THESIS

PREVALENCE AND CORRELATES OF ACTIVE TRANSPORTATION IN UNIVERSITY STUDENTS: A PILOT STUDY

Submitted by

Aubrey Ann Hoover

Department of Health and Exercise Science

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WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY AUBREY HOOVER ENTITLED PREVALENCE AND CORRELATES OF ACTIVE TRANSPORTATION IN UNIVERSITY STUDENTS: A PILOT STUDY BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

Committee on Graduate Work

_____
Susan Gould

_____
Brian Butki

_____
Advisor: Catherine Kennedy

_____
Department Head: Richard G. Israel

ABSTRACT OF THESIS

PREVALENCE AND CORRELATES OF ACTIVE TRANSPORTATION IN UNIVERSITY STUDENTS: A PILOT STUDY

Active transportation (AT) affords a practical opportunity to increase physical activity levels, particularly in university students whose environment is especially conducive to an active lifestyle. To promote AT as a viable means to improve activity levels in college students, this study's purpose was to observe existing rates of AT versus passive transportation (PT) between home and campus in Colorado State University students and to analyze any differences in the relationship between determinants of AT and transportation mode. Those determinants of the transportation decision-making process include the transportation environment, demographics and behavioral determinants.

A total of 440 students completed a 14-item questionnaire including transportation patterns, demographics and behavioral characteristics. Subjects were assigned a primary mode of transport as a ratio of transport mode for the majority of days of the week related to the number of days on campus. Those with a ratio of exactly .5 (n=31) could not be assigned a primary mode and were, therefore, excluded, leaving 409 subjects. Chi square analysis of the relationship between primary mode of transport and demographic and behavioral characteristics was performed to determine any significant differences.

Results revealed that 56.2% of students surveyed primarily used AT and 43.8% used PT. Differences in transportation mode were associated with distance from residence to campus, academic year, self-efficacy and perceived barriers. The majority of students living on campus and within a mile used AT, whereas those living within 1-3 miles or greater than three miles from campus used PT. Freshmen used AT almost exclusively (87.2%), while the majority of sophomores used PT, being the only group to really utilize public transport. Public transport was included with PT due to an unusually short walk time to the bus of three minutes or less. Juniors and seniors did not differ from the overall trend in their use of AT versus PT. Poor perceptions of fitness ability and weight status were associated with greater use of PT. Those selecting PT as their primary mode reported a greater number of barriers to AT; lack of enjoyment and already exercising enough were greater barriers to those using PT than those using AT.

Consequently, to promote AT for physical activity in CSU students, efforts should be directed toward those living within 1-3 miles of campus and to freshmen and sophomores as they transition off campus. Additionally, behavioral interventions to improve self-efficacy in those with a poor perception of their fitness level and/or weight status and to minimize the perception of barriers – particularly those associated with PT – would constitute a valid approach.

Aubrey Hoover
Department of Health and Exercise Science
Colorado State University
Fort Collins, CO 80523
Summer 2010

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CHAPTER I

INTRODUCTION

Despite evidence to the benefits of physical activity, less than half the population achieves adequate levels necessary to promote health ("Prevalence of physical activity, including lifestyle activities among adults--United States, 2000-2001," 2003). Due to the lack of adherence to existing recommendations, experts now encourage an active lifestyle as an alternative to traditional exercise. An individual's daily activities can be categorized into five domains: sleep, leisure, occupation, transportation and home. Aside from sleep, the other domains provide opportunities to incorporate physical activity (Pratt, Macera, Sallis, O'Donnell, & Frank, 2004). In particular, the transportation domain affords practical opportunities to increase activity levels and boasts environmental benefits, cost effectiveness, and in many cases enjoyment and convenience. Active transportation (AT), or the transport of oneself via human power, maximizes time and opportunities to incorporate physical activity. Sufficient evidence shows that active transportation can serve as a viable means to meet recommended physical activity levels with an associated decrease in disease incidence (Gordon-Larsen, Nelson, & Beam, 2005).

College students are particularly susceptible to a sedentary lifestyle as the transition from adolescence to young adulthood denotes a marked decline in activity including up to an 85% decrease in participation in team sports and up to a 40% decrease

in non-team sports (Zick, Smith, Brown, Fan, & Kowaleski-Jones, 2007). Nevertheless, young adulthood marks a crucial time for developing lifelong habits. Due to the nature of this transition in conjunction with the fact that the traditional university environment is conducive to AT, college students are likely candidates to engage in a more active lifestyle. Efforts to influence the transportation decision-making process to promote AT in university students, therefore, represent significant opportunities to increase physical activity levels that may persist into adulthood (Zick, et al., 2007).

Several factors determine the prevalence of active transportation within a given population including the transportation environment, individual and social behavioral determinants and sociodemographic factors (Butler, Orpana, & Wiens, 2007; Saelens, Sallis, & Frank, 2003). Previous research related to active transportation in student populations is minimal. The described study's purpose was to observe existing rates of various modes of transportation and common determinants involved in transportation decision-making including the transportation environment, behavioral determinants and sociodemographic factors specific to Colorado State University students. The results will serve as a basis for efforts to increase activity in this population.

Statement of Purpose

The adoption of active transportation by university students has the potential to reduce levels of inactivity significantly in this population and promote healthy lifestyles. In conjunction with baseline prevalence and observations of the transportation environment, an analysis of certain characteristics of those who primarily select active transportation as their mode of transport between home and campus versus those who

choose a passive mode may serve as the basis for interventions designed to increase activity levels at this critical age.

Research Questions

1. Will the relationship between mode of transport and sociodemographic factors including year of study, major, and distance from home to school differ significantly between transportation groups?
2. Will the relationship between mode of transport and behavioral determinants of active transportation, including activity levels, perceptions of the barriers and benefits of active transportation and perceived weight status and fitness level differ significantly between transportation groups?

Delimitations, Limitations and Assumptions

The study was delimited to 440 students enrolled at Colorado State University, assumed by attendance in classes where the questionnaire was administered. The study was limited by the specificity of the population, and is therefore not applicable to the general population. Subjects who could not be assigned a primary mode of transportation, either because of not answering or because of an exact 50:50 ratio of transportation modes were excluded from the results. Responses may have been limited by subjects' assumptions of the nature of the study as well as perceived attitudes toward transportation by their peers. Self-reported data is a limitation in itself. It was assumed that questions were interpreted correctly and that participants answered truthfully.

Definitions

Active transportation: non-motorized transport, by one's own physical power

Passive transportation: motorized transport

Transportation decision-making: when one has access to both motorized and non-motorized transport, the process by which they decide between the two

Sociodemographics – demographics including socioeconomic status

Transportation Environment: the physical surrounding related to all forms of transportation – motorized transport, public transport, walking and cycling – including but not limited to the built environment (or the man-made surroundings), climate and safety

CHAPTER II

LITERATURE REVIEW

Introduction

As defined by the World Health Organization, *exercise* is purposeful activity intended to improve various aspects of fitness. In contrast, *physical activity* is defined as a broader concept encompassing various activities throughout the day ("Prevalence of physical activity, including lifestyle activities among adults--United States, 2000-2001," 2003). These activities range from lifestyle activities to sports and simply involve the movement of large muscle groups. In 2007, the American College of Sports Medicine (ACSM) and the American Heart Association (AHA) updated their recommendations of 20 minutes of vigorous *exercise* three days per week to encourage 30 minutes of moderate-intensity *activity* most days of the week. Aspects of active living such as various household and transportation-related activities are now included as important measures to achieve health benefits (Haskell, et al., 2007). Whereas in previous years measures of active living were implicit in recommended guidelines for exercise, the newer guidelines now highlight the importance of active living in increasing population-wide activity levels and emphasize *physical activity* as opposed to *exercise*.

In an attempt to alleviate the impact of the obesity epidemic, public health policy requires a shift in thinking to encourage physical activity, particularly active living as an

alternative to more traditional exercise (Sallis, et al., 2006). Active transportation (AT) as a subset of active living involves the transport of oneself using various modes of human power as opposed to some form of motorized or passive transport (PT). Examples include walking, biking, skateboarding, rollerblading and canoeing. Evidence shows that the inclusion of AT as a component of active living is crucial to meet activity recommendations (Berrigan, Troiano, McNeel, Disogra, & Ballard-Barbash, 2006). Several researchers have implicated AT as a cost-effective way to increase activity and improve health parameters population wide (Dombois, Braun-Fahrlander, & Martin-Diener, 2007; Frank, Andresen, & Schmid, 2004; Hu, Tuomilehto, Borodulin, & Jousilahti, 2007; Lindstrom, 2008; Litman, 2003; Pratt, et al., 2004; Shephard, 2008; Vuori, Oja, & Paronen, 1994; Wen & Rissel, 2008). In fact the document titled *Recommended Community Strategies and Measurements to Prevent Obesity in the United States* released by the Centers for Disease Control (CDC) in July, 2009, includes specific suggestions for environmental public policy to promote the use of transportation for physical activity in the prevention of obesity (Khan, et al., 2009).

Active transportation is still commonplace in many Western European countries. In Denmark, approximately 70% of 25-year old men and women commute by bike on a daily basis during the summer months and almost half travel by bike on a daily basis year-round (Shephard, 2008). In underdeveloped countries where access to motorized vehicles is limited, a higher prevalence of AT exists than in more developed countries where access to motorized transportation is greater (Wen, Orr, Millett, & Rissel, 2006). In Canada, only 8% of the working population utilizes AT (Shephard, 2008), and in the U.S., of trips made by adults that are *less than 1 mile*, only 21% are completed by

walking (Ham, Macera, & Lindley, 2005). Researchers have concluded that the prevalence of driving as the major transportation mode has serious health implications, and the promotion of AT is absolutely necessary to increase activity levels and subsequently improve overweight and obesity rates (Frank, et al., 2004; Wen & Rissel, 2008).

Health Impact of Active Transportation

Evidence suggests that transportation decision-making be incorporated into public health policy supported by financial incentives, worksite interventions, campus transportation management, and environmental design to increase AT and potentially improve population health (Litman, 2003; Pollard, 2003; Shephard, 2008). However, to promote AT successfully, the positive health effects must be established.

Transportation Decision-Making: Impact on Health

Passive transport, or driving, is positively associated with insufficient activity and overweight and obesity (Dombois, et al., 2007; Frank, et al., 2004; Lindstrom, 2008; Wen, et al., 2006), while AT is inversely associated with overweight and obesity, several disease risk factors and overall mortality (Andersen, Schnohr, Schroll, & Hein, 2000; Dombois, et al., 2007; Frank, et al., 2004; Hamer & Chida, 2008; Hu, et al., 2007; Lindstrom, 2008; Matthews, et al., 2007; Oja, Vuori, & Paronen, 1998; Wen, et al., 2006). In a cross-sectional study designed to observe the association between overweight and obesity and how it relates to the built environment, Frank et al. found that each hour spent driving per day was associated with a 6% increase in the likelihood of obesity whereas each kilometer walked daily was associated with a nearly 5% decrease in the likelihood of obesity (2004). The reduced time spent in a car in conjunction with the

activity involved in AT, therefore, has the potential to reduce the odds of being overweight or obese. Wen et al., in an examination of the relationship among transportation patterns, physical activity levels and rates of overweight and obesity, found those who drive to work were significantly less likely to achieve recommended levels of physical activity ($p<0.0001$) and were at significantly higher odds of being overweight or obese ($p<0.05$) independent of the insufficient activity associated with driving (2006). Similar findings were observed by Lindstrom et al. in a cross-sectional public health survey of Swedish adults where the odds ratio of overweight and obesity associated with AT was significantly lower than in those who used passive transport (2008). They also found those who utilized public transport were less likely to be overweight or obese citing some degree of activity in traveling to and from the transit stops. The average daily walk-time to and from the transit stop for Americans who used public transport was 19 minutes, and nearly 30% of public transit users achieved the recommended daily 30 minutes of activity simply from their walk time to and from the transit stop (Besser & Dannenberg, 2005). Shepard et al. in a review article of active commuting suggested that transportation related decisions could potentially alter population-level health on account of the reduced risk of obesity associated with AT (2008). Policy concerning transportation decision-making should, therefore, encourage the use of AT and public transport as alternatives to driving to improve rates of overweight and obesity.

Active Transport and Disease Risk

Active transportation, as a result of its association with improved rates of overweight and obesity, is consequently related to a reduction in the risk of diseases related to overweight and obesity and overall mortality. In a study of 75,000 Chinese

women, Matthews et al. found that in addition to the decreased risk of all-cause mortality related to leisure time physical activity, non-exercise physical activity (including AT) provided a 25-50% reduction in risk ($p<.05$) suggesting the association between physical activity and longevity is significant whether it be via traditional exercise or through an active lifestyle (2007). Andersen et al. also examined the differences between leisure time physical activity and aspects of active living, such as occupational and transportation activity, on overall mortality in a population of over 30,000 Danish adults. They discovered that bicycling to work was associated with decreased mortality in nearly 40% of observed participants (95% CI) even after adjusting for their leisure time physical activity (2000).

Important mechanisms by which participation in AT reduces overall mortality risk include improvement of metabolic indices and reduction in cardiovascular disease (CVD) risk. A Finnish active commuting intervention demonstrating the feasibility of active commuting and its potential to achieve regular moderate-intensity physical activity showed that when done regularly, active commuting significantly improved health indices such as HDL cholesterol levels in and of itself (Oja, et al., 1998). A review of several active commuting studies showed that subjects participating in worksite interventions designed to increase levels of AT showed significant improvement in measures of cardiorespiratory fitness and HDL cholesterol when working at or above a specified duration and intensity (Vuori, et al., 1994). Active transportation in women is also associated with a significantly reduced 10-year Framingham risk score for coronary heart disease (CHD) events ($p<.001$) independent of their CHD risk (Hu, et al., 2007). Despite ample evidence of the inverse association between AT and obesity related health

problems, little exists in the way of prospective cohorts or clinical trials regarding AT. Therefore, to establish any causality only inferences can be made regarding the health benefits of AT.

Meeting Physical Activity Guidelines

Sufficient evidence shows that those who engage in active transport are more likely to be active and less likely to be overweight or obese; but, it may be false to assume those results are directly related to active transport. If we are going to suggest to the public that simply riding a bike to work versus driving will improve their health, AT in and of itself needs to represent a viable source of physical activity that meets recommended guidelines necessary to improve health. The association between regular activity and improved health has been established repeatedly; therefore, if we can substantiate AT's effectiveness to achieve recommended activity levels, we can reasonably support its viability to improve health.

The few prospective cohorts related to AT demonstrate its promise as a resource for achieving recommended activity levels (Vuori, et al., 1994). Dombois et al. observed physical activity patterns in three Swiss communities with varying degrees of access to motorized transport and found that decreased access to motorized transport was associated with higher levels of moderately intense physical activity, explained in part by participation in active transport (2007). The WHO contends, "Moderate-intensity physical activity occurs when an individual experiences some increase in breathing or heart rate during exercise. However, it should still be possible to carry on a normal conversation (but not singing). Examples of moderate-intensity activities include walking briskly, gardening, dancing, swimming, bicycling, scrubbing floors and

housework." When computed mathematically, the necessary activity recommended over the week (in terms of energy expenditure) can be accomplished by walking 1.2 miles in 22 minutes twice per day, 5 days a week or by cycling at 10 mph for 11 minutes twice per day, 5 days a week (Shephard, 2008). It is more realistic to reach necessary intensities by cycling, but walking can provide adequate intensity at a quick pace and even more so if hills are involved. With knowledge that AT can reasonably provide 30 minutes of moderate-intensity activity most days of the week in conjunction with its associations with overweight and obesity and subsequent health effects, AT can be recommended as a means to achieve activity and decrease disease risk given adequate duration and intensity. Because AT can provide sufficient activity, policies or programs targeting determinants of active transportation could impact population health significantly (Shephard, 2008).

The decision whether or not to incorporate activity into one's day is based on individual, social and environmental factors (Pratt, et al., 2004). In instances where accessibility to motorized transport is the norm, individual and social behavioral determinants, the transportation environment, and sociodemographic factors are the most common predictors of the prevalence of AT (Butler, et al., 2007; Saelens, et al., 2003). Public health policy must, therefore, address both the transportation environment and individual determinants related to AT (Sallis, et al., 2006).

Determinants of Active Transportation

The known health benefits associated with AT have little importance if people are unwilling to engage in the activity. When an individual has a choice between active or motorized transport, the chief predictors determining active transport are sociodemographic factors, the transportation environment and behavioral determinants

(de Geus, De Bourdeaudhuij, Jannes, & Meeusen, 2008). Accordingly, predictors of AT need to be established and addressed to successfully implement the adoption of AT by the public.

Sociodemographics

Numerous studies have shown that those engaging in AT are more active overall than the general population, even when controlling for AT (Butler, et al., 2007; de Geus, et al., 2008; Gordon-Larsen, et al., 2005; Merom, Miller, van der Ploeg, & Bauman, 2008; Sisson & Tudor-Locke, 2008). The typical demographic of someone who utilizes active transport is a young, active, highly educated individual of a higher socioeconomic status. Consequently, sociodemographic characteristics need to be established in interventions to increase AT targeting segments of the population less likely to participate in AT but who could benefit greatly from its outcomes. Promotion of AT has the potential to reduce disparities in activity levels among varying degrees of socioeconomic status (Berrigan, et al., 2006), another relevant aspect of its importance.

The Transportation Environment

In addition to access to recreational facilities, the transportation environment is an integral factor in facilitating an active community (Brennan Ramirez, et al., 2006). Health, as it relates to transportation planning, is, therefore, important to consider (Litman, 2003). In fact, the most recent recommended community strategies to prevent obesity include enhancing infrastructure to support walking and biking based on evidence that conducive infrastructure is associated with increased levels of activity (Khan, et al., 2009). As a result, a surge in research has occurred associating the built environment with obesity by way of activity levels (Frank, Saelens, Powell, & Chapman, 2007).

Several important aspects of the built environment that influence active transportation include land-use mix, sidewalk and bike lane connectivity, neighborhood/community walkability, and residential density (Frank, et al., 2007; Sallis, et al., 2006). Concurrently, the Task Force on Community Preventive Services concluded that targeting community walkability is an important means to increase activity in the community (Sallis, et al., 2006).

Although the transportation environment, both real and perceived, plays a critical role in transportation decision-making, evidence shows that when the transportation environment is sufficient, behavioral factors, such as self-efficacy and decisional balance, are more predominant predictors of whether or not a person will participate in AT (de Geus, et al., 2008). A study of Austrian city bike commuters demonstrated the additional role of peer support and perceived benefits and barriers in deciding whether or not to participate in active transportation (Titze, Stronegger, Janschitz, & Oja, 2007). One worksite intervention, "Walk in to Work Out," found that while cycling to work was affected more by the environment, targeting behavioral determinants associated with the Transtheoretical Model was successful in increasing the prevalence of walking to work (Mutrie, et al., 2002). Authors of a review of existing interventions designed to increase AT found that programs targeting behavioral determinants had greater success in improving rates of AT than those focused solely on educating the public or addressing the transportation environment alone (Ogilvie, Egan, Hamilton, & Petticrew, 2004; Saelens, et al., 2003).

Behavioral Determinants

The decision whether or not to utilize AT, similar to any behavior, depends on a dynamic balance of benefits and barriers – perceived and real. Active transportation not only provides health benefits, but also environmental and economic benefits; however, the perception of benefits varies from person to person. Time is a very important barrier in the transportation-decision making process (Berrigan, et al., 2006). Obviously, a realistic distance is necessary to be able to commute actively; but, lack of interest, motivation, skills and physical disabilities also pose significant barriers to AT (de Geus, et al., 2008). Self-efficacy and social influences are inherent in decision-making processes, and attention to their importance is requisite in any attempt to encourage adoption of a new behavior (de Geus, et al., 2008). Perception of the transportation safety conditions also plays a role in transportation decision-making (Oja, et al., 1998). Behavioral determinants will vary from population to population as will the transportation environment within each community. Accordingly, these factors must be established specific to the population and community being affected for efforts to increase the use of active transportation within that population to be successful.

University Students

The transition from adolescence to young adulthood marks one of the greatest declines in activity over the lifetime due to decreased participation in team sports that is not compensated for with other forms of physical activity (Zick, et al., 2007). As a result, less than half of university students in the U.S. and Canada are achieving recommended activity levels (Irwin, 2004). Due to the decreased availability of structured activity

during this transition, considering a lifestyle approach to increase activity in this population is important.

Young adults, particularly college students offer significant potential for implementing elements of active living due to their transitional nature and the university environment. Furthermore, the introduction of such behaviors at this age has potential to instill lifelong habits of maintaining adequate activity levels and subsequently decreasing obesity and disease risk (Gordon-Larsen, et al., 2005). Despite a lack of research in this particular population, a pilot study examining the role of a lifestyle approach intervention in college students resulted in significant increases in activity – including walking behaviors - that were maintained at follow-up (Gieck & Olsen, 2007).

Efforts to incorporate elements of active living, such as AT in university students, deserve significant attention (Zick, et al., 2007). *Healthy Campus 2010* cited physical activity as a leading health indicator in the college-aged population and recognized the role of AT in its objectives to increase physical activity in college students including: *Objective 22-14* to "Increase the proportion of trips made by walking," and *Objective 22-15* to "Increase the proportion of trips made by bicycling" (*Healthy Campus 2010: Making it Happen*, 2004) In addition, the use of public transport to campus should be considered as an alternative to driving given that those who utilize public transport accumulate an average of 20 minutes of activity each day walking or biking to and from transit stops and that access to public transport is often free for university students (Besser & Dannenberg, 2005).

Determinants of AT on College Campuses

To design an intervention supporting the objectives of *Healthy Campus 2010*, baseline prevalence of AT must be determined and its determinants in college students established. Sociodemographic trends for AT persist in the young adult population where the majority of those currently participating in AT are healthy, active and of a high socioeconomic status (Gordon-Larsen, et al., 2005). Sisson et al. found those who cycled for transport between home and school lived significantly closer to campus than those who drove. In addition, students who cycled to school engaged in significantly more physical activity overall than those who drove (2008). In high school students, age, activity level and perception of athletic ability have been demonstrated as significant determinants of AT (Robertson-Wilson, Leatherdale, & Wong, 2008).

Cycling as a form of transportation by university students is positively correlated with safety from bicycle theft, having friends who cycle for transport, emotional satisfaction, environmental attractiveness, and low physiological effort and mobility (i.e. continuity and freedom from traffic regulations) among other factors (Titze, et al., 2007). Knowledge and self-efficacy also are important behavioral determinants of adoption and maintenance of behavior change at any age (Gieck & Olsen, 2007). Some indicators of motivational readiness to adopt AT in college students included travel distance, convenience, time, infrastructure and social support (Cole, et al., 2008). Undergraduates have also cited appearance as a barrier to active transport (Dunton & Schneider, 2006).

Although residential density and land-use mix tend to be favorable in college communities, weather, safety, and other elements of the built environment represent perceived barriers to AT for students (Sisson, McClain, & Tudor-Locke, 2008). Physical

activity behaviors of college students have also been shown to be influenced significantly by perceptions of crime and sidewalk safety (Reed & Ainsworth, 2007). Campus walkability is an important factor in the prevalence of AT on campus. Sisson et al. compared two campuses in the same climate but with different degrees of walkability. The campus with greater walkability had almost twice the amount of on-campus AT – the difference likely attributable to differences in the built environment between the two campuses (2008). Successful interventions to increase the prevalence of AT to and from campus will, therefore, address behavioral determinants and the transportation environment.

Summary

Public health measures to increase AT have been suggested as one solution to reducing the obesity epidemic by improving rates of inactivity. At the university level, such measures have the potential to increase activity in the young adult population at a crucial time for instilling an active lifestyle and subsequent positive health outcomes. To increase activity levels in this population, the purpose of the following study is to determine existing rates of AT to and from campus in students at Colorado State University (CSU), observe the nature of the transportation environment around CSU, and explore any differences in sociodemographic factors and/or behavioral determinants between those whose primary mode of transportation is active versus those who drive or use public transport.

CHAPTER III

METHODS AND PROCEDURES

The study consisted of a 14-item questionnaire designed to investigate transportation patterns, demographics and behavioral characteristics related to transportation in a representative sample of students at Colorado State University. Approval from the Colorado State University Institutional Review Board (IRB) was obtained prior to the start of the study (Appendix D). Participants were informed of the purpose of the study, their rights as volunteers, and consent was assumed from completion of the questionnaire. Subjects also were informed of their right not to participate by returning a blank questionnaire and that their grade in the class would in no way be affected by participation. All data were kept confidential throughout the study and stored in a locked cabinet according to IRB regulations.

Subjects

Subjects were self-selected through enrollment in various classes in the Departments of Health and Exercise Science, Food Science and Human Nutrition and Construction Management. Inclusion criteria consisted simply of Colorado State University enrollment assumed by attendance in the classes where questionnaires were administered and voluntary completion of the questionnaire. Four hundred forty students from several classes completed the questionnaire.

Methodology

The 14-item questionnaire was administered to students during class in various departments on the Colorado State University campus in Fort Collins, CO. Prior to the study, investigators obtained consent from instructors to administer the questionnaire in their classes. Investigators administered the anonymous questionnaire and remained present as participants completed it. Questions included general demographics, transportation patterns between home and school, distance from residence to campus, activity level, as well as perceptions of weight status, fitness level and benefits and barriers of active transportation.

After data were collected, questionnaires were numbered for data-entry purposes. Answers were entered into an Excel spreadsheet and then transferred to SPSS for further analysis. Response count varied from question to question as subjects were instructed to answer only questions they felt comfortable answering. One question was commonly answered with checks rather than the requested rank. A ranking system was devised for that case based on the number of checked selections - a one was given when only one selection was checked, ones for each of two selections checked and twos for each of three selections checked.

Subjects were assigned a primary mode of transportation based on their mode for the majority of days of the week relative to the number of days they were on campus. The ratio was calculated through SPSS using the number of days students walked, biked or skateboarded to school compared to the number of days on campus. A ratio of 0-.4999 indicated passive transport as the primary mode and .5001-1.0 indicated active transport as the primary mode. Subjects with a ratio of exactly .500 were excluded as a majority of

days dedicated to either mode could not be established, leaving a total of 409 subjects. Three possibilities for mode of transport – walk/bike/skateboard, public transport (bus) or driving – were included. Those were then collapsed into active transport and passive transport. The investigators decided that because the average walk-time to the bus stop was found to be only three minutes that public transportation would be grouped with driving and labeled as passive transport. If in fact the average walk time would have been closer to 20 minutes as the literature indicates (Besser & Dannenberg, 2005) then public transport would have been grouped with walking/biking/skateboarding as part of active transport. Measures of the transportation environment, demographics and behavioral characteristics were then compared between groups that used active transportation as their primary mode and those that used the bus or car as their primary mode to determine any significant differences between groups.

Data Analysis

Any significant differences between groups was determined by chi-square comparison of counts and verified with non-overlapping confidence intervals of 95% when comparing percentiles in graph format. When significance was achieved ($p \leq 0.05$), the source of the difference was deduced by citing deviations from the trend.

CHAPTER IV

RESULTS AND DISCUSSION

Results

The purpose of this study was to observe the relationship between primary mode of transport and determinants of transportation decision-making in university students to identify any significant differences between those that primarily use active transportation (AT) and those that use passive transportation (PT). These results were organized into three aforementioned determinants of AT: demographics, behavioral determinants and the transportation environment.

Demographics

Subject counts were not significantly different in gender, academic year or travel distance from home to school (Table 4.1). The majority of respondents were white (90%) where 31.7% were Health and Exercise Science majors and 68.3% represented a variety of other majors including Sociology, Journalism, etc... Overall, 56.2% of respondents used (AT) as their primary mode of transport to and from school and 43.8% used (PT) as their primary mode (26.8% by public transport and 73.2% by vehicle). Public transport was included in PT because the average walk time of three minutes to/from the stops was not enough to substantiate it as AT. Of those who primarily utilized AT, 38.8% walked, 22.5% biked, 2.2% skateboarded and 36.6% did some combination of those. No

significant difference in transportation mode between genders nor in the number of women who used AT versus PT was observed; however, significantly more men used AT than PT (Figure 4.1).

Table 4.1

Demographic Variables Compared Between Transportation Modes

Demographic	n	Active Transport (n)	Passive Transport (n)
Primary Mode:	**409**	**230 (56.2%)**	**179 (43.8%)**
Gender:			
Male	197	118 (59.9%)	79 (40.1%)
Female	212	112 (52.8%)	100 (47.2%)
Race:			
White	364	205 (56.3%)	159 (43.7%)
Non-White	42	23 (54.8%)	19 (45.2%)
Academic Year:			
Freshman	117	102 (87.2%)[b]	15 (12.8%)[b]
Sophomore	100	41 (41.0%)[a]	59 (59.0%)[a]
Junior	84	38 (45.2%)[a]	46 (54.8%)[a]
Senior	97	46 (47.4%)[a]	51 (52.6%)[a]
Major:			
HES	123	74 (60.2%)	49 (39.8%)
Non-HES	265	144 (54.3%)	121 (45.7%)
Travel Distance:			
On Campus	104	100 (96.2%)[b]	4 (3.8%)[b]
< 1 mile	112	83 (74.1%)[b]	29 (25.9%)[b]
1-3 miles	129	38 (29.5&)[c]	91 (70.5%)[c]
> 3 miles	64	9 (14.1%)[c]	55 (85.9%)[c]

n[a]= no difference across mode but different from the general trend for primary mode
n[b]= different across mode but no difference from the general trend for primary mode
n[c]= both different across mode and from the general trend for primary mode

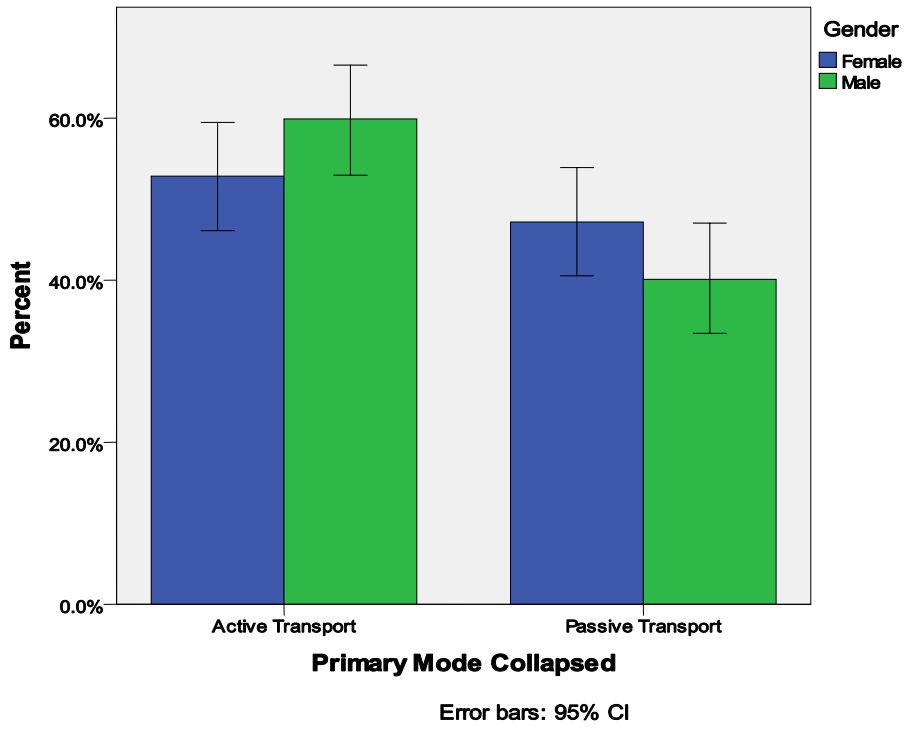

Figure 4.1 Primary Transportation Mode by Gender (p=0.09)

Freshmen utilized AT significantly more than PT, but no significant differences between or among sophomores, juniors and seniors were observed (Figure 4.2). When we expanded transportation mode to active transport, public transport and driving (Figure 4.3), no significant difference in transportation mode for sophomores was seen – they were split evenly among active transport, public transport and driving. Significantly fewer juniors and seniors took the bus; however, no significant difference between the number of juniors and seniors using active transport was seen. No significant differences among or between sophomores, juniors and seniors in distance from residence to campus eliminated distance as a confounder in the relationship between these academic years and transportation mode (Figure A.1).

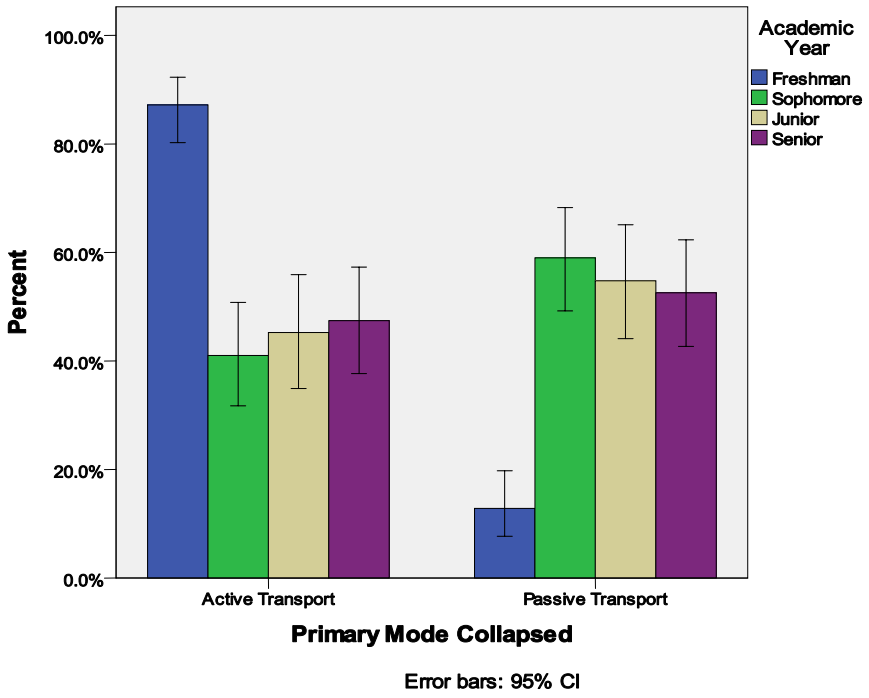

Figure 4.2 Primary Transportation Mode by Academic Year (p<0.005)

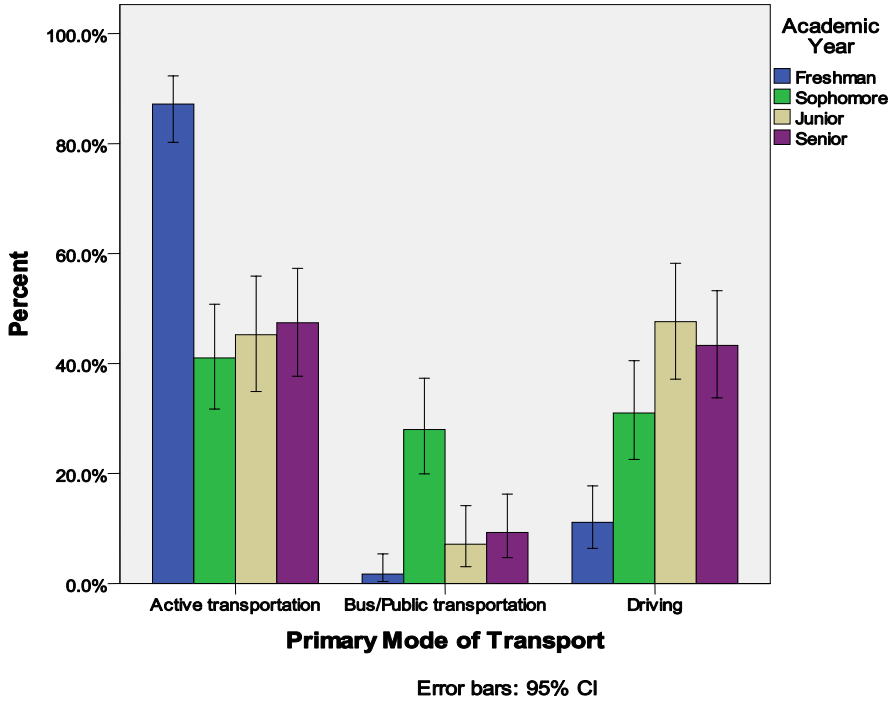

Figure 4.3 Primary Transportation Mode (Expanded) by Academic Year (p<0.005)

Figure 4.4 demonstrates the relationship between primary mode and travel distance. Those living on campus or within a mile of campus used AT almost exclusively and those living within one to three miles of campus or greater than three miles from campus used PT almost exclusively. Of those primarily using PT, 31.8% were unwilling to consider AT, 48.5% were somewhat willing, and 17.4% were very willing.

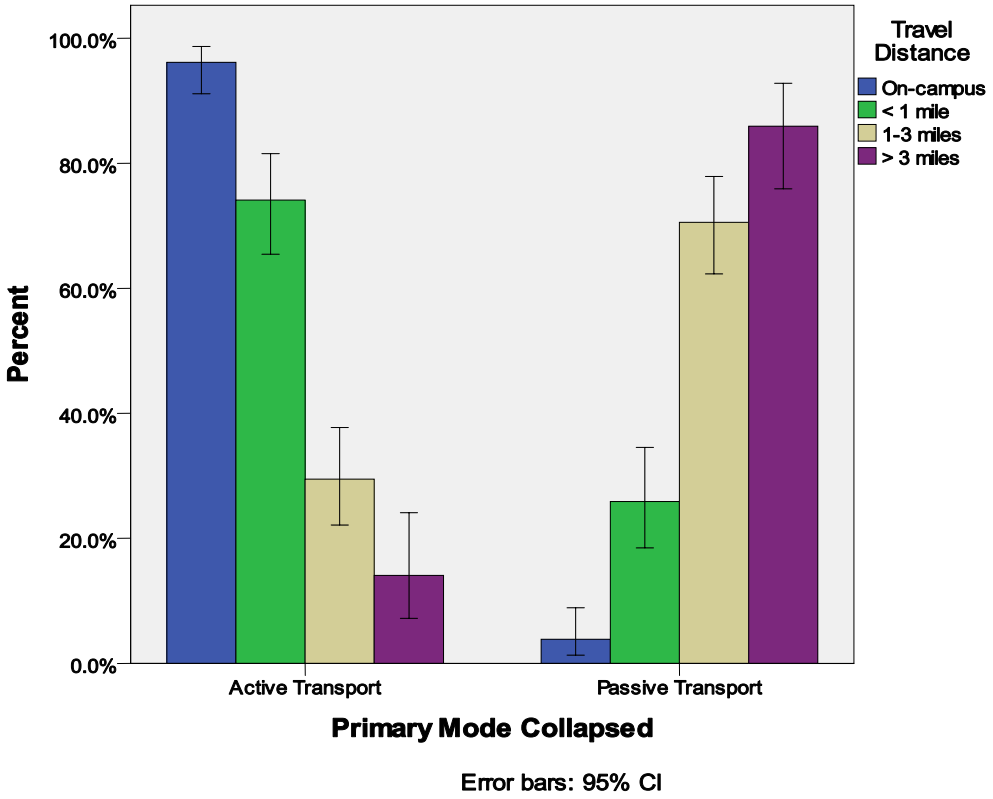

Figure 4.4 Primary Transportation Mode by Travel Distance ($p<0.005$)

Behavioral Factors

Sixty-five percent of respondents were moderately to vigorously active more than 90 minutes each week. Difference in activity level ($\leq$90 min versus >90 min) was most pronounced in Freshmen and least so in Sophomores (Figure A.2). Those subjects active

less than or equal to 90 minutes each week followed the trend of the whole group in transportation mode – 52.1% AT to 47.9% PT. In subjects active greater than 90 minutes each week, a trend toward AT was observed, but not significantly (Fig. 4.5).

Of respondents' weekly activity from AT, 10% reported most or all of their weekly activity coming from AT, 52.7% reported some or half and 37.3% reported none. Thirty-nine students who used AT as their primary mode reported none of that transportation time as part of their weekly physical activity (Table 4.2).

Table 4.2

Physical Activity Patterns Compared Between Transportation Modes

Behavioral Factor	**n**	**Active Transport (n)**	**Passive Transport (n)**
Primary Mode:	**409**	**230 (56.2%)**	**179 (43.8%)**
Activity Level (minutes/week):			
0-90	144	75 (52.1%)	69 (47.9%)
>90	265	155 (58.5%)	110 (41.5%)
Active Transport as it Contributes to Weekly Activity:			
None	152	39 (25.7%)[b]	113 (74.3%)[b]
Some/Half	215	153 (71.2%)[a]	62 (28.8%)[a]
Most/All	41	37 (90.2%)[a]	4 (9.8%)[a]

n[a]= different across mode but no difference from the general trend for primary mode
n[b]= both different across mode and from the general trend for primary mode

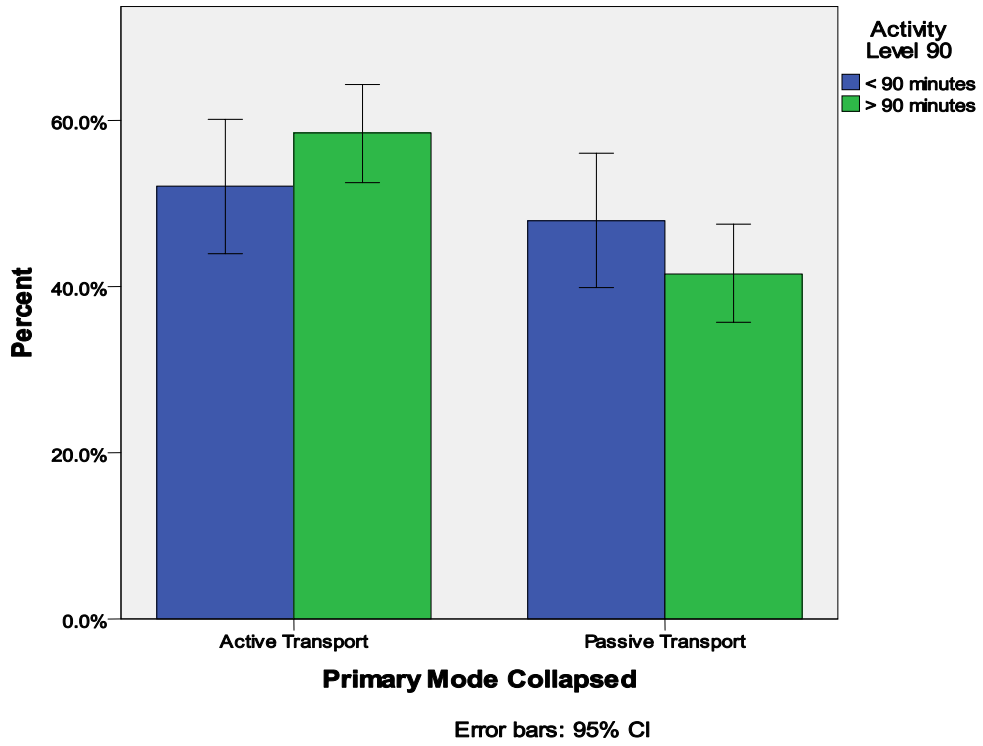

Figure 4.5 Primary Transportation Mode by Activity Level (p>0.05)

In total, 3.2% of respondents perceived themselves as not fit, 64.4% as somewhat fit and 32.4% as very fit. Only 3.7% of respondents perceived themselves as underweight, 86.2% as normal weight and 10.1% as overweight.

Table 4.3

Self-Efficacy Compared Between Transportation Modes

Behavioral Factor	n	Active Transport (n)	Passive Transport (n)
Primary Mode	**409**	**230 (56.2%)**	**179 (43.8%)**
Perceived Fitness Level:			
Not Fit	13	6 (46.2%)[a]	7 (53.8%)[a]
Somewhat Fit	262	141 (53.8%)	121 (46.2%)
Very Fit	132	83 (62.9%)[b]	49 (37.1%)[b]
Perceived Weight Status:			
Underweight	15	10 (66.7%)[b]	5 (33.3%)[b]
Normal Weight	349	204 (58.5%)	145 (41.5%)
Overweight	41	14 (34.1%)[c]	27 (65.9%)[c]

n[a]= no difference across mode but different from the general trend for primary mode
n[b]= different across mode but no difference from the general trend for primary mode
n[c]= both different across mode and from the general trend for primary mode

Too few respondents perceived themselves as not fit to draw any conclusions. Although no significant differences in mode between those who perceived themselves as somewhat fit were seen, significantly more of those who perceived themselves as very fit utilized AT vs PT (Figure 4.6).

Too few respondents perceived themselves as underweight to draw any conclusions. Those who perceived themselves as normal weight utilized AT significantly more than PT as opposed to those who perceived themselves as overweight who utilized PT significantly more than AT (Figure 4.7).

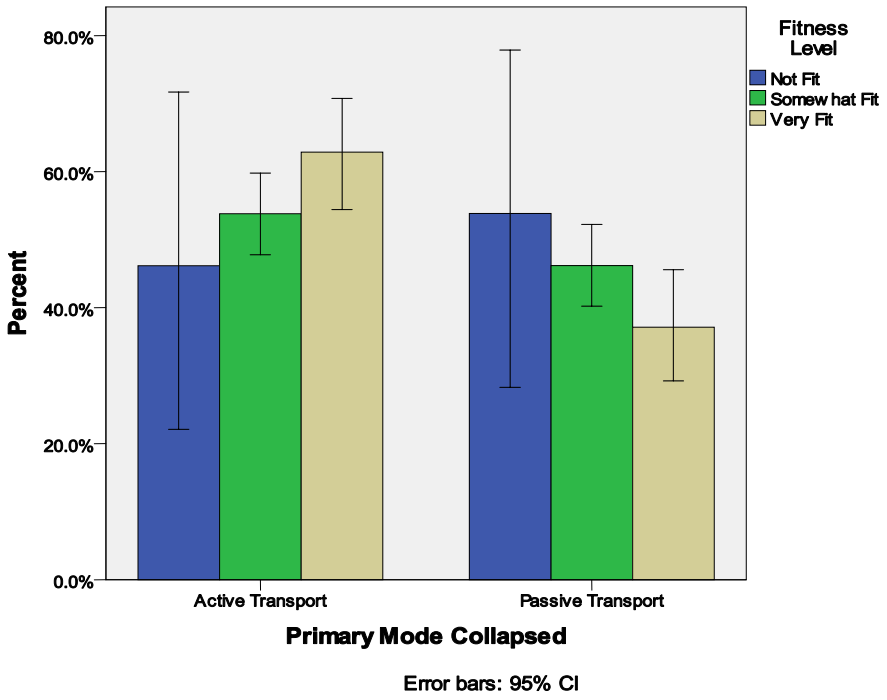

Figure 4.6 Primary Transportation Mode by Perceived Fitness Level (p=0.061)

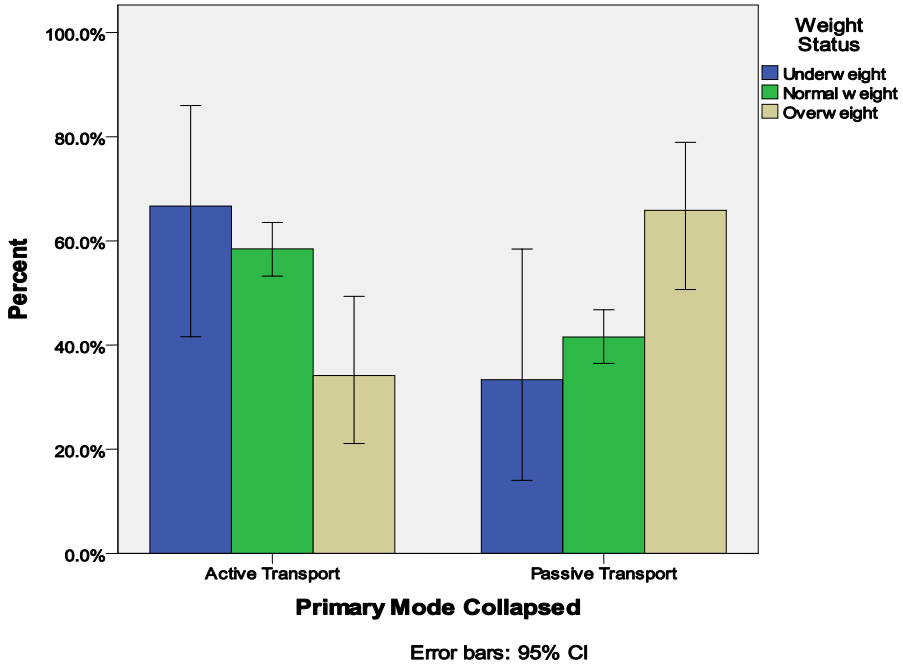

Figure 4.7 Primary Transportation Mode by Perceived Weight Status (p<0.005)

Of perceived benefits, 65.1% of subjects ranked health benefits as the number one benefit of AT with no difference between groups, 19.9% ranked environmental benefits as the number one benefit with no difference between groups, and 17.7% ranked economic benefits as the number one benefit with no difference between groups.

The majority of respondents reported anywhere between two and six perceived barriers (79%). Overall the mode number of barriers for respondents was four. For those using AT, the mode number of barriers was four and for PT, five. Weather and transport of items/people were the most commonly reported barriers overall.

Table 4.4

Decisional Balance Compared Between Transportation Modes

Behavioral Factor	n	Active Transport (n)	Passive Transport (n)
Primary Mode	**409**	**230 (56.2%)**	**179 (43.8%)**
Perceived Benefits (n=#1 benefit):			
Health	235	124 (52.8%)	111 (47.2%)
Economic	72	39 (54.2%)	33 (45.8%)
Environmental	64	37 (57.8%)	27 (42.2%)
Perceived Barriers (n=yes):			
Weather	366	200 (54.6%)	166 (45.4%)
Need to carry too much	236	118 (50.0%)	118 (50.0%)
Takes too much time	188	82 (43.6%)[a]	106 (56.4%)[a]
Too far	185	86 (46.5%)[a]	99 (53.5%)[a]
Health status/disability	163	104 (63.8%)[b]	59 (36.2%)[b]
Lack of energy/ too tired	141	59 (41.8%)[a]	82 (58.2%)[a]
Feel unsafe	140	74 (52.9%)	66 (47.1%)
No bike or skateboard	130	67 (51.5%)	63 (48.5%)
No sidewalks/bike lane	62	34 (54.8%)	28 (45.2%)
Already exercise enough	48	16 (33.3%)[c]	32 (66.7%)[c]
Appearance	29	12 (41.4%)[a]	17 (58.6%)[a]
Don't enjoy	25	8 (32.0%)[c]	17 (68.0%)[c]

n[a]= no difference across mode but different from the general trend for primary mode
n[b]= different across mode but no difference from the general trend for primary mode
n[c]= both different across mode and from the general trend for primary mode

Health status/disability was the only barrier that was significantly greater for those using AT versus PT. Lack of enjoyment and already exercising enough were the only barriers that were significantly greater for those using PT versus AT. Distance, time, lack of energy and appearance were all greater barriers for those using PT than AT, but not significantly.

Transportation Environment

Perceptions of safety and bike lanes were the two measures of the transportation environment depicted in the results. Neither was significantly different between primary modes of transport.

Discussion

The purpose of this study was to observe students' active versus passive transportation (AT versus PT) patterns and examine the relationship between their chosen mode and determinants of transportation decision-making. It was observed that 56% of students surveyed primarily commute actively (walk, bike, skateboard) between home and school and that 44% primarily commute passively by car or bus. To better understand the transportation decision-making process and, thus, where to direct efforts to increase the use of AT, the investigation of common determinants of AT in this group and how those determinants relate to the primary mode of transport were important.

Evidence shows the decision whether or not to participate in AT depends on the transportation environment and individual factors including demographics and behavioral determinants. At this point, much research and policy making related to transportation decision making focuses on the transportation environment. However, research demonstrates that efforts to improve rates of AT also must address individual factors.

Furthermore, evidence shows that when the transportation environment is sufficient and conducive to AT, individual factors become the primary determinant in the transportation decision-making process (de Geus, et al., 2008). As a result, the focus of this discussion is to relate common predictors of AT (transportation environment, sociodemographics and behavioral factors) to primary mode of transport to observe any differences in those determinants between those that use AT and those that use PT.

Transportation Environment

Tools exist to assess the transportation environment for walkability and cyclability, however community assessment in this study was not done. Nevertheless, Fort Collins, Colorado, home to Colorado State University, has been particularly progressive in tailoring the community to encourage activity and aspects of active living including AT. In 1997, city council adopted the Complete Streets Program requiring that all new construction include infrastructure supporting walkers and cyclists as well as motorists and transit users. The town boasts 280 plus miles of bike lanes, 1500 spots for bike parking downtown and 8500 spots on campus. In addition, Fort Collins recently achieved gold status from the League of American Bicyclists setting it apart for its "cycleability".

When asked about their perceptions of the transportation environment as a barrier to AT, specifically the safety of the environment and the availability of bike lanes and sidewalks, 34.2% of subjects reported feeling unsafe as a barrier to AT with no difference between groups, and 15.2% reported a lack of sidewalks and/or bike lanes as a barrier with no difference between groups. Safety has been cited in previous studies as a major barrier to AT (Oja, et al., 1998) as well as connectivity of bike lanes and sidewalks

(Frank, et al., 2004). But, the nature of the transportation environment in Fort Collins in combination with perceptions of the environment rated fairly low as barriers to AT allow investigators to assume the transportation environment around Colorado State University is sufficient and individual factors play a more central role in determining transportation decision-making in this population.

Climate needs to be addressed when observing the transportation environment, and in this study weather was the number one barrier to AT for both groups – 89.5% of subjects overall reported weather as a barrier to AT. However, unlike bike lanes and safety which can be modified, weather would be categorized as an unmodifiable barrier. *Perception* of the weather, as opposed to the weather itself, could therefore be categorized as a behavioral predictor, which is modifiable through education and preparedness. Consequently weather was addressed as a behavioral factor.

Sisson, et al., in a study comparing prevalence of AT on two campuses with very different transportation environments, suggested that in addition to addressing the built environment, research assessing students' characteristics, including academic year as well as behavioral traits related to transportation mode, would provide greater understanding of motivation and decision-making related to AT for physical activity (Sisson, et al., 2008). Given the nature of the transportation environment in this study an analysis of behavioral characteristics is then where our research was focused.

Demographics

Within the same transportation environment, and in this case an environment that has been deemed sufficient and conducive to AT, we would expect to see some differences in the individual determinants of AT including demographics and behavioral

factors between those who commute actively and those who commute passively. The two demographic attributes that produced significant differences between groups were academic year and distance from residence to campus. It is no surprise that significant differences in transportation choice existed between freshmen, who live primarily on campus, and the rest of the group, who live primarily off campus. However, the aim of the study was to observe transportation choices between home and campus. If we had asked about transportation choices once on campus, it is likely that even students commuting to campus passively were getting as much AT on campus as the freshmen were. The results of this study, therefore, give freshmen too much credit for AT and future research should exclude those living on campus.

We considered the possibility that distance was confounding the relationship between academic year and transportation mode, and in the case of freshmen versus the other classes, that is true. However, when we excluded freshmen, there was no difference in distance from home to school for sophomores, juniors and seniors. Between *driving* and AT, the numbers were very similar among classes other than freshmen. Significantly more sophomores did, however, ride the bus compared to juniors and seniors. The community surrounding CSU includes several apartment complexes along a major bus line that serve as a natural transition from the dorms to off-campus living. As a result, many sophomores choose to live in those apartments and utilize the public transportation system more than in other community neighborhoods where access to the bus is less convenient.

For those living on campus and those living greater than three miles from campus, differences in transportation patterns were expected. We also expected that the majority

of those living within a mile from campus would use AT, and that held true. Of those living less than a mile from campus but not on campus, roughly 75% used AT and 25% used PT. However, in the range of those living greater than a mile from campus but *within three miles*, the pattern flips where roughly 30% used AT and 70% PT. Previous transportation studies in college students have shown an average commute distance of less than a mile for those using AT, but that anything within 5 miles can be considered a reasonable cycling distance (Sisson & Tudor-Locke, 2008). The group living within one to three miles of campus, therefore, represents a primary target for recommending AT.

Although the average "walk" time between home and transit stops for those using public transportation in this study was only three minutes – most likely because subjects using the bus were living in the apartment complexes located right on the bus line – evidence shows that typical transit users have a 20-minute walk to the stop (Besser & Dannenberg, 2005). It may be advantageous, therefore, to promote the use of public transport for those students living within one to three miles of campus who are using PT – particularly if distance is a perceived barrier to AT.

Although not significant, we did see some differences in transportation choice between the genders. There was enough of a trend toward AT for males ($p=0.09$) that did not exist in females to consider that females may require more attention in the promotion of AT. We did not look at activity level differences in males versus females, but activity levels overall could be greater for males. Data from the National College Health Association taken from CSU in 2007 revealed that 65.0% of males were vigorously active three or more days each week as opposed to 58.7% of female (Kennedy, 2010). Activity levels in our subjects were higher than the national average but consistent with

NCHA data from 2007, which showed that 60.6% of students at CSU were vigorously active three or more days each week.

Sophomores represented the greatest number of students doing less than 90 minutes of activity, which reinforces the decline in physical activity associated with the transition away from structured activity. As students move off campus, physical activity becomes increasingly less convenient and activity levels decline. In juniors and seniors, significantly more students were doing greater than 90 minutes of activity per week than those doing less, so improvement occurs as they adjust to their environment. Freshmen actually represented the greatest number of students doing greater than 90 minutes of physical activity each week. This could be because they live on campus in close proximity to the student recreation center, but it is also likely because of the amount of AT they do walking and biking on campus.

When asked about how much AT contributes to their weekly physical activity, very few students surveyed were attributing most or all of their activity to AT (10%). About half of students said that some or half of their weekly activity is derived from AT, and close to 40% said that none of their activity comes from AT. That 40% represents a substantial population in which the adoption of AT could significantly improve activity levels. Furthermore, of those primarily using PT, 48.5% were somewhat willing to consider the adoption of AT and 17.4% were very willing. An interesting note is that 39 students whose primary mode of transport was AT reported none of their weekly activity coming from AT. So, either the question was unclear, or it is very possible that some people do not even consider active transportation as a form of physical activity. If so,

education regarding the benefits of AT and its potential to increase activity levels is needed.

Research shows that in the U.S. the typical active commuter is a young, active, educated individual of a higher socioeconomic status (Gordon-Larsen, et al., 2005). One limitation of this study is that description closely matches that of our survey participants. In fact, 90% of our subjects were white, post-secondary students. And although we did not specifically ask about socioeconomic level, some assumptions can be made due to the fact that subjects were university students. There was however, no difference in transportation mode among non-white students which would have been expected based on previous research.

We expected to see greater variance in transportation mode related to activity levels. If in fact the typical active commuter is already active, we would have anticipated a majority of those doing less than 90 minutes of physical activity each week to be passive commuters and a greater majority of those doing more than 90 minutes to be active commuters, neither of which was true. The reason we do not see the expected difference could be the nature of our population, being that college students do not accurately reflect the general population, or because CSU students' activity levels are higher than the national average. In any case, we have demonstrated some key demographic characteristics that, in relation to transportation mode, reveal significant differences and consequently target groups for promotion of AT.

Behavioral Factors

Self-efficacy, decisional balance and social support have all been cited as noteworthy aspects of the transportation-decision making process, particularly in college

students (de Geus, et al., 2008). Although this study did not directly examine the role of social support, it is likely that the perception of social norms related to AT influenced responses. Future studies should, therefore, address social support and norms more specifically. Self-efficacy, or the belief in one's own ability to perform the behavior, was addressed in this study through questions related to the subjects' perception of fitness level and weight status. Results were as expected – students who perceived themselves as overweight had significantly higher levels of PT than AT. Those students who perceived themselves as very fit had significantly higher levels of AT than PT, whereas those who perceived themselves as unfit chose PT over AT, concurrent with evidence that a poor perception of athletic ability is associated with a lower likelihood of active transportation in students (Robertson-Wilson, et al., 2008). A possibility that deserves further consideration is low self-efficacy in this population may also be related to inadequate activity levels, in which case this population especially could benefit from the adoption of AT as a convenient way to maximize opportunities to increase activity levels. In addition to self-efficacy, recommendations from the CDC also implicate perceived barriers and enjoyment of activity as predictors of participation in activity (Pate, et al., 1995).

When ranking their perception of the benefits of AT, students perceived health benefits as the number one benefit followed by environmental benefits and then economic, no matter the transportation mode. Unfortunately, this measure only ranks benefits relative to each other – it does not indicate absolute perception of benefits.

The greatest reported barriers to AT for CSU students were weather and the need to carry too much or drop someone off followed by those barriers commonly associated

with physical activity in general – time, distance, health status and lack of energy. Cole et al. found similar results in a study of motivational readiness for AT in university students. They observed long travel distances, inconvenience and time constraints as the most common barriers to AT (Cole, et al., 2008). Those who chose PT as their primary mode not only perceived a greater number of barriers to AT (five as compared to four for those who use AT), but they also perceived already exercising enough and lack of enjoyment as barriers significantly more than those who use AT.

In this study, distance is both a demographic characteristic and a behavioral predictor of AT. Evidence shows that a realistic distance is a demographic characteristic necessary to be able to commute actively, but that the perception of distance as a barrier, lack of interest, motivation, and self-efficacy are all important behavioral determinants of AT (de Geus, et al., 2008). Behavioral models suggest that improved self-efficacy and a perception of benefits outweighing barriers are necessary for behavior adoption.

Conclusion

Adoption of active transportation between home and school has the potential to increase activity levels in college students at a critical time point in their lives when activity levels decline markedly. An analysis of the characteristics, specifically predictors of transportation decision-making, of students currently selecting AT as their primary mode of transportation compared to PT is necessary to effectively promote AT in the college population.

The transportation environment, demographics and behavioral factors are the three most common determinants of AT when the individual has the choice between AT and PT. The transportation environment in this population was sufficient and conducive

to AT, so demographics and behavioral determinants played a more primary role in predicting AT in this population. The attributes that were significantly different between transportation groups and, therefore, require attention in efforts to increase AT in CSU students are academic year, distance between home and campus, perceptions of fitness level and weight status and certain perceived barriers.

To successfully increase AT in this population, it is necessary to educate the students on the benefits of AT and how to minimize those barriers affecting them – weather, transport of items/people, time, distance, health status and lack of energy. Those students with poor perceptions of their weight status and fitness level require interventions to improve self-efficacy related to AT because they may very well benefit the most from adoption of AT. Another critical focus is on students living within one to three miles of campus where very few are utilizing AT despite being within a feasible distance to walk or bike and to educate freshmen and sophomores as they become more independent on the benefits of AT as a means of physical activity.

CHAPTER V

SUMMARY, CONCLUSIONS & RECOMMENDATIONS

Summary

For all the known benefits of physical activity, rates of inactivity are surprisingly high. Nevertheless, the transition from adolescence to young adulthood, when rates of activity decline considerably, represents a crucial opportunity to promote activity and reverse the trend. Active transportation (AT) affords a convenient and cost-effective approach to improve physical activity levels and alleviate the obesity trend. Furthermore, the nature of the university environment is especially favorable for the adoption of AT. Promotion and adoption of AT by college students, therefore, has the potential to improve activity levels, and *Healthy Campus 2010* suggests increasing the proportion of trips made by walking and biking by college students as a practical means to increasing physical activity at this critical age.

The transportation decision-making process is dictated by three key elements: the transportation environment, demographics and behavioral determinants. The purpose of this study was to provide an analysis of the predictors of AT related to transportation mode in college students allowing for a greater understanding of necessary measures to successfully implement AT and increase activity levels. Subjects completed a 14-item questionnaire including demographics, transportation patterns between home and school, distance from residence to campus, activity level, and perceptions of weight status,

fitness level and benefits and barriers of active transportation. A primary mode of transportation was assigned to each subject and chi square analysis was used to identify any significant differences in the determinants of AT between transportation groups.

Overall rates of transportation were observed to be 56.2% active transport (walking, biking or skateboarding) and 43.8% passive transport (driving and public transport.) Results revealed that academic year, distance from residence to campus, self-efficacy and perceived barriers were the key differences affecting the transportation decision making-process of university students at Colorado State University. In particular, students living within 1-3 miles of campus primarily selected PT despite living within a feasible distance for AT. In addition, the majority of sophomores used PT, in large part due to the use of public transport that includes an uncharacteristically short walk time to the stop of three minutes or less. Passive transport was also associated with poor perceptions of fitness level and weight status as well as a greater number of reported barriers to AT including lack of enjoyment and already exercising enough.

Conclusions

There were some significant differences in several demographic and behavioral characteristics of those students primarily using AT versus PT. Given the findings, we now have a basis for the promotion of AT as a means to increase activity levels in CSU students. Increased awareness of the benefits and practicality of active transportation aimed at those living within 1-3 miles of campus and freshmen and sophomores would be a realistic approach. In addition to awareness, efforts to improve self-efficacy and alleviate barriers represent logical steps for increasing the use of AT.

Recommendations

Additional research in the following areas is suggested:

1. Gender differences among determinants of AT
2. Intensity and duration of the commute between home and school
3. Absolute perceptions of benefits (as opposed to relative perceptions)
4. The role of social support in the transportation decision-making process
5. Determination of a “compatible” distance
6. The relationship between commute distance and willingness to adopt AT

REFERENCES

Andersen, L. B., Schnohr, P., Schroll, M., & Hein, H. O. (2000). All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. *Arch Intern Med,160*(11), 1621-1628.

Berrigan, D., Troiano, R. P., McNeel, T., Disogra, C., & Ballard-Barbash, R. (2006). Active transportation increases adherence to activity recommendations. *Am J Prev Med, 31*(3), 210-216.

Besser, L. M., & Dannenberg, A. L. (2005). Walking to public transit: steps to help meet physical activity recommendations. *Am J Prev Med, 29*(4), 273-280.

Brennan Ramirez, L. K., Hoehner, C. M., Brownson, R. C., Cook, R., Orleans, C. T., Hollander, M., et al. (2006). Indicators of activity-friendly communities: an evidence-based consensus process. *Am J Prev Med, 31*(6), 515-524.

Butler, G. P., Orpana, H. M., & Wiens, A. J. (2007). By your own two feet: factors associated with active transportation in Canada. *Can J Public Health, 98*(4), 259-264.

Cole, R., Leslie, E., Donald, M., Cerin, E., Neller, A., & Owen, N. (2008). Motivational readiness for active commuting by university students: incentives and barriers. *Health Promot J Austr, 19*(3), 210-215.

de Geus, B., De Bourdeaudhuij, I., Jannes, C., & Meeusen, R. (2008). Psychosocial and environmental factors associated with cycling for transport among a working population. *Health Educ Res, 23*(4), 697-708.

Dombois, O. T., Braun-Fahrlander, C., & Martin-Diener, E. (2007). Comparison of adult physical activity levels in three Swiss alpine communities with varying access to motorized transportation. *Health Place, 13*(3), 757-766.

Dunton, G. F., & Schneider, M. (2006). Perceived barriers to walking for physical activity. *Prev Chronic Dis, 3*(4), A116.

Frank, L. D., Andresen, M. A., & Schmid, T. L. (2004). Obesity relationships with community design, physical activity, and time spent in cars. *Am J Prev Med, 27*(2), 87-96.

Frank, L. D., Saelens, B. E., Powell, K. E., & Chapman, J. E. (2007). Stepping towards causation: do built environments or neighborhood and travel preferences explain physical activity, driving, and obesity? *Soc Sci Med, 65*(9), 1898-1914.

Gieck, D. J., & Olsen, S. (2007). Holistic wellness as a means to developing a lifestyle approach to health behavior among college students. *J Am Coll Health, 56*(1), 29-35.

Gordon-Larsen, P., Nelson, M. C., & Beam, K. (2005). Associations among active transportation, physical activity, and weight status in young adults. *Obes Res, 13*(5), 868-875.

Ham, S. A., Macera, C. A., & Lindley, C. (2005). Trends in walking for transportation in the United States, 1995 and 2001. *Prev Chronic Dis, 2*(4), A14.

Hamer, M., & Chida, Y. (2008). Active commuting and cardiovascular risk: a meta-analytic review. *Prev Med, 46*(1), 9-13.

Haskell, W. L., Lee, I. M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., et al. (2007). Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc, 39*(8), 1423-1434.

Healthy Campus 2010: Making it Happen. (2004). Baltimore, MD: American College Health Association.

Hu, G., Tuomilehto, J., Borodulin, K., & Jousilahti, P. (2007). The joint associations of occupational, commuting, and leisure-time physical activity, and the Framingham risk score on the 10-year risk of coronary heart disease. *Eur Heart J, 28*(4), 492-498.

Irwin, J. D. (2004). Prevalence of university students' sufficient physical activity: a systematic review. *Percept Mot Skills, 98*(3 Pt 1), 927-943.

Kennedy, C. A. (2010). (Personal Communication. May 1, 2010) (NCHA Data for CSU, 2005-2007. ed.).

Khan, L. K., Sobush, K., Keener, D., Goodman, K., Lowry, A., Kakietek, J., et al. (2009). Recommended community strategies and measurements to prevent obesity in the United States. *MMWR Recomm Rep, 58*(RR-7), 1-26.

Lindstrom, M. (2008). Means of transportation to work and overweight and obesity: a population-based study in southern Sweden. *Prev Med, 46*(1), 22-28.

Litman, T. (2003). Integrating public health objectives in transportation decision-making. *Am J Health Promot, 18*(1), 103-108.

Matthews, C. E., Jurj, A. L., Shu, X. O., Li, H. L., Yang, G., Li, Q., et al. (2007). Influence of exercise, walking, cycling, and overall nonexercise physical activity on mortality in Chinese women. *Am J Epidemiol, 165*(12), 1343-1350.

Merom, D., Miller, Y. D., van der Ploeg, H. P., & Bauman, A. (2008). Predictors of initiating and maintaining active commuting to work using transport and public health perspectives in Australia. *Prev Med, 47*(3), 342-346.

Mutrie, N., Carney, C., Blamey, A., Crawford, F., Aitchison, T., & Whitelaw, A. (2002). "Walk in to Work Out": a randomised controlled trial of a self help intervention to promote active commuting. *J Epidemiol Community Health, 56*(6), 407-412.

Ogilvie, D., Egan, M., Hamilton, V., & Petticrew, M. (2004). Promoting walking and cycling as an alternative to using cars: systematic review. *BMJ, 329*(7469), 763.

Oja, P., Vuori, I., & Paronen, O. (1998). Daily walking and cycling to work: their utility as health-enhancing physical activity. *Patient Educ Couns, 33*(1 Suppl), S87-94.

Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., et al. (1995). Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA, 273*(5), 402-407.

Pollard, T. (2003). Policy prescriptions for healthier communities. *Am J Health Promot, 18*(1), 109-113.

Pratt, M., Macera, C. A., Sallis, J. F., O'Donnell, M., & Frank, L. D. (2004). Economic interventions to promote physical activity: application of the SLOTH model. *Am J Prev Med, 27*(3 Suppl), 136-145.

Prevalence of physical activity, including lifestyle activities among adults--United States, 2000-2001. (2003). *MMWR Morb Mortal Wkly Rep, 52*(32), 764-769.

Reed, J., & Ainsworth, B. (2007). Perceptions of environmental supports on the physical activity behaviors of university men and women: a preliminary investigation. *J Am Coll Health, 56*(2), 199-204.

Robertson-Wilson, J. E., Leatherdale, S. T., & Wong, S. L. (2008). Social-ecological correlates of active commuting to school among high school students. *J Adolesc Health, 42*(5), 486-495.

Saelens, B. E., Sallis, J. F., & Frank, L. D. (2003). Environmental correlates of walking and cycling: findings from the transportation, urban design, and planning literatures. *Ann Behav Med, 25*(2), 80-91.

Sallis, J. F., Cervero, R. B., Ascher, W., Henderson, K. A., Kraft, M. K., & Kerr, J. (2006). An ecological approach to creating active living communities. *Annu Rev Public Health, 27*, 297-322.

Shephard, R. J. (2008). Is active commuting the answer to population health? *Sports Med, 38*(9), 751-758.

Sisson, S. B., McClain, J. J., & Tudor-Locke, C. (2008). Campus walkability, pedometer-determined steps, and moderate-to-vigorous physical activity: a comparison of 2 university campuses. *J Am Coll Health, 56*(5), 585-592.

Sisson, S. B., & Tudor-Locke, C. (2008). Comparison of cyclists' and motorists' utilitarian physical activity at an urban university. *Prev Med, 46*(1), 77-79.

Titze, S., Stronegger, W. J., Janschitz, S., & Oja, P. (2007). Environmental, social, and personal correlates of cycling for transportation in a student population. *J Phys Act Health, 4*(1), 66-79.

Vuori, I. M., Oja, P., & Paronen, O. (1994). Physically active commuting to work--testing its potential for exercise promotion. *Med Sci Sports Exerc, 26*(7), 844-850.

Wen, L. M., Orr, N., Millett, C., & Rissel, C. (2006). Driving to work and overweight and obesity: findings from the 2003 New South Wales Health Survey, Australia. *Int J Obes (Lond), 30*(5), 782-786.

Wen, L. M., & Rissel, C. (2008). Inverse associations between cycling to work, public transport, and overweight and obesity: findings from a population based study in Australia. *Prev Med, 46*(1), 29-32.

Zick, C. D., Smith, K. R., Brown, B. B., Fan, J. X., & Kowaleski-Jones, L. (2007). Physical activity during the transition from adolescence to adulthood. *J Phys Act Health, 4*(2), 125-137.

APPENDICES

APPENDIX A

FIGURES & TABLES

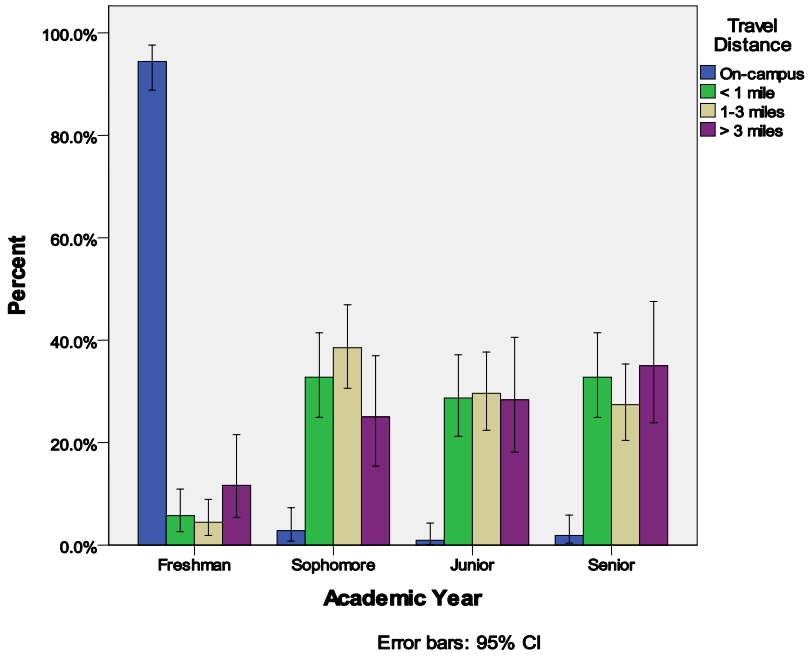

Figure A.1 Distance from Campus by Academic Year (p<0.005)

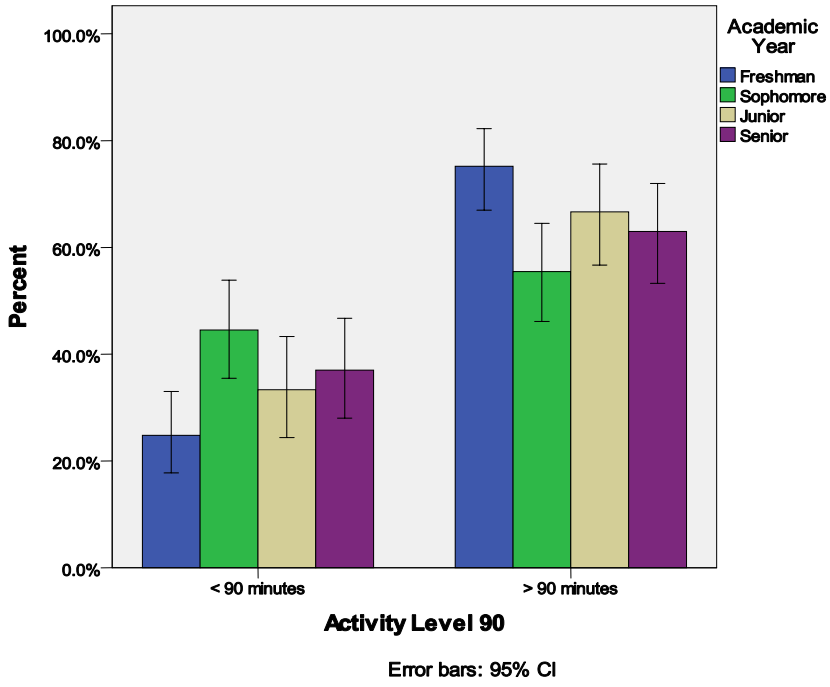

Figure A.2 Activity Level by Academic Year (p<0.05)

APPENDIX B

STUDY QUESTIONNAIRE

1. Gender: M _____ F _____
2. Race/Ethnicity (optional). Check all that apply.

   _____ White - Caucasian (not of Hispanic origin)
   _____ Black or African American (not of Hispanic origin)
   _____ Asian or Pacific Islander
   _____ Native American or Alaska Native
   _____ Other _____

3. Declared Major(s): Please list _____
4. Grade Level: _____

For questions 5-12, please circle your answer:

5. Distance from residence to campus: On campus <1 mile 1-3 miles 3-5 miles >5 miles
   (see attached map)
6. Your perceived fitness level: Not Fit Somewhat Fit Very Fit
7. Your perceived weight status: Underweight Normal Weight Overweight
8. Over the past school year, on average how many days per week did you go to campus?

   0 1 2 3 4 5 6 7

9. Over the past school year, on average how many days per week did you walk/bike/skateboard to school?

   0 1 2 3 4 5 6 7

- With respect to question #9, if your answer was 1-7, what means of transportation did you use?

  Walk Bike Skateboard Combination Other _____

- If your answer was 0, would you consider starting to walk/bike/skateboard to school?

  Not Willing Somewhat Willing Very Willing

10. Over the past school year, on average how many days per week did you use the bus to get to school?

    0 1 2 3 4 5 6 7

    If so, about how many minutes was your walk to the bus stop?_____

11. Over the past school year, on average how many minutes **per week** did you engage in moderate or vigorous physical activity?

    Less than 30 30-60 60-90 90-120 120-150 More than 150

12. How much of that time was spent walking/biking/skateboarding to and from school?

    None Some of the time About half of the time Most of the time All of the Time

13. Which of the following would you perceive to be benefits of walking/biking/skateboarding to school? Rank in order of importance.

_____ Health benefits

_____ Environmental benefits

_____ Economic benefits

_____ Other: (please describe) _____

14. Which of the following would you consider to be reasons for not walking/biking/skateboarding to school? Check all that apply.

_____ Weather

_____ Health status/disability

_____ Lack of energy/ too tired

_____ Don't enjoy walking or biking

_____ Feel unsafe (dark, poor drivers)

_____ No sidewalks/bike lanes

_____ Too far

_____ Takes too much time

_____ Need to carry too much stuff/ drop someone off

_____ Already exercise enough

_____ Concerned about appearance (hair, clothing, dirty, etc…)

_____ No bike or skateboard, bike or skateboard is broken, flat tire

_____ Other (please describe)_____


Fort Collins Country Club
Long Pond
Falcon Ridge
Pheasant Ridge
Storybrook
Lindenmeier Lake
North College MHP
Greenbriar
Evergreen
Old Town North
Alta Vista
Lee Martinez Park
Andersonville
Dry Creek MHP
Mountain View
Poudre Plains
Cherry St
Mountain View Heights
Tennyson Heights
Grandview Cemetery
Approximate 1 mile radius
Buffalo Run
Link N Greens Golf Course
Mulberry Hill
City Park Nine Golf Course
City Park
Old Town West
Old Town
W Mulberry St
E Mulberry St
Rams Village
Colorado State University
Eastside Park
Overland Park
POET
Ponds at Overland
Lake Street Homes
Highlander Heights
Fort Collins
E Prospect Rd
Westgate
Westwood
Fairbrooke
Heatheridge Lakes
Spring Creek Village
Edora Park
Old Prospect
Hughes Stadium Csu
Indian Hills
Parkwood East
Rolland Moore Park
Parkwood Lake
Hampshire Court
Drakes
Dixon Reservoir
Quail Hollow
Cottonwood Glen Park
West Swallow
Scotch Pines
Lake Sherwood Corporation
Meadows East
Meadowlark
Lake Sherwood
Timberline Village
Milfred Acres
Southwest Community Park
Northwest Rossborough
Foothills Fashion Mall
Warren Farms
Five Oaks
Silver Oaks
Collindale
Omega
Warren Park
E Horsetooth Rd
Kingston Woods
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APPENDIX C

STUDY SCRIPT

Good morning/afternoon,

I am (investigator's name) from the Department of Health and Exercise Science. I am conducting research to examine physical activity patterns. If you volunteer to participate in this study you will be asked to complete a questionnaire during class. The anonymous questionnaire will take approximately 10 minutes to complete. Your completed questionnaire will then be turned into me. Your decision whether or not to participate in this study will have no impact on your grade in this class. There are a few demographic questions included. You may skip any question you are not comfortable in answering. If you should feel distressed after completing (or attempting to complete) this assessment, please contact the University Counseling Center at 491-6052, and they will set up an appointment for you to speak with someone.

Although there are no known risks to participating in this research study, the benefits to be gained are that we will gain valuable information to better promote physical activity for all CSU students.

I would like to thank you for your consideration for involvement in this study and would welcome a phone call if you have any questions. Your consent to participate will be assumed by the completion of the questionnaire.

Thank you for your time.

APPENDIX D

IRB LETTER OF APPROVAL

Insert Letter

APPENDIX E

INSTRUCTOR LETTERS OF APPROVAL

Insert Letters