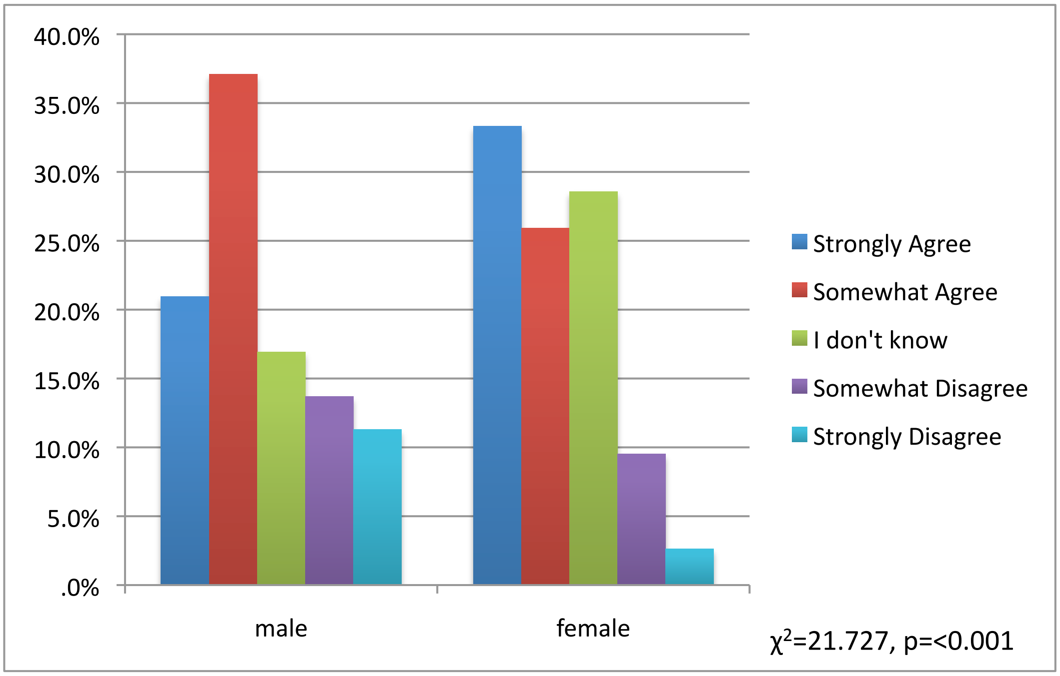

Figure 13. Distribution of responses to the variable "my bicycle might be stolen at GSU even when properly secured" stratified by gender.

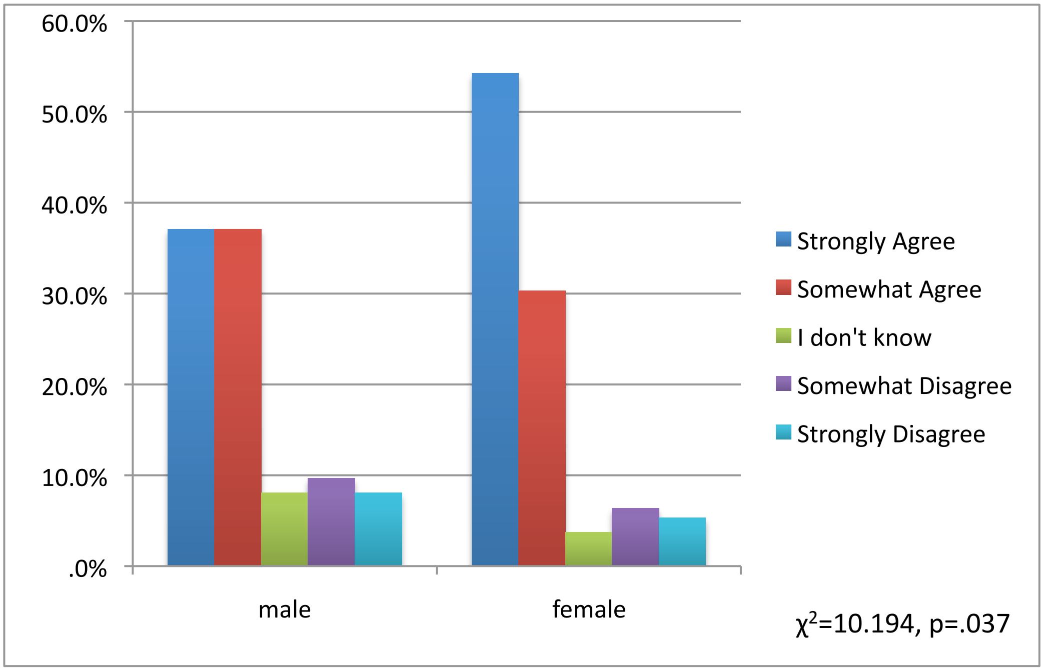

Figure 14. Distribution of responses to the variable "route is unsafe due to motor vehicle traffic" stratified by gender.

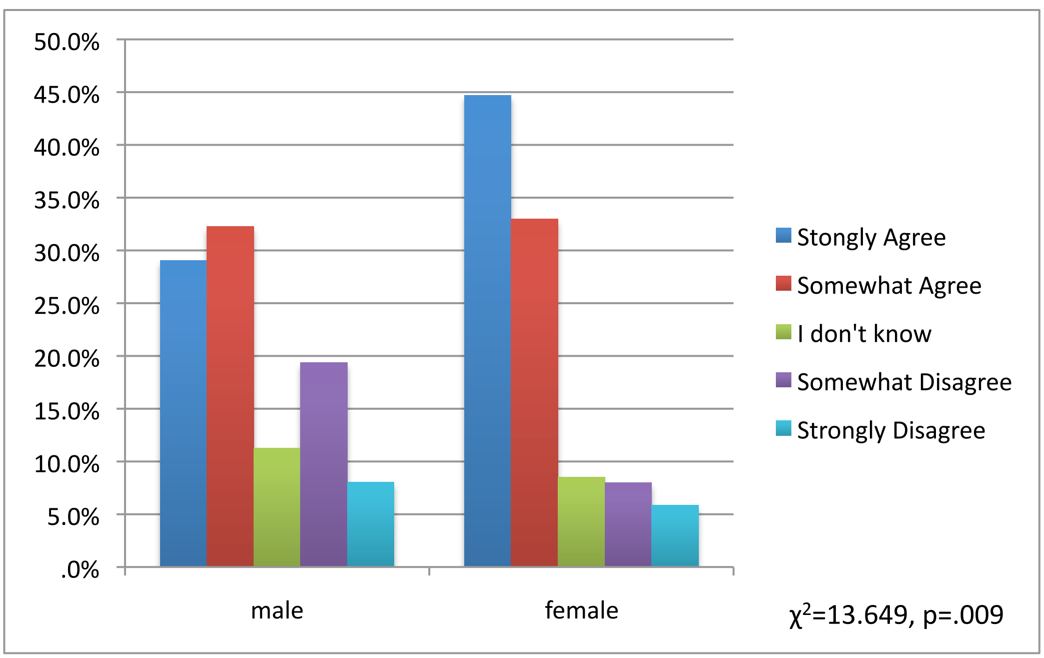

Figure 15. Distribution of responses to the variable "route is unsafe due to roadway conditions" stratified by gender.

T-test Analysis

Table 12 shows the independent samples t-test analysis results for each perception category (built environment, facilities/support at GSU, social support, and future support at GSU). Overall, cyclists' perceptions of the built environment, social support, and future bicycle support at GSU were statistically more favorable than non-cyclists, t (306)=-3.35, p=0.001, t (306)=-7.424, p=<0.001, t (51.20)=-5.124, p=0.001, respectively. The independent samples t-tests did not find significantly different perceptions of facilities/support on GSU campus between the two groups.

Predictions of Bicycling based on Odds Ratios

Odds ratios, adjusted for gender, were generated for each perception variable in order to predict bicycling (Table 11). With respect to the built environment, the following variables were significant predictors of bicycling: "route hilliness," "distance is reasonable," "bicycling is a pleasant experience," and "public transportation is within bicycling distance from residence." Route hilliness perceptions were inversely related to cycling for transportation (OR=0.599, 95% CI=0.395-0.908). Students who perceived a reasonable distance, bicycling as a pleasant experience, and agreed that public transportation was within bicycling distance from their home were significantly more likely to be cyclists, (OR=2.063, 95% CI=1.39-3.062; OR=2.083, 95% CI=1.337-3.247; OR=2.167, 95% CI=1.317-3.564, respectively) (Table 11).

Perceptions of facilities/support for bicycling on the GSU campus were not found to significantly predict bicycling. The odds ratios and 95% confidence intervals are shown in Table 11 and do not show any statistical significance.

Analysis of the social support category shows that each social support variable was a significant predictor of bicycling. Specifically, students with friends who bicycle, who think bicycling is "cool", who know of a bicycle organization and where to get bicycling information are significantly more likely to bicycle for transportation, (OR=1.576, 95% CI=1.18-2.107; OR=2.407, 95% CI=1.566-3.701; OR=2.062, 95% CI=1.528-2.782; OR=2.154, 95% CI=1.577-2.943, respectively) (Table 11).

Analysis of the future bicycling support at GSU category shows that students who perceived future bicycling support to be beneficial in increasing bicycling for transportation were more likely to be cyclist for each variable except "bicycles available to use at little or no cost." Odds ratios and 95% confidence intervals for each variable in this category are shown in Table 11. Future support involving better safety and security for bicycle parking and a facility on campus to get minor repairs show the most significantly positive effects on bicycling, with odds ratios of 3.781 and 2.611, respectively.

Table 3. Demographic characteristics of the study population and the GSU student population in 2009.

Variable	Study Population (n=314)	GSU Student Population (n=30, 431)
Gender:		
Female	189 (60.2%)	18,453 (60.6%)
Male	125 (39.8%)	11,978 (39.4%)
Age	Mean (SD): 23.5 (6.5)	Mean: 23
Major (by college):		
College of Arts and Sciences	163 (52.6%)	13,207 (43.4%)
College of Education	21 (6.8%)	3,810 (12.5%)
College of Health and Human Sciences	46 (14.8%)	3,044 (10.0%)
Business/Policy related disciplines	55 (17.7%)	9,646 (31.7%)
Uncertain	25 (8.1%)	724 (2.38%)

Table 4. Chi-squared analysis of demographic characteristics associated with bicycling for transportation at GSU.

Variable	Non-cyclist (n=277)	Cyclist (n=32)	Chi-Square (p-value)
Age	Mean (SD): 23.3 (6.2)	Mean (SD): 26.3 (8.4)	-2.42 (0.016)[a]
Gender:			25.59 (<0.001)
Female	180 (65%)	6 (18.8%)	
Male	97 (35%)	26 (81.3%)	
Major (by college):			3.96 (0.412)
College of Arts and Sciences	144 (52.6%)	17 (54.8%)	
College of Education	20 (7.3%)	1 (3.2%)	
College of Health and Human Services	44 (16.1%)	2 (6.5%)	
Business/Policy related disciplines	45 (16.4%)	7 (22.6%)	
Uncertain	21 (7.7%)	4 (12.9%)	
Health Status:			4.63 (0.031)
Good/Fair/Poor	85 (30.7%)	4 (12.5%)	
Excellent/Very Good	192 (69.3%)	28 (87.5%)	
Exercise Level:			5.85 (0.054)
Not Active	54 (19.5%)	3 (9.4%)	
Moderately Active	94 (33.9%)	7 (21.9%)	
Active	128 (46.2%)	22 (68.8%)	
Mode of Transportation to/from GSU:			
Motor Vehicle n=245,28	186 (75.9%)	23 (71.9%)	0.542 (0.461)
Bicycle n=201, 31	5 (2.5%)	30 (96.8%)	186.4 (<0.001)
Public Transportation n=236,27	128 (45.8%)	14 (51.9%)	0.56 (0.814)
GSU Panther Shuttle Bus n=212, 25	73 (34.4%)	5 (45.6%)	2.11 (0.146)
Walk/Wheelchair n=215,25	98 (45.6%)	10 (40%)	0.282 (0.595)
Access to Bicycle	122 (44%)	32 (100%)	35.71 (<0.001)
In the Fall Semester, 2009:			
Bicycle for fun n=277, 32	57 (20.7%)	28 (87.5%)	64.13 (<0.001)
Bicycle for Transportation n=275, 32	17 (6.2%)	32 (100%)	188.1 (<0.001)

[a] Two-sample t-test used for continuous variable.

Table 5. Frequencies of bicycling behavior among cyclists at GSU.

Behavior	Percentage
Days bicycled to GSU within past 7 days:	
0 days	8 (25.8%)
1-2 days	4 (12.9%)
3-7 days	19 (61.3%)
Time spent bicycling to and from GSU:	
0-20 minutes	10 (33.3%)
21-40 minutes	12 (40%)
41-60 minutes	7 (23.3%)
≥61 minutes	1 (3.3%)

Table 6. Demographic characteristics of cyclists by interview location.

Variable	Bike rack Interview (n=15)	Classroom Interview (n=17)
Age	Mean (SD): 30 (10.6)	Mean (SD): 23 (3.4)
Gender:		
Female	1 (6.7%)	5 (29.4%)
Male	14 (93.3%)	12 (70.6%)
Major (by college):		
College of Arts and Sciences	8 (57.1%)	9 (52.9%)
College of Education	1 (7.1%)	0
College of Health and Human Services	0	2 (11.8%)
Business/Policy related disciplines	5 (35.7%)	2 (11.8%)
Uncertain	0	4 (23.5%)
Health Status:		
Good/Fair/Poor	1 (6.7%)	3 (17.6%)
Excellent/Very Good	14 (93.3%)	14 (82.4%)
Exercise Level:		
Not Active	2 (13.3%)	1 (5.9%)
Moderately Active	3 (20.0%)	4 (23.5%)
Active	10 (66.7%)	12 (70.6%)
Mode of Transportation to/from GSU:		
Motor Vehicle	11 (84.6%)	12 (80.0%)
Motorcycle/Scooter	0	0
Bicycle	15 (100%)	15 (93.8%)
Public Transportation	6 (54.5%)	8 (50.0%)
GSU Panther Shuttle Bus	1 (10%)	4 (26.7%)
Walk/Wheelchair	2 (20%)	8 (53.3%)
In the Fall Semester, 2009:		
Bicycle for fun	14 (93.3%)	14 (82.4%)
Bicycle for Transportation	15 (100%)	17 (100%)

Table 7. Univariate binary logistic regression analysis of the association between independent demographic variables and bicycling for transportation at GSU.

Variable	OR	95% CI	P-value
Gender:			
Female	1.00	REF	REF
Male	8.04	3.20-20.20	<0.001
Major (by college):			
College of Arts and Sciences	1.00	REF	REF
College of Education	0.424	0.053-3.357	0.416
College of Health and Human Services	0.385	0.086-1.732	0.213
Business/Policy related disciplines	1.318	0.514-3.379	0.566
Uncertain	1.613	0.495-5.259	0.427
Health Status:			
Good/Fair/Poor	1.00	REF	REF
Excellent/Very Good	3.099	1.05-9.11	0.04
Exercise Level:			
Not Active	1.00	REF	REF
Moderately Active	1.340	0.333-5.40	0.68
Active	3.094	0.889-10.77	0.076

Table 8. Adjusted odds ratios computed from multivariate binary logistic regression analysis of the association between independent demographic variables and bicycling for transportation at GSU.

Variable	OR	95% CI	P-value
Gender:			
Female	1.00	REF	REF
Male	6.819	2.545-18.272	<0.001*
Major (by college):			
College of Arts and Sciences	1.00	REF	REF
College of Education	0.783	0.088-7.004	0.827
College of Health and Human Services	0.685	0.137-3.378	0.638
Business/Policy related disciplines	0.787	0.291-2.129	0.637
Uncertain	1.417	0.396-5.063	0.592
Health Status:			
Good/Fair/Poor	1.00	REF	REF
Excellent/Very Good	2.154	0.687-6.756	0.188
Exercise Level:			
Not Active	1.00	REF	REF
Moderately Active	1.423	0.329-6.152	0.667
Active	2.168	0.572-8.226	0.255

Table 9. The most frequently reported responses and chi-square analysis of perception variables by cyclists and non-cyclists.

Built Environment On the way to GSU and back:	Non-Cyclist	Cyclist	Chi-Square (p-value[a])
Route is hilly*	Somewhat Agree	Somewhat Agree	8.07 (0.089)
Distance is reasonable	Strongly Disagree	Strongly Agree	25.698 (<0.001)
Unsafe (motor vehicle)*	Strongly Agree	Somewhat Agree	3.009 (0.541)
Unsafe (roadway conditions)*	Strongly Agree	Strongly Agree	1.271 (0.866)
Detours necessary*	Strongly Agree	Strongly Agree	6.186 (0.186)
Pollution level is low	Somewhat Disagree	Somewhat Disagree	3.450 (0.486)
Lots of trees, gardens, parks or interesting features	Somewhat Agree	Somewhat Agree	3.656 (0.455)
Noise level is high*	Somewhat Agree	Somewhat Agree	5.979 (0.201)
Bicycling is a pleasant experience	Somewhat Agree	Strongly Agree	22.022 (<0.001)
Many houses, building or other properties in disrepair or vacant*	Somewhat Agree	Somewhat Agree	10.725 (0.030)
Weather makes bicycling difficult or unpleasant*	Somewhat Agree	Somewhat Agree	6.969 (0.138)
Where I currently live:			
There is a bus stop or train station within a reasonable bicycling distance	Strongly Agree	Strongly Agree	5.309 (0.257)
Is a good neighborhood for bicycling	Somewhat Agree	Strongly Agree	9.049 (0.060)
Facilities/Support on GSU campus			
There are enough bicycle racks	I don't know	Somewhat Disagree	9.747 (0.045)
Bicycle racks are convenient	I don't know	Somewhat Agree	12.142 (0.016)
Bicycle racks are easy to find	I don't know	Somewhat Agree	12.113 (0.017)
My bicycle might be stolen even if properly secured*	Somewhat Agree	Somewhat Agree	13.598 (0.009)
I can find info about cycling	I don't know	Somewhat Disagree	16.144 (0.003)
I can find a place to help repair my bicycle	I don't know	Strongly Disagree	27.973 (<0.001)
Social Support at GSU			
My GSU friends ride bicycles	Strongly Disagree	Somewhat Agree	35.864 (<0.001)
Bicycling for transportation is "cool"	I don't know	Somewhat Agree	25.158 (<0.001)
I know the name of at least one bicycle organization	Strongly Disagree	Strongly Agree	54.070 (<0.001)
I know where to get info about bicycle routes	Strongly Disagree	Strongly Agree	53.375 (<0.001)
Future Bicycle support at GSU			
More convenient bicycle racks	Strongly Agree	Strongly Agree	10.476 (0.036)
Educational programs	Somewhat Agree	Somewhat Agree	6.795 (0.147)
Info about routes to, from and around GSU campus	Somewhat Agree	Strongly Agree	8.202 (0.084)
A facility on campus to get minor repairs	Somewhat Agree	Strongly Agree	26.021 (<0.001)
Better safety and security for bicycle parking and storage	Strongly Agree	Strongly Agree	18.668 (0.001)
Bicycles available to use by students, staff or faculty at little or no cost	Strongly Agree	Strongly Agree	3.591 (0.464)

* Likert scale reversed to favor cycling.

[a] Bonferroni-adjusted p-value cutoffs: Built Environment ($p \leq 0.0039$), Facilities/Support at GSU ($p \leq 0.0083$), Social Support ($p \leq 0.013$), and Future Bicycle Support at GSU ($p \leq 0.0083$)

Table 10. Scale reliability of perception categories, Built Environment, Facilities/Support on GSU Campus, Social Support at GSU, and Future Bicycle Support on GSU Campus, reported by Cronbachs's Alpha.

Scale Components	Cronbach's Alpha (α)
Built Environment	α: 0.61
1. The route is hilly*	
2. The distance is reasonable for riding a bicycle	
3. The motor vehicle traffic (speed, type, or volume) on some streets makes the route unsafe for bicyclists*	
4. The roadway conditions (markings, signals, width, lighting, etc.) on some streets make the route unsafe for bicyclists*	
5. I would have to take detours from the most direct route in order to use bike paths, bike lanes, or streets more suited for bicycles*	
6. The pollution level is low	
7. There are lots of trees, gardens, parks, or interesting features	
8. The noise level is high*	
9. Bicycling is a pleasant experience	
10. There are many houses, buildings or other properties in disrepair or vacant	
11. The weather (temperature, humidity, storms, etc.) often makes bicycling difficult or unpleasant*	
Where I currently live…	
12. There is a bus stop or train station within a reasonable bicycling distance	
13. Is a good neighborhood for riding a bicycle	
Facilities/Support on GSU campus	α: 0.63
1. There are enough parking racks for bicycles	
2. Bicycle racks are found in convenient locations	
3. Bicycle racks are easy to find	
4. My bicycle might be stolen even if properly secured*	
5. I can find information about bicycling such as safety, repairs, properly securing, and parking	
6. I can find a place to help repair my bicycle if needed	
Social Support at GSU	α: 0.74
1. My GSU friends ride bicycles	
2. Bicycling for transportation is considered cool among my friends	
3. I know the name of at least one bicycle organization in Atlanta	
4. I know where to get information about bicycle routes around Atlanta	
Future Bicycle Support on GSU campus	α: 0.90
1. Bicycle racks on campus that allow parking in locations that are more convenient to the places I go on campus	
2. Educational programs (courses, web-based learning, etc.) about bicycling to, from, an around the GSU campus	
3. Information about routes for bicycling to, from, and around the GSU campus	
4. A facility on the GSU campus to get help with minor bicycle repairs	
5. Better safety and security for bicycle parking an storage areas on the GSU campus	
6. Bicycles available to use by students, staff, or faculty at little or no cost	
Total scale (29 items)	α: 0.74

* Likert scale reversed to favor bicycling.

Table 11. Odds ratios adjusted for gender and 95% confidence intervals of binary logistic regression for perceived built environment, social support, facilities/support on campus, and future support factors associated with bicycling to campus.

Built Environment On the way to GSU and back:	OR[ab]	95% CI
Route is hilly	0.599*	0.395-0.908
Distance is reasonable	2.063**	1.39-3.062
Unsafe (motor vehicle)	1.11	0.819-1.504
Unsafe (roadway conditions)	0.735	0.523-1.035
Detours necessary	0.83	0.605-1.138
Pollution level is low	0.96	0.688-1.342
Interesting features	1.289	0.958-1.733
Noise level is high	1.187	0.858-1.642
Bicycling is a pleasant experience	2.083**	1.337-3.247
Vacant Houses	0.87	0.630-1.201
Weather makes bicycling difficult	1.166	0.858-1.586
Where I currently live:		
Public transport with in bicycle distance	2.167*	1.317-3.564
Is a good neighborhood for bicycling	1.150	0.835-1.585
Facilities/Support on GSU campus		
There are enough bicycle racks	0.839	0.598-1.175
Bicycle racks are convenient	1.043	0.745-1.46
Bicycle racks are easy to find	1.324	0.95-1.845
My bicycle might be stolen	0.937	0.682-1.287
I can find info about cycling	0.873	0.642-1.187
I can find a place to help repair my bicycle	0.828	0.615-1.114
Social Support for Bicycling		
My GSU friends ride bicycles	1.576*	1.18-2.107
Bicycling is "cool"	2.407**	1.566-3.701
I know the name of one bicycle organization	2.062**	1.528-2.782
I know where to get info about bicycle routes	2.154**	1.577-2.943
Future Bicycle support at GSU		
More convenient bicycle racks	1.907*	1.239-2.933
Educational programs	1.535*	1.116-2.113
Info about routes	1.837*	1.207-2.797
A facility on campus to get minor repairs	3.781**	1.922-7.44
Better safety and security for bicycle parking	2.611*	1.423-4.794
Bicycles available to use at little or no cost	1.117	0.825-1.513

[a] ORs are adjusted for gender
[b] ORs predict bicycling
* p=<0.05; ** p= <0.001

Table 12. Overall perception differences between cyclists and non-cyclists based on t-scores.

Perception Categories	Non-cyclist Mean (sd)	Cyclist Mean (sd)	T-score (df)	p-value
Built Environment	2.67 (0.55)	3.02 (0.46)	-3.35 (306)	0.001
Facilities/Support on GSU campus	2.76 (0.67)	2.83 (0.84)	-0.511 (306)	0.610
Social Support for Bicycling	2.45 (0.98)	3.84 (1.01)	-7.424 (306)	<0.001
Future Bicycling Support at GSU	3.58 (1.10)	4.28 (0.66)	-5.124 (51.02)[a]	0.001

[a] Equal variances not assumed

Chapter V

Discussion and Conclusion

5.1 Discussion

Bicycling for transportation has become an important research topic because active transport has been shown to significantly improve the health of individuals as well as the environment (Frank et al., 2010). While cities around the United States can greatly benefit from foreign studies addressing factors surrounding bicycling for transportation, more investigations need to be conducted nationally, specifically addressing bicycling on college campuses. Very little research has addressed bicycling on college campuses, and the existing research has generally been confined to traditional college campus settings. GSU is unique as the campus is non-traditional and is located in the center of a large urban environment. This characteristic makes GSU unique. In an attempt to address the lack of research in this area, this study aimed to identify and describe socio-demographic characteristics of bicyclists at GSU and to describe the attitudes and perceptions surrounding bicycling for transportation to, from and around GSU of both cyclists and non-cyclists.

Demographic Characteristics

The non-cyclists and cyclists groups were established based on a question in the survey asking if the student had bicycled for transportation to, from, and/or around GSU in the fall of 2009. However, this was not the only question in the survey that addressed bicycling for transportation. Five of the non-cyclists reported bicycling as a form of

transportation that they sometimes used at GSU. These five students were not included in the cyclist group because they answered "no" to the question, "Since the beginning of the current semester, have you used a bicycle for transportation to, from, or around the GSU campus at least once?" It is possible that these respondents misunderstood the question or had bicycled at GSU a minimal amount of times in the distant past. Seventeen of the non-cyclists reported bicycling for transportation in the fall of 2009 (not specific to GSU). Additionally, 44% of the non-cyclists reported having access to a bicycle. Further investigation to determine the bicycling behavior of these students and why they do not bicycle at GSU would be useful in program creation. Additionally, future efforts to identify other students at GSU who bicycle for transportation off campus could assist in narrowing down specific intervention groups.

At GSU, males were found to be over six times more likely to be cyclists than females (Table 8) after adjusting for all other variables. This gender-dependent observation was expected and consistent with previous studies (Tin Tin et al., 2009; Garrard et al., 2008). Pucher et al (2008) reported that utilitarian bicycling in the U.S. is low and highly gender dependent with approximately 76% of bicycle trips being made by males. However, countries with high utilitarian bicycling levels such as the Netherlands, Germany, and Denmark report fairly gender equal bicycling rates (Pucher & Buehler, 2008).

Multiple studies have found age to be significantly associated with bicycling for transportation (Butler et al., 2007; Moudon et al., 2005). The general finding is that young and middle aged adults are the most likely to bicycle. A significant difference was observed between the mean ages of the two groups in this study (Table 4). However, both 23 and 26 fall into the age range that has been shown to be the most likely to bicycle. In this study,

the age range of the students interviewed was fairly small with a few outliers. This finding is not strong due to the great difference in size of the two groups; with non-cyclist being much more represented than cyclists. One outlier in the cyclist group could inflate the mean age.

Self reported health status was not found to be significant after adjusting for all other demographic characteristics (Table 8). However, the unadjusted odds ratios found students who reported excellent/very good health were more likely to be cyclists suggesting that in general, bicyclists perceive themselves as a healthy group. This finding was in agreement with what is known about cycling behavior. Moudon et al (2005) found that cyclists reported a higher level of perceived health status. According to results from the 2008 U.S. College Health Assessment, less than half of college students, male and female, were participating in the recommended amount of exercise (American College Health Association, 2008). Bicycling for transportation is an easy and affordable way to increase students' physical activity levels. Increasing students' physical activity levels could lead to an increase in better self-reported health statuses among students.

Perceptions Variables

Built Environment

Significant associations between built environment characteristics and bicycling behavior were expected, as many studies have shown associations between the built environment and physical activity (Mota et al., 2007; Nelson et al., 2008; Troped et al., 2003). Overall, students who were already cyclists perceived the built environment significantly more favorably. This finding was similar to the findings of a New England

study which showed positive associations between self-reported street lights, enjoyable scenery, sidewalk presence, and distance to a paved trail and transportation physical activity (Troped et al., 2003).

Distance was shown to be an important indicator of bicycling in this study, with cyclists strongly agreeing that the distance was reasonable and non-cyclists strongly disagreeing (Figure 9). Consistent with studies by Moudon et al (2005) and Nelson et al (2008), which found that distance was an important perceived barrier to active commuting. Historically, GSU was a commuter school with no on-campus or university-owned housing until 2002. While the on-campus living community is growing, less than 20% of the students reside on campus. Distance is a barrier that may be fairly difficult to overcome at GSU due to the communities' general acceptance of GSU as a commuter school. Previous research has shown that when asked about travel distances to destinations, non-cyclists tend to report exaggerated distances when compared to cyclists and perceive these distances to be unreasonable for bicycling (de Geus et al., 2008). Future comparative studies of students' perception of distance and actual distance as it relates to bicycling should be conducted to help direct interventions. Additionally, this finding emphasizes that an on-campus bicycle share program, similar to "Bike Emory", could be useful to students once on campus.

Non-cyclists and cyclists both had the same mode, strongly agree, when asked if their residence was within bicycling distance to public transportation. Additionally, the regression analysis (Table 11) found this factor to be a significant predictor of bicycling. This finding suggests that non-cyclists may not be aware that bicycles are permitted on public transportation trains and buses in Atlanta, Georgia. Atlanta appears to be an

exception to the norm by allowing bicycles on public transportation with no restrictions. A review by Pucher et al (2010) showed that few public transportation systems permit bicycles onboard without restrictions. Information about bicycling and public transportation in Atlanta should be included as part of educational interventions to increase utilitarian bicycling at GSU.

Personal safety from roadway conditions and motor vehicle traffic was directly addressed in this category. Both non-cyclists and cyclists perceived bicycling for transportation at GSU as unsafe due to roadway conditions, with modes of strongly agree for each group. Non-cyclists strongly agreed that bicycling was unsafe due to motor vehicle traffic, while cyclists somewhat agreed. The distribution of response frequencies for each of these variables was not significant. (Pucher & Dijkstra, 2003; Reynolds et al., 2009; Steele, 2010) have found that safety is an important concern surrounding bicycling. Bicycling in urban, mixed-use areas is known to be more common and safer than rural areas (Steele, 2010). The lack of significant differences here is interesting because those in the cyclist group bicycle for transportation despite perceiving unsafe roadway and traffic conditions.

Facilities/Support at GSU

Non-cyclists, for the most part, did not know about facilities/support for bicycling at GSU; however, non-cyclists overwhelmingly perceived that if they rode a bicycle, it might get stolen on the GSU campus, as did cyclists. Due to the similar perception between groups, bicycle theft risk was not found to significantly impact utilitarian bicycling at GSU. Previous studies have found significant negative associations with bicycle theft risk and bicycling for transportation (Pucher et al., 2010a; Titze et al., 2007). Titze, et al (2007)

found that students who were not concerned with bicycle theft were more than twice as likely to bicycle to and from the university. Theft risk is likely an important barrier to bicycling at GSU also although significant associations were not observed. The agreement between cyclists and non-cyclists is interesting and may be a reflection of the downtown, urban location of GSU. GSU's campus is not traditional and is not in a confined, seemingly safe area as most traditional campuses are (Balsas, 2003).

Cyclists, on average, did not agree that there were sufficient bicycle racks on the GSU campus. However, they agreed that the existing bicycle racks were in convenient locations and easy to find. In this study, these variables were not significantly associated with bicycling, yet other studies have observed significant associations between bicycle parking availability and utilitarian bicycling (Pucher, Dill, & Handy, 2010b). Limited sample size and small representation of bicyclists could have caused the lack of significance. This observation can help direct the placement of future bicycle racks, as those who use the bicycle racks reported that the amount of available bicycle parking was a greater problem than the location.

Social Support at GSU

Research has consistently shown that social support is significantly associated with physical activity (de Geus et al., 2008; Titze et al., 2008). In this study, supportive results were found, showing highly significant positive associations between social support variables and bicycling for transportation (Table 11). Non-cyclists have very little social interaction surrounding bicycling. These observations should be an important consideration when developing and initiating programs to promote and increase bicycling.

Future Bicycling Support at GSU

Cyclists and non-cyclists had similar modes of agreement throughout this category and perceived that future support options would help to increase bicycling for transportation at GSU. The odds ratio analysis (Table 11) shows that better safety for bicycle parking and a repair facility would have the greatest impact on bicycling at GSU. Not surprisingly, respondents highlighted safety as an issue again. Here, safety is related to bicycle theft but the perceptions of safety with respect to crash risk have been observed throughout the survey. Safety as a reoccurring theme emphasizes the need to address safety in future programs surrounding bicycling for transportation.

Investment in changes to the built environment to add the appropriate bicycle infrastructure and facilities, such as traffic control devices and more bicycle lanes and trails would be great addition to the downtown area and would likely assist in increasing bicycling at GSU. A review of case studies of cities implementing multiple intervention bicycle programs found that even very large cities have dramatically increased levels of bicycling while improving safety. The successful programs generally encompass many interventions such as changes to the built environment along with educational campaigns (Pucher et al., 2010). Unfortunately, these advancements are beyond the scope of the Bicycling for Transportation at GSU project and therefore were not specifically addressed here. However, interviewees were given the opportunity to comment at the end of the survey. A general theme seen throughout the comments was the need for safe bicycle lanes and routes around campus.

Perceptions of safety by gender

As mentioned before, females have been found more likely to be concerned with safety (Reed & Ainsworth, 2007; Pucher et al., 2010). Reed et al (2007) found that only 30% of females perceived the college campus to be extremely safe compared to 49% of males when examining physical activity patterns at a U.S university. While this association was not the focus of this study, bar charts of the variables directly addressing safety (bicycle theft risk, bicycling is unsafe due to roadway conditions, and bicycling is unsafe due to motor vehicle traffic) stratified by gender (Figures 13-15) were generated. This visualization depicts that; in general, females reported a greater concern for safety from dangers due to traffic and roadway conditions and a greater concern that the bicycle would be stolen than males.

5.2 Limitations

While this study has provided a much-needed start to investigating bicycling for transportation on college campuses and in urban areas, there are many limitations. Sample size was a major limitation for this study. The portion of cyclists in the sample was also a limitation because cyclists represented only 11% of the study population. This limited the analysis capabilities and could have caused the findings to be weak and to lack statistical significance. However, the majority of the findings were consistent with what we already know about bicycling for transportation.

Sampling strategy was also a limitation, as random sampling was not used. This factor makes it difficult to generalize these findings to other locations nationally and internationally. It would be more feasible to generalize these findings to the entire GSU population as the sample proved to be fairly well representative. Also, perspectives

courses are general, introductory level courses that are not major specific. However, caution should be used even when generalizing these findings to GSU's population.

The nature of a survey study is a limitation in itself because data is compiled from self-reported behaviors and beliefs. The assumption is made that this data is accurate and valid although there is no way to prove this.

Finally, the methods used do not allow for the assumption of a causal relationship. However, these findings offer leads to future studies and interventions.

5.3 Conclusion

This was the first bicycling study conducted at GSU. The results describe the attitudes and perceptions of both cyclists and non-cyclists surrounding bicycling on campus. Overall, the findings were consistent with the current knowledge about bicycling for transportation. The findings show that distance appears to be the most statistically significant, important barrier to bicycling at GSU. However, although safety due to roadway conditions and motor vehicle traffic and risk of bicycle theft did not produce significant results, these factors should be addressed in future studies and/or programs. Cyclists and non-cyclists, in general, believed that the environment was unsafe for these three factors. Further investigation into how to alter these perceptions and create safer environments for the community would be beneficial to the health of the environment and the individuals in the community.

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Appendix A

Survey

Bicycling for Transportation to GSU – Fall 2009

About you

Important: Please provide an email address that we can use to contact you in the Spring 2010: ____

1. Gender

female ☐$_1$

male ☐$_2$

2. In what year were you born? ___________

3. What is your major?_________________________ **Check if undeclared or uncertain**

4. When do you anticipate graduating? (Semester and year)_________________________

5. How many semesters have you been at Georgia State?

less than 1 semester ☐

1-2 semesters ☐

3-4 semesters ☐

5-6 semesters ☐

longer than 6 semesters ☐

6. **Would you say that in general your health is**

Excellent ☐

Very good ☐

Good ☐

Fair ☐

Poor ☐

7. **Thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health *not good*?**

____ Number of days

Check if not known ☐

8. **During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking *for exercise*?**

Yes ☐1

No ☐2 ⟶ ***If no, continue to question 10; do not answer Question 9.***

9. **During the past 7 days**, how many days did you participate in physical activities or exercises in which your heart rate and breathing was above normal for more than 10 minutes?

____ number of days

Check if not known ☐

What forms of transportation do you use for getting to and from GSU? Please provide the *best answer* for each question. *Do not include* trips between classroom buildings or from an on-campus parking lot.

		All of the time	**Some of the time**	**None of the time**
10	I drive myself or ride in a motor vehicle (car, SUV, truck, or van).	☐1	☐2	☐3
11	I ride a motorcycle/scooter.	☐1	☐2	☐3
12	I ride a bicycle.	☐1	☐2	☐3
13	I take public transportation (MARTA or other government system).	☐1	☐2	☐3
14	I take the GSU Panther Shuttle Bus from an outlying parking lot.	☐1	☐2	☐3
15	I go on foot or by wheelchair.	☐1	☐2	☐3

16. Do you have a permanent physical condition which prevents you from bicycling?

Yes ☐$_1$ → ***If yes, continue to question 23; do not answer questions 17-22.***

No ☐$_2$

17. Do you have access to a bicycle to use for transportation at the present time (even if you are not currently using it for transportation)?

Yes, I own or can borrow a bicycle. ☐$_1$

No, there is no bicycle available for me to use. ☐$_2$

18. Since the beginning of the current semester, did you bicycle *for fun or recreation* at least once?

Yes ☐$_1$

No ☐$_2$

19. Since the beginning of the current semester, did you bicycle *for transportation* at least once to *a location anywhere*?

Yes ☐$_1$

No ☐$_2$

Bicycling for Transportation to GSU

20. Since the beginning of the current semester, have you used a bicycle for transportation to, from, or around the GSU campus at least once?

Yes ☐$_1$

No ☐$_2$ → ***If no, skip to question 23; do not answer questions 21 and 22.***

21. During the *last 7 calendar days*, how many days did you bicycle for transportation to, from, or around the GSU campus?

_____ days

22. On the days that you did bicycle, what is the average amount of time that you spent bicycling for transportation to, from, or around the GSU campus?

____ total minutes in the average day

Proceed to the next page

Answer questions 23 through 52 by ***thinking about making your typical commute using a bicycle, along your actual or possible route, or using it on campus for transportation, even though you may not currently bicycle to or around GSU***. Exclude freeways from your consideration as commuting routes. Select the *best answer for each question.*

Functionality, Safety, and Aesthetics

	On the way to GSU and back …	**Strongly disagree**	**Somewhat disagree**	**Somewhat agree**	**Strongly agree**	**I don't know**
23	the route is hilly.	☐1	☐2	☐3	☐4	☐77
24	the distance is reasonable for riding a bicycle.	☐1	☐2	☐3	☐4	☐77
25	the motor vehicle traffic (speed, type, or volume) on some streets makes the route unsafe for bicyclists.	☐1	☐2	☐3	☐4	☐77
26	the roadway conditions (markings, signals, width, lighting, etc.) on some streets make the route unsafe for bicyclists.	☐1	☐2	☐3	☐4	☐77
27	I would have to take detours from the most direct route in order to use bike paths, bike lanes, or streets more suited for bicycles.	☐1	☐2	☐3	☐4	☐77

	On the way to GSU and back…	**Strongly disagree**	**Somewhat disagree**	**Somewhat agree**	**Strongly agree**	**I don't know**
28	the pollution level is low.	☐1	☐2	☐3	☐4	☐77
29	there are lots of trees, gardens, parks, or interesting features.	☐1	☐2	☐3	☐4	☐77
30	the noise level is high.	☐1	☐2	☐3	☐4	☐7
31	bicycling is a pleasant experience.	☐1	☐2	☐3	☐4	☐77

32	there are many houses, buildings or other properties in disrepair or vacant.	☐$_1$	☐$_2$	☐$_3$	☐$_4$	☐$_{77}$
33	the weather (temperature, humidity, storms, etc.) often makes bicycling difficult or unpleasant.	☐$_1$	☐$_2$	☐$_3$	☐$_4$	☐$_{77}$

Proceed to the next page

On the GSU Campus

	On the GSU campus…	**Strongly disagree**	**Some what disagree**	**Some what agree**	**Strongly agree**	**I don't know**
34	there are enough parking racks for bicycles.	☐1	☐2	☐3	☐4	☐77
35	bicycle racks are found in convenient locations.	☐1	☐2	☐3	☐4	☐77
36	bicycle racks are easy to find.	☐1	☐2	☐3	☐4	☐77
37	my bicycle might be stolen even if properly secured.	☐1	☐2	☐3	☐4	☐77
38	I can find information about bicycling such as safety, repairs, properly securing, and parking.	☐1	☐2	☐3	☐4	☐77
39	I can find a place to help repair my bicycle if needed.	☐1	☐2	☐3	☐4	☐77

Social environment at GSU

		Strongly disagree	**Some what disagree**	**Some what agree**	**Strongly agree**	**I don't know**
40	My GSU friends ride bicycles.	☐$_1$	☐$_2$	☐$_3$	☐$_4$	☐$_{77}$
41	Bicycling for transportation is considered cool among my friends.	☐$_1$	☐$_2$	☐$_3$	☐$_4$	☐$_{77}$
42	I know the name of at least one bicycle organization in Atlanta.	☐$_1$	☐$_2$	☐$_3$	☐$_4$	☐$_{77}$
43	I know where to get information about bicycle routes around Atlanta.	☐$_1$	☐$_2$	☐$_3$	☐$_4$	☐$_{77}$

Neighborhood

	Where I currently live…	Strongly disagree	Some what disagree	Some what agree	Strongly agree	I don't know
44	there is a bus stop or train station within a reasonable bicycling distance.	☐1	☐2	☐3	☐4	☐77
45	is a good neighborhood for riding a bicycle.	☐1	☐2	☐3	☐4	☐77
46	I **would not** leave my bicycle outside my residence because of the chance it might be stolen.	☐1	☐2	☐3	☐4	☐77

Support For Bicycling

	Which of the following would make it more likely that you would bicycle for transportation to, from, or around GSU?	Strongly disagree	Some what disagree	Some what agree	Strongly agree	I don't know
47	Bicycle racks on campus that allow parking in locations that are more convenient to the places I go on campus.	☐1	☐2	☐3	☐4	☐77
48	Educational programs (courses, web-based learning, etc.) about bicycling to, from, and around the GSU campus.	☐1	☐2	☐3	☐4	☐77
49	Information about routes for bicycling to, from, and around the GSU campus.	☐1	☐2	☐3	☐4	☐77
50	A facility on the GSU campus to get help with minor bicycle repairs.	☐1	☐2	☐3	☐4	☐77
51	Better safety and security for bicycle parking and storage areas on the GSU campus.	☐1	☐2	☐3	☐4	☐77
52	Bicycles available to use by students, staff, or faculty at little or no cost.	☐1	☐2	☐3	☐4	☐77

53. Do you currently live in Georgia State University housing?

Yes ☐ → ***If yes, continue to question 56; do not answer Question 55.***

No ☐

54. Please write the address where you usually live during the week.

Street and number____ ZIP Code _______________

55. Please provide comments or ideas about what could be done to promote bicycling at Georgia State or about the survey itself.

____

____

____

____

____

____

End of the questionnaire – Thank you very much for your response!

Appendix B

Data Cleaning

The following procedures were carried out in Microsoft Excel. The variable answering the question, *What is your major?* was filtered and assigned a nominal value coding the reported major to the college containing that major. Gender, health status, forms of transportation, and all of the perception questions were assigned nominal values as shown in Table 1. After these changes, the data was imported into SPSS.

In SPSS the following changes were made to the data. *Age* was calculated from *Birth Year* using the date/time wizard. The age was calculated using January 1, *Birth Year* because month and date of birth were not collected in the survey. *Health Status* was collapsed into *excellent/very good* and *good/fair/poor* because the frequencies in the *fair* and *poor* categories were 9 and 1 respectively. *Exercise Level* was calculated by combining the answers to the questions: *Did you exercise in the past 30 days* and *How many days of the past seven days did you participate in physical activity.* Those who said that they did not exercise in the past 30 days were assigned a value of (0). Those who reported that they did exercise in the past 30 days were assigned a value of (1) if they reported physical activity zero, one, or two days in the past seven days or if they skipped that question. Those who reported exercise in the past 30 days were assigned a value of (2) if they reported physical activity in three or more of the past seven days. A review of United States exercise guideline literature led to a three of the past seven days cut-off. The United States Department of Health and Human Services suggests that adults should participate in

physical activity at least three days a week to achieve substantial health benefits. (http://www.health.gov/Paguidelines/guidelines/chapter4.aspx) The *Forms of Transportation to and from GSU* questions offered three options: yes, sometimes, and never. *Yes* and *sometimes* were collapsed into *yes* making the variables dichotomous.