THE RELATIONSHIP BETWEEN ACTIVE COMMUTING,
LIFESTYLE, AND EDUCATION

A Thesis
Presented
to the Faculty of
California State University, Chico

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
in
Kinesiology

by
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Fall 2012
THE RELATIONSHIP BETWEEN ACTIVE COMMUTING,
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by

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Fall 2012

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DEDICATION

I would like to dedicate this thesis to God, and to my family.

To God, through whom all things are possible.

To my Mom and Dad, who have given me tremendous amounts of support, guidance, love, and everything that is good.

To my Uncle Rick, who has given me guidance in life and in my academic endeavors.

To my Grandparents, who have set a wonderful example for me to live by.

To my Sisters, who have cheered for me every step of the way.

To my Nephews, Nieces, Great Nephew, Great Nieces, Aunts, Uncles, and Cousins and to all of my family for your love and support.

I offer a sincere thanks to all of you, and I would like to dedicate this thesis to you. This would not have been possible without you.
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ABSTRACT

THE RELATIONSHIP BETWEEN ACTIVE COMMUTING, LIFESTYLE, AND EDUCATION

by

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Master of Arts in Kinesiology

California State University, Chico

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The purpose of this study was to investigate the relationship between active commuting, lifestyle, and education in college graduates. This study was conducted as a survey. Email invitations were sent to California State University Chico Alumni who had email addresses on file from the graduating classes of 2009, 2010, and 2011. The first section of the survey included 6 questions designed to assess commuting style, education level, and gender. The second section of the survey was a lifestyle evaluation adapted from Healthstyle: A Self Test developed by the U.S. Public Health Service. The survey itself was conducted for 1 month between June 26 and July 26, 2012; 6,031 alumni were contacted via e-mail.

Eighty-four people completed the survey. Fourteen respondents engaged in active commuting.
Rates of active commuting were significantly different between alumni who had earned undergraduate degrees and alumni who had earned graduate degrees. The same trend was observed among male and female respondents. However, no significant difference was observed among the female respondents.

Overall, there was a significant difference between active commuters and those who said they would commute actively under ideal circumstances.

A higher proportion of female respondents answered “Almost Always” to questions having something to do with physical appearance, as compared to male respondents. Furthermore, among participants whose highest level of education was an undergraduate degree, a higher proportion of females answered “Almost Always” as compared to males, when asked if they maintain a healthy body weight. This difference was significant.

Proportional data revealed trends between commuting style and lifestyle. Although no significant differences were observed in lifestyle factors between active and non-active commuters, certain trends were observed between the two groups, particularly a higher proportion of active commuters reported “almost always” to engaging in regular aerobic and muscular strength and endurance exercise.

From these data, we can infer a relationship between commuting style and education. Although this study demonstrated significant differences between commuting style and education, further research is needed to expand our understanding of these two variables, especially within genders.
CHAPTER I

INTRODUCTION

Physical activity leads to improved health and wellness. The scientific literature has demonstrated a protective effect of physical activity on chronic disease (Paffenbarger, Blair, & Lee, 2001).

To promote and maintain health, all healthy adults between the ages of 18-65 years old need moderate-intensity aerobic (endurance) physical activity for a minimum of 30 minutes on five days each week or vigorous-intensity aerobic physical activity for a minimum of 20 minutes on three days each week. (Haskell et al., 2007, p. 1)

Despite the many benefits of living an active lifestyle, levels of physical activity still remain low among American adults (Fahey, Insel, & Roth, 2009). Active commuting contributes to increased levels of total physical activity (Sahlqvist, Song, & Ogilvie, in press), and it is one form of lifestyle exercise that provides a creative solution to meeting physical activity recommendations.

Active commuting is associated with numerous benefits to health (Bopp, Kaczynski, & Besenyi, 2012), including a reduced risk for obesity (Lindstrom 2008 as cited in Bopp et al., 2012) cardiovascular disease (Hamer & Chida, 2008 as cited in Bopp et al., 2012), and all-cause mortality (Anderson, Schnohr, Schroll, & Hein, 2000 as cited in Bopp et al., 2012) among others. Lindstrom (2007) demonstrated that walking and bicycling to work are linked to a decreased incidence of overweight and obesity. Wen and Rissel (2008) demonstrated similar associations. Active commuting is favorably associated with a reduced risk of cardiovascular disease (Gordon-Larsen et al., 2009), and
other studies have demonstrated similar results (Barengo, Kastarinen, Lakka, Nissinen, &
Tuomilehto, 2006; Hamer, & Chida, 2008). Cycling to work has been linked to a reduced
all-cause mortality (Anderson et al., 2000). Additionally, transportation related physical
activity is associated with a lower prevalence of metabolic syndrome (Kwasniewska et
al., 2010a), and a reduced risk for type 2 diabetes in middle aged people (Hu a et al.,
2003).

Considering these promising results, active commuting might be a viable form
of physical activity for improving health (Gordon-Larsen et al., 2009).

Statement of the Problem

Strong evidence demonstrates an association between physical inactivity and
increased risk for numerous adverse health problems (Lee et al., 2012), including
increased risk of cardiovascular disease, type 2 diabetes mellitus, and several types of
cancer. In the United States, the rate of physical activity continues to decline (Brownson,
Boehmer, & Luke, 2005). Consequently, the rate of chronic disease, and the economic
cost of medical expenses needed to treat chronic disease continue to rise. Ultimately, this
trend translates into higher taxes and higher health insurance premiums (Sator, 2010).

It is estimated that 82,600,000 adults in America (greater than one in three)
have at least one type of cardiovascular disease, including hypertension, coronary heart
disease, previous myocardial infarction, angina pectoris, heart failure, and
cerebrovascular accident (Roger et al., 2012). An estimated 18.3 million Americans aged
20 and above have been diagnosed with diabetes mellitus (Roger et al., 2012).
The number of deaths attributable to cardiovascular disease in the United States remains high. Based on 2008 mortality data, 811,940 Americans died of cardiovascular disease (Roger et al., 2012). One out of every eighteen deaths were attributed to cerebrovascular accident (Roger et al., 2012). Coronary heart disease caused 405,309 deaths in 2008 (Roger et al., 2012). Every minute, someone in America will die from a coronary event (Roger et al., 2012). In 2008, eight percent of the adult U.S. population had been diagnosed with type 2 diabetes mellitus (Roger et al., 2012).

The medical expenses associated with treating chronic disease are of epic proportion. In the United States, direct and indirect costs of cardiovascular disease were $190.3 million in 2008 (Roger et al., 2012). The estimated direct and indirect costs of hypertension, cerebrovascular accident, and other types of cardiovascular disease were 50.6, 34.3, and 22.5 million dollars, respectively (Roger et al., 2012). Diabetes mellitus accounted for $45.9 billion in direct health expenditures in 2008 (Roger et al., 2012). Projected total costs of cardiovascular disease continue to rise as well. It is estimated by the year 2030, medical costs in the United States needed to treat hypertension, coronary heart disease, heart failure, cerebrovascular accident, and other forms of cardiovascular disease will cost $1,117.6 billion to treat annually (Roger et al., 2012). The prevalence, mortality, and economic burden of chronic disease are significant public health issues. Of the major risk factors for chronic disease, physical inactivity is significant. Physical inactivity has similar effects on chronic disease such as smoking and obesity do (Lee et al., 2012). Worldwide, physical inactivity is responsible for an estimated six to ten percent of the major non-communicable diseases including coronary heart disease, type 2 diabetes mellitus, and cancer of the breast and colon (Lee et al., 2012). Currently in the
United States, medical costs due to physical inactivity are estimated to be $75 billion annually (Centers for Disease Control, 2011).

Health-promoting agencies have attempted to increase the levels of physical activity in the United States and worldwide. However, this task is met with additional challenges. Currently, different forms of physical activity are recommended to promote health and wellness. These forms include exercise, occupational activity, leisure-time activity, and active commuting. The scientific literature demonstrates an association between active commuting and numerous benefits to health (Bopp et al., 2012). However, we do not fully understand the motivations or influences behind active and non active commuting (Bopp et al., 2012). Understanding these factors could help communities develop cogent strategies for promoting active commuting (Bopp et al., 2012), which could have an impact on health and wellness (Bopp et al., 2012). Research investigating the association between education level and active commuting is sparse, and has produced mixed results.

Purpose of the Study

The purpose of this study was to investigate the relationship between active commuting and education level. A secondary purpose was to investigate the relationship between active commuting and lifestyle.

Rationale

Lifestyle has a significant role in preventing chronic disease (Hu, Li, Colditz, Willett, & Manson, 2003 and Joshipura et al., 2001 as cited in Fahey et al., 2009). For example, diet, physical activity, smoking, and excessive alcohol consumption influence
cardiovascular disease, cancer, diabetes mellitus, Alzheimer’s disease, kidney disease, and chronic liver disease and cirrhosis (National Center for Health Statistics, 2007 as cited in Fahey et al., 2009). Several studies investigating the association between active commuting with chronic disease, all cause-mortality, and physical activity have demonstrated promising results. Research investigating the association between lifestyle and commuting activity is sparse. Research into the association between commuting activity and education level is also sparse, and not well understood. Also, limited data exists on the influence of educational level and socioeconomic status on commuting style. Current literature has demonstrated an association between education and commuting activity, and a link between lifestyle in the prevention of chronic disease. Research into the association between active commuting, lifestyle and education would contribute to the existing body of literature, possibly aiding in the prevention of chronic disease.

Surveys are important, credible research tools in the health sciences. To add to the credibility and consistency of this study, the lifestyle evaluation used in this study was adapted from the one developed by the U.S. Public Health Service (cited and adapted by Fahey et al., 2009.)

Hypothesis

People who have earned graduate and professional degrees will report active commuting at a different rate as compared to people who have earned undergraduate degrees.
Null Hypothesis

There will be no observed differences in the rate of active commuting between people who have earned graduate and professional degrees and people who have earned undergraduate degrees.

Delimitations of the Study

1. The results of this study were delimited to California State University, Chico (CSUC) alumni.
2. The results of this study were delimited to the age of the participants.
3. The results of this study were delimited to people who have access to active commuting routes to or from work or school.
4. The results of this study were delimited to people who chose walking or bicycling as a means of active transportation.
5. The results of this study were delimited to healthy able-body adults.

Limitations of the Study

1. The results of this study were limited by possible selection bias in survey respondents. People who answered the survey might have responded differently than people who did not.
2. The results of this study were limited by motivation. Some of the subjects may have been poorly motivated to be physically active, which could have obscured the relationship between commuting style and education level. People who are more inclined to be physically active might be more likely to choose active means of transportation.
3. The results of this study were limited by lack of motivation to be physically active. People who are inclined to be physically active might be more likely to choose active means of transportation.

4. The results of this study were limited by social standards and status symbols. Arriving to work by foot or on bicycle might not be accepted in certain cultures for certain occupational positions. People might commute a certain way because of what social standards dictate.

5. The results of this study are limited by the fact that commuting via walking or cycling might not be viable in people living with chronic diseases, limited physical ability, or to pregnant women.

Definition of Terms

**Active Commuting**

A form of lifestyle exercise characterized by commuting to work or school by means of walking, riding a bicycle, or by other means that do not involve motorized transport.

**Angina Pectoris**

“A disease marked by brief paroxysmal attacks of chest pain precipitated by deficient oxygenation of the heart muscles” (Pease, 2006, p. 36).

**Cardiovascular Disease**

“A general term that describes disease of the heart and blood vessels including, but not limited to coronary artery disease, cerebrovascular accident, myocardial infarction, and hypertension” (Fahey et al., 2009, p. 65).
Cerebrovascular Accident

“Sudden diminution or loss of consciousness, sensation, and voluntary motion caused by rupture or obstruction (as by a clot) of a blood vessel of the brain” (Pease, 2006, p. 116).

Chronic Disease

“A disease that develops and continues over a long period of time, such as heart disease or cancer” (Fahey et al., 2009, p. 4).

Coronary Heart Disease

“A condition and especially one caused by atherosclerosis that reduces the blood flow through the coronary arteries to the heart muscle and typically results in chest pain or heart damage” (Pease, 2006, p. 153).

Diabetes Mellitus

A variable disorder of carbohydrate metabolism caused by a combination of hereditary and environmental factors and usually characterized by inadequate secretion or utilization of insulin, by excessive urine production, by excessive amounts of sugar in the blood and urine, and by thirst, hunger, and loss of weight. (Pease, 2006, p. 188)

Dyslipidemia

“A condition marked by abnormal concentrations of lipids or lipoproteins in the blood” (Pease, 2006, p. 208).

Exercise

“Planned, structured, repetitive movement of the body intended to improve or maintain physical fitness” (Fahey et al., 2009, p. 29).

Graduate Education

Post undergraduate education, consisting of master’s or doctoral education.
Health

“The overall condition of a person’s body or mind. The presence or absence of illness or injury” (Fahey et al., 2009, 3).

Hypertension

1. Abnormally high arterial blood pressure usually indicated by an adult systolic blood pressure of 140 mmHg or greater or a diastolic blood pressure of 90 mmHg or greater, is chiefly of unknown cause, but may be attributable to a preexisting condition (as renal or endocrine disorder), and that is a risk factor for various pathological conditions or events (as heart attack or stroke). 2. A systematic condition resulting from hypertension that is either symptomless or is accompanied especially by dizziness, palpitations, fainting, or headache. (Pease, 2006, p. 335)

Impaired Fasting Glucose

“Fasting blood glucose greater than or equal to 100 mg/dL (5.6 mmol/L) confirmed by measurements on at least two separate occasions” (Armstrong et al., 2006, p. 22).

Metabolic Syndrome

A syndrome marked by a presence of usually three or more of a group of factors (as high blood pressure, abdominal obesity, high triglyceride levels, low HDL levels, and high fasting levels of blood sugar) that are linked to an increased risk of cardiovascular disease and type II diabetes-called also insulin resistance syndrome, and syndrome X. (Pease, 2006, p. 449).

Myocardial Infarction

“An acute episode of heart disease marked by the death or damage of heart muscle due to insufficient blood supply to the heart muscle itself usually as a result of a coronary thrombosis or a coronary occlusion and that is characterized especially by chest pain” (Pease, 2006, p. 482).

Non active Commuting

Commuting to work or school by means of motorized transportation.
Obesity

“A condition that is characterized by excessive accumulation and storage of fat in the body and that in an adult is typically indicated by a body mass index of 30 or greater” (Pease, 2006, p. 511).

Physical Activity

“Any body movement carried out by the skeletal muscles and requiring energy” (Fahey et al., 2009, p. 29).

Postgraduate Education

Education beyond that of a master’s degree.

Prediabetes

“An inapparent abnormal state that precedes the development of clinically evident diabetes” (Pease, 2006, p. 602).

Sedentary Lifestyle

“Persons not participating in a regular exercise program or not meeting the minimal physical activity recommendations from the U.S. Surgeon General’s Report” (Armstrong et al., 2006, p. 22).

Type 1 Diabetes

Diabetes of a form that usually develops during childhood or adolescence and is characterized by a severe deficiency of insulin secretion resulting from atrophy of the islets of Langerhans and causing hyperglycemia and a marked tendency towards ketoacidosis-called also insulin-dependent diabetes, insulin-dependent diabetes mellitus, juvenile diabetes, juvenile-onset diabetes, type 1 diabetes mellitus. (Pease, 2006, p. 789)
Type 2 Diabetes

A diabetes mellitus of a common form that develops especially in adults and most often in obese individuals and that is characterized by hyperglycemia resulting from impaired insulin utilization coupled with the body’s inability to compensate with increased insulin production - called also adult-onset diabetes, late-onset diabetes, maturity-onset diabetes, non–insulin-dependent diabetes, non-insulin dependent diabetes mellitus, type 2 diabetes mellitus. (Pease, 2006, p. 789)

Undergraduate Education

Education consisting of work towards an undergraduate degree, including an associate’s degree, or bachelor’s degree.
CHAPTER II

REVIEW OF LITERATURE

The Relationship Between Active Commuting and Cardiovascular Disease

Current literature suggests that active commuting is beneficial for health (Bopp et al., 2012). Health benefits from active commuting include a contribution to overall total physical activity levels (Chillon et al., 2010; Cooper, Page, Foster, & Qahwaji, 2003; Heelan et al., 2005; Roth, Millett, & Mindell, 2012; Sahlqvist et al., in press; Sirard, Riner, McIver, & Pate, 2005; Tudor-Locke, Ainsworth, & Popkin, 2001), improved physical fitness (Anderson, Lawlor, Cooper, Froberg, & Anderssen, 2009), improved cardiovascular fitness (Cooper et al., 2006), a reduced risk in all-cause mortality (Anderson et al., 2000), endometrial cancer (Matthews et al., 2005), colon cancer (Hou et al., 2004), overweight and obesity (Wen & Rissel, 2008; Lindstrom, 2008), type 2 diabetes mellitus (Hu et al., 2003), metabolic syndrome (Kwasniewska et al., 2010a), hypertension (Hayashi et al., 1999), and cardiovascular disease and its associated risk factors (Barengo et al., 2006; Gordon-Larsen et al., 2009; Hamer & Chida, 2008; Hu, Jousilahti, et al., 2007; Hu et al., 2001; Hu et al., 2005; Hu, Tuomilehto, et al., 2007; von Huth Smith, Borch-Johnsen, & Jorgensen, 2007; Wennberg et al., 2006). This review will examine the relationship between active commuting, its association with cardiovascular disease, and cardiovascular disease risk factors.
Twenty-nine studies comprised this review. These studies investigated the association between active commuting and cardiovascular disease risk. Each study was performed between 1999 and 2012.

Research investigating the association between active commuting and cardiovascular disease is relatively new, and has demonstrated mixed, but promising results. Wagner, et al. showed that transportation related physical activity was not related to myocardial infarction or deaths due to coronary disease (Wagner, Simon, Evans, Ferrieres, Montaye, Ducimetiere, & Arveiler, 2002). Similarly, Barengo et al. (2004) demonstrated reduced risk for cardiovascular disease, and all-cause mortality among women who spent fifteen or more minutes walking or cycling to work. After controlling for confounding variables, there was no longer any association. Data from the same study found no protective effect of active commuting on cardiovascular disease, or all-cause mortality in men (Barengo et al., 2004). However, data from a 2007 study by the same group of researchers demonstrated somewhat conflicting results, suggesting a protective effect from active commuting on the risk of coronary heart disease in women, but not in men (Hu et al., 2007). Similarly, in a 2007 study by Hu, et al., a significant inverse association between active commuting and risk of incident coronary heart disease events was demonstrated among women, but not among men (Hu et al., 2007). Wennberg et al. (2006) found a positive association between commuting by car and an increased risk for myocardial infarction. This association was observed in men but not women. These studies have demonstrated mixed results among genders, however, Hu et al showed an inverse association between daily physical commuting activity and cerebrovascular accident in men and women (Hu et al., 2005). Although these studies demonstrated
mixed results, the majority of the evidence demonstrates an inverse relationship between active commuting and the risk of cardiovascular disease.

Positive risk factors for cardiovascular disease include family history, cigarette smoking, hypertension, dyslipidemia, impaired fasting glucose, obesity, and a sedentary lifestyle (Armstrong et al., 2006).

While risk factors such as family history are not modifiable, people can increase physical activity. Many studies have demonstrated an inverse association between physical activity and a reduction in risk factors such as hypertension, dyslipidemia, impaired fasting glucose, and obesity. Studies on the association between active commuting and a reduction in risk factors for cardiovascular disease have produced mixed but promising results.

Hypertension is a significant risk factor for atherosclerosis, myocardial infarction, and cerebrovascular accident. Hypertension creates excess stress on the walls of arteries, leading to increased shear force and accelerated disease. Studies in the scientific literature have demonstrated that physical activity and active commuting reduces the risk of hypertension (Gordon-Larsen et al., 2009; Hayashi et al., 1999; Hu et al., 2001; Pereira et al., 1999; von-Huth Smith et al., 2007).

Hayashi and colleagues (1999), in a study of 6,017 middle-aged Japanese men, found a reduced risk of incident hypertension that was proportional to the time spent walking to work. They found an additional “12 percent reduction in the risk for hypertension when the duration of the walk to work was increased by ten minutes” (Hayashi et al., 1999, p. 24). Similar associations were seen in a 1999 study by Pereira and colleagues. Walking to work reduced the risk of hypertension by 34 percent in
Caucasian, Asian, American Indian, and Hispanic men and women “in the highest quartile of leisure activity,” when compared to the least active quartile (Pereira et al., 1999, p. 307). Leisure activity was defined by an index that included physical activity associated with commuting (Pereira et al., 1999). Hu and colleagues investigated the association between cardiovascular risk factors and commuting and leisure-time physical activity in China. They demonstrated an association between active commuting and a reduced risk for hypertension in men and women (Hu et al., 2001). Of the 3,976 participants, fifty one percent of men, and fifty five percent of women performed 1-30 minutes of active commuting per day, thirty percent of men, and thirty four percent of women performed 31-60 minutes of active commuting per day, and eleven percent of men, and seven percent of women performed more than 1 hour of active commuting per day (Hu et al., 2001). In men, the duration of commuting activity was positively related to systolic blood pressure (Hu et al., 2001). The lowest prevalence of hypertension was observed in both men and women who spent 31-60 minutes actively commuting on a daily basis, while the highest prevalence was observed in participants who spent more than 1 hour actively commuting daily (Hu et al., 2001). These data suggest a specific association between active commuting and a low prevalence of hypertension in the Chinese population, although greater than 60 minutes of physical activity including active commuting was associated with increased risk of hypertension (Hu et al., 2001). Similarly, von Huth Smith et al. (2007) found a negative association between duration of active commuting and total physical activity with systolic blood pressure among women. In addition to the 2007 von Huth Smith et al. study, Gordon-Larsen et al. (2009) found an inverse association between active commuting and systolic blood pressure. However, the
association was only observed in men. In the Gordon-Larsen et al. (2009) cross sectional CARDIA study, 2,364 participants who worked somewhere other than home were studied during the twentieth year of the study. Participants reported the distance and duration required to travel between home and work, and the percentage of the travel “taken by car, public transportation, walking, or bicycling” (Gordon-Larsen et al., 2009, p. 1217). Body mass index, obesity, measurements of physical activity, lipid concentrations, glucose concentrations, insulin concentrations, blood pressure, and fitness measurements were assessed. The descriptive characteristics demonstrated that 16.7% of the sample actively commuted to work (Gordon-Larsen et al., 2009).

After controlling for sociodemographics, smoking status, alcohol intake, and leisure physical activity, a significant inverse association was observed between active commuting and diastolic blood pressure in men (Gordon-Larsen et al., 2009, p. 1219).

We can infer from these data that an association exists between commuting physical activity, and a reduced risk for hypertension. The majority of the studies found that active commuting reduced the risk of hypertension in men and women.

Dyslipidemia is a risk factor for cardiovascular disease (Armstrong et al., 2006). Recent studies have found a link between active commuting and a reduced risk of dyslipidemia (Hu et al., 2001); (Barengo et al., 2006; Gordon-Larsen et al., 2009; von Huth Smith et al., 2007).

Hu and colleagues (2001) found a significant inverse association between active commuting and total cholesterol, low density lipoprotein cholesterol, and triglycerides in men, and a significant positive association between active commuting and high density lipoprotein cholesterol in women. (p. 414)
Barengo et al. (2006) investigated the association between active commuting and cardiovascular disease risk factors in men and women between the ages of 24 and 64 years. Those who performed at least thirty minutes of active commuting each day had significantly higher high density lipoprotein cholesterol levels when compared to those performing less than fifteen minutes of active commuting per day (Barengo et al., 2006). These data agree with those of von Huth Smith and colleagues (2007) who found a positive association between time spent active commuting and high density lipoprotein cholesterol. Additionally, von Huth Smith et al. (2007) found negative associations between active commuting and low density lipoprotein cholesterol, triglycerides, waist circumference, and body mass index. These associations were observed among a random sample of subjects between the ages of 30-60 years old (von Huth Smith et al., 2007). These studies suggest an association between commuting physical activity and dyslipidemia.

The 2009 CARDIA study has presented mixed results regarding the relationship between active commuting and dyslipidemia. After controlling for sociodemographics, they observed a positive association between active commuting and high density lipoprotein cholesterol levels in men. This association was no longer significant, however, after controlling for smoking, alcohol, and leisure time physical activity (Gordon-Larsen et al., 2009). Even after controlling for sociodemographics, smoking, alcohol, and leisure time physical activity, there remained an inverse association between active commuting and triglyceride levels in men (Gordon-Larsen et al., 2009). No significant associations were observed between active commuting and low density lipoprotein cholesterol levels in either gender, or between active commuting, high
density lipoprotein cholesterol levels, or triglyceride levels in women (Gordon-Larsen et al., 2009). All statistical significance disappeared after adjusting for body mass index (Gordon-Larsen et al., 2009). The relationship between commuting activity and dyslipidemia remains unclear. The majority of the evidence, however, suggests an association between commuting physical activity and a reduced risk for dyslipidemia.

Impaired fasting glucose is defined as “fasting blood glucose concentrations of greater than or equal to 100 mg/dL confirmed by measurements on at least two separate occasions” (Armstrong et al., 2006. p. 22).

For the purposes of this study, type 2 diabetes mellitus will be included under the more general term of impaired fasting glucose.

“Regular physical activity improves insulin sensitivity and also reduces other components of insulin resistance syndrome [10, 34]” (Hu et al., 2003, p. 328). Two studies of interest have investigated commuting physical activity and its relationship to risk for type 2 diabetes mellitus, fasting glucose and insulin levels. One study demonstrated a significant inverse association between active commuting and risk for type 2 diabetes mellitus (Hu et al., 2003). However, a study by Gordon-Larsen et al. (2009) demonstrated mixed results between active commuting and fasting glucose and insulin levels.

In a 2003 study by Hu and colleagues (2003), researchers prospectively followed 14,290 men and women over 12 years. Exclusion criteria included individuals with coronary heart disease, stroke, and diabetes. A self-administered questionnaire was completed by study participants and included questions regarding medical history, socioeconomic factors, physical activity, and smoking habits. Types of physical activity
were divided into occupational, commuting, and leisure time physical activity. Of the total number of subjects, 373 diagnoses of type 2 diabetes mellitus were observed over a twelve-year follow up period (Hu et al., 2003). They found an inverse association between duration of walking or cycling to and from work with type 2 diabetes in men and women (Hu et al., 2003). After adjusting for the other types of physical activity, the inverse relationship between active commuting and risk for type 2 diabetes mellitus remained significant only in women (Hu et al., 2003). Interestingly, “with both genders combined, the inverse association remained after controlling for the two other types of physical activity, gender, and other risk factors” (Hu et al., 2003, p. 325). The risk of developing type 2 diabetes mellitus was lowest in men and women who commuted actively for more than thirty minutes per day (Hu et al., 2003).

The 2009 study by Gordon-Larsen et al. demonstrated mixed results. After controlling for sociodemographics and other confounding variables, a significant association was observed between active commuting and fasting insulin levels in men, but not in women (Gordon-Larsen et al., 2009). No significant associations were observed between active commuting and fasting glucose level (Gordon-Larsen et al., 2009). After controlling for body mass index, there was no longer a significant relationship between active commuting and fasting glucose or fasting insulin levels in men (Gordon-Larsen et al., 2009). These data from the 2003 Hu study and the 2009 Gordon-Larsen study, although somewhat conflicting, suggest an association between active commuting and a reduced risk for type 2 diabetes mellitus.
Metabolic syndrome is “a strong predictor of cardiovascular diseases” (Kwasniewska et al., 2010a, p. 482). According to the National Cholesterol Education Adult Treatment Panel (NCEP-ATP III, 2001), the metabolic syndrome includes the presence of three or more of the following factors: a waist circumference of equal to or greater than 102 cm for men, and greater than or equal to 88 cm for women, fasting plasma glucose equal to or greater than 5.6 mmol/L, triglycerides equal to or greater than 1.7 mmol/L, systolic and or diastolic blood pressure equal to or greater than 130/85 mmHg, and high density lipoprotein cholesterol less than 1.3 mmol/L for men, and less than 1.03 mmol/L for women. (Kwasniewska et al., 2010a, p. 483)

The International Diabetes Foundation (IDF) defines metabolic syndrome as, the presence of a waist circumference of equal to or greater than 94 cm for men, and equal to or greater than 80 cm for women, and two or more of the following factors: fasting blood glucose equal to or greater than 5.6 mmol/L, triglycerides equal to or greater than 1.7 mmol/L, systolic and or diastolic blood pressure equal to or greater than 130/85 mmHg and high density lipoprotein less than 1.3 mmol/L for men, and less than 1.03 mmol/L for women. (Kwasniewska et al., 2010a, p. 483)

Data from a 2010 study by Kwasniewska and colleagues demonstrated a decreased prevalence of metabolic syndrome in those who performed more than thirty minutes of commuting physical activity daily (Kwasniewska et al., 2010a). The results of the 2010a Kwasniewska et al. study suggested that active commuting reduced the risk for metabolic syndrome.

Obesity is a risk factor for cardiovascular disease (Armstrong et al., 2006). Obesity is defined as, a body mass index of equal to or greater than 30kg/m², or a waist girth greater than 102 centimeters for men, and greater than 88 centimeters for women, or a waist to hip ratio equal to or greater than 0.95 for men and equal to or greater than 0.86 for women. (Armstrong et al., 2006, p. 22)
The current scientific literature has investigated a potential relationship between active commuting and a reduced risk for obesity (Frank, Andresen, & Schmid, 2004; Lindstrom, 2007; Rosenberg, Sallis, Conway, Cain, & McKenzie, 2006; Wen, Orr, Millett, & Rissel, 2006; Wen & Rissel, 2008). One particular study of interest found a link between driving to work and overweight and obesity (Wen et al., 2006). In the 2006 study, Wen and colleagues found a positive association between frequency of car use and overweight and obesity. Among participants in the study, 47% of people who drove more than ten times a week were overweight or obese, compared to 41% of participants who drove six to ten times per week (Wen et al., 2006). Only 30% of participants who drove less than six times per week were overweight or obese (Wen et al., 2006). Additionally, 51% of participants who reported driving to work were classified as being overweight or obese, compared to only 43% of those who did not drive cars to work (Wen et al., 2006). These results suggest that active commuting might help prevent obesity (Wen et al., 2006). Similarly, a 2004 study by Frank and colleagues found that each hour spent in a car per day increased the risk of obesity by 6% (Frank et al., 2004). Additional data from the 2004 Frank study demonstrated a 4.8% reduction in the likelihood of obesity with each kilometer walked per day (Frank et al., 2004). These findings concur with findings from a 2008 study by Wen and Rissel and a 2005 study by Gordon-Larsen and colleagues.

The 2008 Wen and Rissel study suggested that, “men who cycled to work were less likely to be overweight and obese compared to men who drove to work” (p. 29). This trend was not observed between men or women who walked and men or women
who drove to work (Wen & Rissell, 2008). Also, no significant association was observed between cycling to work and overweight or obesity in women (Wen & Rissell, 2008).

The 2005 Gordon-Larsen, Nelson, and Beam study also investigated the association between overweight status and active transportation methods. This study sampled 10,771 young adults between the ages of 18 and 28 years of age who originally participated in a previous study that included eighty U.S. high schools, and 52 U.S. middle schools (Gordon-Larsen et al., 2005). Gordon-Larsen and colleagues (2005) found that a higher proportion of non-overweight young adults participated in active commuting, compared to overweight young adults. Although no cause and effect relationship was established between these variables, they established an association between weight status and commuting activity.

A similar study investigating the relationship between active commuting and overweight status in young people was performed by Rosenberg and colleagues (2006). They found a significant inverse relationship between active commuting, body mass index and skinfold thickness in fourth grade boys at baseline (Rosenberg et al., 2006). Similar relationships were not observed among fourth grade girls at baseline. However, there were no observed significant associations between commuting activity and body mass index or skinfold thickness in either gender after two school years (Rosenberg et al., 2006). These data still support baseline results, which demonstrated an association between active commuting, a lower body mass index, and skinfold thickness in fourth grade boys (Rosenberg et al., 2006).

Finally, in 2007, Lindstrom investigated the association between modes of transportation and overweight and obesity, in 16,705 participants. Body mass index, age,
country of origin, education, time for travel to work, and means of transportation to work were assessed (Lindstrom, 2007). Prevalence and odds ratios were calculated to examine the association between variables (Lindstrom, 2007). Overweight was defined as “a body mass index of 25.0 – 29.9 kg/m²,” and obesity was defined as “a body mass index of equal to or greater than 30 kg/m²” (Lindstrom, 2007, p. 23). Among all respondents included in the survey, 46% of men and 26.6% of women were overweight (Lindstrom, 2007). Additionally, 11.6% of men and 10.3% of women participating in the study were considered obese (Lindstrom, 2007). 68.3% of men and 55.8% of women included in the study commuted to work by car every day (Lindstrom, 2007). 18.2% of the male participants and 25.9% of the female participants commuted to work by means of active transportation (Lindstrom, 2007). The remainder of the participants used public transportation (Lindstrom, 2007). Statistical analyses revealed significantly lower odds ratios of overweight and obesity in men and women who performed active commuting as compared to non-active commuters (Lindstrom, 2007). Odds ratios of obesity among men who commuted actively were significant after adjusting for age and country of origin. After adjusting for education and time spent traveling to work, the odds ratios of obesity among men in the study was non-significant (Lindstrom, 2007). In women, the significant inverse association between active commuting and overweight and obesity, and obesity alone remained significant compared to non-active commuters (Lindstrom, 2007). The results of the 2007 Lindstrom study suggest an association between active commuting, overweight, and obesity (Lindstrom, 2007).

A sedentary lifestyle is defined by the American College of Sports Medicine as, “not participating in a regular exercise program or not meeting the minimal physical

Sedentary lifestyle is a positive risk factor for cardiovascular disease (Armstrong et al., 2006). Current literature has demonstrated that active commuting contributes to total daily physical activity (Sahlqvist et al., in press), suggesting that people who commute actively are more physically active compared to non-active commuters. Additionally, data from current literature demonstrated an association between active commuting and participation in other instances of physical activity (Roth et al., 2012). These findings suggest that active commuting might help people meet established physical activity recommendations, thereby reducing the incidence of sedentary lifestyle and cardiovascular disease.

Data from current literature has demonstrated that individuals who use only active modes of commuting between home and work, and those that use a combination of active commuting and other modes of commuting between home and work participate in more total physical activity as compared to individuals who use no active modes for transportation (Sahlqvist et al., in press). Those who performed greater than or equal to 60 minutes per week of active commuting accrued more total physical activity than individuals who performed no active commuting (Sahlqvist et al., in press). Additionally, data from the same study demonstrated that among those who participated in travel for shopping, personal business, visiting friends and relatives, and other social activities, individuals who used only active modes for transportation, and a combination of active and non active modes accrued more total physical activity as compared to individuals who used only non active modes of transportation (Sahlqvist et al., in press).
The findings of the 2012 Sahlqvist et al. study are similar to findings from a 2008 study by Sisson and Tudor-Locke, which suggest that cyclists were more likely than motorists to achieve public health exercise recommendations (Sisson, & Tudor-Locke, 2008). Additionally, data from the 2008 Sisson study demonstrated that cyclists accrued more total moderate to vigorous physical activity than motorists (Sisson, & Tudor-Locke, 2008).

Similar results have been demonstrated in children. In a systematic review by Faulkner, Builung, Flora, and Fusco (2009), Cooper et al. (2003, 2005, 2006), Rosenberg et al. (2006), Sirard et al. (2005), Alexander et al. (2005), Michaud-Tomson et al. (2003), Loucaides & Jago (2008), and Duncan et al. (2008) demonstrated that children ages five to eighteen years old who performed active commuting accumulated significantly higher amounts of physical activity. Furthermore, Saksvig et al. (2007) and Tudor-Locke et al. (2003) demonstrated that children who commuted actively to and from school expended more kilocalories per day compared to children who commuted by non active means (as cited by Faulker et al., 2009).

Roth and colleagues (2012) demonstrated that in children aged five to fifteen years old, those who commuted actively to school were more active than those that did not. They found a link between cycling to school and meeting physical activity recommendations (Roth et al., 2012). Those who walked and cycled to school were more likely to participate in other bouts of walking or cycling (Roth et al., 2012). These findings compliment the results from a 2010 study by Chillon and colleagues that demonstrated significant positive associations between active commuting and increased physical activity in children nine to ten years old and adolescents fifteen to sixteen years
old (Chillon et al., 2010). Although no significant differences in girls were observed, the findings from the 2010 Chillon et al. study demonstrated “significant positive associations between active commuting to school and moderate, vigorous, and average physical activity levels in boys” (p. 875). Boys who commuted actively to school had a higher likelihood of meeting physical activity recommendations (Chillon et al., 2010).

Similar results were observed in a 2005 study by Sirard and colleagues. In fifth grade students, those who commuted actively to and from school accumulated 8.5% more minutes of moderate to vigorous physical activity both before and after school (Sirard et al., 2005). This translates to 24 additional minutes of moderate to vigorous physical activity per day for those who commuted actively on a regular basis (Sirard et al., 2005).

Heelan and colleagues (2005) also found significant positive associations between active commuting and increased total physical activity. According to the results of the 2005 study on 10 year olds by Heelan and colleagues, those who commuted actively to and from school traveled $3.6 \pm 4.3$ kilometers per week. Additionally, they demonstrated significant positive associations between active commuting and physical activity levels “before school and more time spent in moderate intensity physical activity” (Heelan et al., 2005), p. 345. The results demonstrated that when compared to non-active commuting children, children who commuted actively were more physically active before school, and spent more time participating in moderate intensity physical activity (Heelan et al., 2005). These findings agree with a 2003 study by Cooper and colleagues. Although no significant differences were observed between active and non active commuters in regards to meeting physical activity recommendations, children who performed active commuting to school on weekdays were significantly more physically
active than those who commuted by non active means (Cooper et al., 2003). The children who walked to school performed approximately 50% more moderate to vigorous physical activity as compared to those who traveled to school by car (Cooper et al., 2003). Students who commuted actively to school were significantly more active between 8:00 am and 9:00 am, compared to those who traveled by car (Cooper et al., 2003). Interestingly, boys in the study who walked to school performed significantly more moderate to vigorous physical activity (an additional 30 minutes) between the hours of 3:00 pm and 8:00 pm compared to car commuters (Cooper et al., 2003). No significant differences were observed in girls between active and non-active commuters in physical activity after school (Cooper et al., 2003).

The results of the studies mentioned in this literature review demonstrated an association between active commuting, cardiovascular disease incident, and several risk factors for cardiovascular disease. Although most studies have not established a cause effect relationship between active commuting and reduced risk of cardiovascular disease, the similarities between the numerous studies among different age groups and several different geographical populations suggest a strong association between active commuting and a decreased risk of cardiovascular disease.

The Relationship Between Active Commuting and Education

Very few studies have investigated the association between active commuting and education. Studies investigating socio-demographics and predictors of commuting activity exist, but are limited and have demonstrated mixed results. Eight studies have been included in this review and were published between 2007 and 2012.
Bopp et al. (2012) found no significant associations between education level and active commuting. Similarly, one selected study found no association between education and “health enhancing” commuting activity (Merom, Miller, van der Ploeg, & Bauman, 2008). One study found a positive association between lower education and active commuting (Bauman et al., 2011), and another found a positive association between commuting inactivity with university education (Kwasniewska et al. 2010a).

A 2008 study by Merom et al. investigating predictors of active commuting in Australia demonstrated a significant positive association between education level and participation in a walk to work day campaign. However, education level was not significantly associated with participation in health enhancing active commuting, which was described as “participation in greater than or equal to 30 minutes per day of active commuting” (Merom et al., 2008, pp. 343. 345). The study found a higher participation of educated individuals participating in a single day walk to work day campaign, but no significant association between regular participation in active commuting between different levels of education (Merom et al., 2008). Similar results were reported in a 2012 study by Bopp and colleagues. They found a trend towards inactive commuting in all participants in all education levels (Bopp et al., 2012). These data suggest that regardless of education level, more people reported non-active commuting behavior than active commuting (Bopp et al., 2012).

A similar trend was found in Asia. A 2011 study by Bauman and colleagues investigated socioeconomic differences in the prevalence of different forms of physical activity including active commuting in six different Asia-Pacific countries. They found that educated Chinese men and women had a decreased likelihood to commute actively
when compared to those with lower education (Bauman et al., 2011). Additionally, the results demonstrated “no significant association between education level and physical activity in the Philippines, Malaysia, and Nauru” (Bauman et al., 2011, p. 37). People with higher education who lived in urban areas in China, Fiji, Australia, and Malaysia performed less active commuting compared to those who lived in rural areas with lower education (Bauman et al., 2011). Furthermore, a 2012 study examining sociodemographics and “lifestyle correlates of commuting activity” in Poland suggests that the “risk of being physically inactive during commuting is significantly higher in individuals with university education” (Kwasniewska et al., 2010b, p. 259).

Although the studies mentioned so far have suggested no significant differences between education and commuting activity, a trend between lower education and higher rates of active commuting, and an association between higher education and decreased levels of active commuting, several other studies have demonstrated conflicting results. The following studies suggest a positive association between higher education level, and active commuting (Agrawal, & Schimek, 2007; Boone-Heinonen et al., 2009; Gordon-Larsen et al., 2009; Kruger, Ham, Berrigan, & Ballard-Barbash, 2008). These conflicting findings might be due to cultural differences between people living in the United States and those living in Asia and Eastern Europe.

Several studies of people living in the United States found positive correlations between higher education level and active commuting (Agrawal, & Schimek, 2007; Boone-Heinonen et al., 2009; Gordon-Larsen et al., 2009; Kruger et al., 2008).

In a 2009 study by Bonne-Heinonen and colleagues, investigators attempted to examine sociodemographic predictors of active commuting to neighborhood amenities.
Boone-Heinonen et al. found a positive association between education (high school or greater) and active commuting (cycling) to the park. Although these results were significant, no other significant associations were observed between education level and walking or cycling to other neighborhood amenities.

Agrawal and Schmiek demonstrated similar results to those of Boone-Heinonen and colleagues. They examined the extent and correlates of walking in the United States (Agrawal & Schimek, 2007). The study is based on the 2001 National Household Transportation Survey which was designed to investigate travel patterns, attitudes about travel experiences, household vehicle information, and demographic data of Americans (Agrawal & Schimek, 2007). Similar studies were performed in 1969, 1977, 1983, 1990, 1995, and 2001 (Agrawal & Schimek, 2007). Data included mode of travel, time of travel, purpose of travel, and travel distance (Agrawal & Schimek, 2007). They found that higher education was positively associated with utility walking (Agrawal & Schimek, 2007) and, that earning a bachelor’s degree “increased the odds of utility walking by 56%” (Agrawal & Schimek, 2007, p. 562).

Results from a 2008 study by Kruger and colleagues concur with the results observed in the 2007 study by Agrawal and Schimek. They demonstrated that incidence of walking for transportation increased with educational level (Kruger et al., 2008). Specifically, data from the 2008 study by Kruger and colleagues demonstrated a trend of higher prevalence of walking for transportation among college graduates as compared to those with less education. The same trend was observed when comparing people with some college education to people with high school education alone (Kruger et al., 2008). Similar results were observed in the 2009 CARDIA study by Gordon-Larsen and
colleagues. Data from the 2009 Gordon-Larsen study showed a positive trend between higher education and active commuting to work and school, among participants in the CARDIA study (Gordon-Larsen et al., 2009). Active commuting was positively associated with graduate school and professional training in men (Gordon-Larsen et al., 2009). The same association was observed among women in the CARDIA study and was also observed in women with some college education (Gordon-Larsen et al., 2009).

These studies have demonstrated mixed results regarding the relationship between level of education and commuting activity. Despite the conflicting results, the majority of these studies suggest that an association between education and active commuting exists. Because of these conflicting results, and due to the limited number of studies investigating this association, more research is needed to add to the literature to determine if there exists a relationship between education and active commuting.
CHAPTER III

METHODOLOGY

Design of the Investigation

This study was conducted as a survey. Participants were California State University Chico (CSUC) Alumni from the graduating classes of 2009, 2010, and 2011. Email invitations to participate in the survey were sent to all 2009, 2010, and 2011 CSUC Alumni who had email addresses on file with the University. The survey itself was created and presented to participants through a web based survey program called “Survey Gizmo.” Survey gizmo is a web-based program that allows for the creation and implementation of online surveys. Each invitation to participate included a link to the Survey Gizmo website, where each participant could access and complete the survey. Email addresses were obtained with permission from California State University Chico, and kept completely confidential.

The survey itself was a combination of thirty six questions designed to evaluate commuting style, education level, gender, and lifestyle. The survey was conducted for 1 month between Jun 26, 2012, and July 26, 2012. Figure 1 illustrates the first section of the survey which was designed by the primary investigator and his thesis committee, and consisted of six questions which evaluated commuting style, education level, and gender. Questions 1, 2, 3, and 5 followed a structured dichotomous response type format, while questions 4 and 6 were unstructured, open ended questions (Figure 1).
Figure 1. Section 1 of survey.

The purpose of the second section of the survey was to evaluate lifestyle, and consisted of seven categories of questions relative to lifestyle, including exercise and fitness, nutrition, tobacco use, alcohol and drugs, emotional health, safety, and disease prevention. It was developed by the U.S. Public Health Service. Each question in the lifestyle evaluation followed a structured response format in which each participant could choose his or her response as “Almost Always,” “Sometimes,” or “Never.” For the purposes of making the survey user friendly within a web based survey program, questions on tobacco use were modified. This modification did not affect the outcome of
the survey. The second section of the survey consisted of the following questions and statements:

Question
7. “I engage in moderate exercise, such as brisk walking or swimming, for 20-60 minutes, three to five times a week.
8. I do exercises to develop muscular strength and endurance at least twice a week.
9. I spend some of my leisure time participating in individual, family, or team activities, such as gardening, bowling, or softball.
10. I maintain a healthy body weight, avoiding overweight and underweight.
11. I eat a variety of foods each day, including seven or more servings of fruits and/or vegetables.
12. I limit the amount of total fat, saturated fat and trans fat in my diet.
13. I avoid skipping meals.
14. I limit the amount of salt and sugar I eat.
15. If you never use or no longer use tobacco, click 10 and click skip on the next two questions. If not, click proceed and answer the next two questions.
16. I avoid using tobacco.
17. I smoke only low-tar-and nicotine cigarettes, or, I smoke a pipe or cigars, or I use smokeless tobacco.
18. I avoid alcohol, or I drink no more than one (women) or two (men) drinks a day.
19. I avoid using alcohol or other drugs as a way of handling stressful situations or the problems in my life.
20. I am careful not to drink alcohol when taking medications (such as cold or allergy medications) or when pregnant.
21. I read and follow the label directions when using prescribed and over-the-counter drugs.
22. I enjoy being a student, and I have a job or do other work that I enjoy.
23. I find it easy to relax and express my feelings freely.
24. I manage stress well.
25. I have close friends, relatives, or others whom I can talk to about personal matters and call on for help when needed.
26. I participate in group activities (such as community or church organizations) or hobbies that I enjoy.
27. I wear a safety belt while riding in a car.
28. I avoid driving while under the influence of alcohol or other drugs.
29. I obey traffic rules and the speed limit while driving.
30. I read and follow instructions on the labels of potentially harmful products or substances such as household cleaners, poisons and electrical appliances.
31. I avoid smoking in bed.
32. I know the warning signs of cancer, heart attack, and stroke.
33. I avoid overexposure to the sun, and use sunscreen.
34. I get recommended medical screening tests (such as blood pressure and cholesterol checks and Pap tests), immunizations, and booster shots.
35. I practice monthly skin and breast/testicle self exams.
36. I am not sexually active, or I have sex with only one mutually faithful, uninfected partner, or I always engage in safer sex (using condoms), and I do not share needles to inject drugs. (U.S. Public Health Service lifestyle evaluation study, as cited and adapted by Fahey et al., 2009, pp. 25-26)

Exactly 6,031 California State University Chico Alumni were invited to participate in the study. A total of 84 people completed the survey. 1 response was eliminated due to the fact that the participant’s response was considered invalid after responding yes and no to the question that asked the participant if he or she currently participated in active commuting. After this elimination, 83 responses were included in this study. All survey responses were complete.

Of the 83 respondents, 30 were male, and 53 were female. 38 had earned graduate and postgraduate degrees, while 45 had earned an undergraduate but no graduate degree. 79 participants responded from the United States, while 4 responded from outside of the United States (Figure 2).

<table>
<thead>
<tr>
<th>N = 83</th>
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<tbody>
<tr>
<td>Males = 30</td>
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<tr>
<td>Females = 53</td>
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<tr>
<td>Educational Level: Graduate/Postgraduate Degree = 38</td>
</tr>
<tr>
<td>Undergraduate Degree only = 45</td>
</tr>
<tr>
<td>Location: United States = 79</td>
</tr>
<tr>
<td>Outside of United States = 4</td>
</tr>
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*Figure 2. Demographics of the study population.*
After a preliminary analysis of data, errors in participant’s responses were found. 22 participants stated that they had earned graduate or postgraduate degrees (Question #3). However, when asked what type of degree they had earned (Question #4), they had indicated an undergraduate degree. These errors were corrected by the primary investigator. All data analyses and tests for significance were performed on the corrected data.

Data from the study were tabulated, analyzed, and graphed using 2003 and 2007 versions of Microsoft Excel. Further, proportional data were calculated and analyzed graphically using 2003 and 2007 versions of Microsoft Excel. Statistical analyses were performed using Vassarstats.net. Because of the small sample size, both Pearson Chi Square and Fisher Exact Probability Tests were used. Statistical significance was set at $p = 0.05$.

Rates of active commuting between participants who had earned graduate and postgraduate degrees and participants who had earned only undergraduate degrees were analyzed for significance using a Pearson chi square analysis. Rates of active commuting between males who had earned graduate and postgraduate degrees and males who had earned only undergraduate degrees were analyzed for significance using the Fisher Exact Probability Test. Similarly, rates of active commuting between females who had earned graduate and postgraduate degrees and females who had earned only undergraduate degrees were also analyzed for significance using the Fisher Exact Probability Test. Rates of active commuting under ideal circumstances among both males and females with undergraduate and graduate degrees were tabulated and graphed using the 2007 version of Microsoft Excel, and analyzed for statistical significance using Pearson’s chi square
analysis. Male and female responses to questions 7, 10, and 33 were tabulated, graphed and analyzed using 2003 and 2007 versions of Microsoft Excel, and analyzed for statistical significance using Pearson’s chi square analysis and Fisher’s Exact Probability Test when appropriate. Proportional data from the lifestyle evaluation was compared to commuting style (Active vs. Non Active) and was analyzed for significance using the Pearson chi square test and Fisher Exact Probability Test when appropriate.
CHAPTER IV

RESULTS

Of the 83 total responses, 14 participants (16.9%) reported that they currently commute to work or school by means of active commuting. The remainder of participants reported that they did not currently commute to work or school by means of active commuting (69 participants; 83.1%).

Of the total participants who reported active commuting (n = 14), 10 had earned graduate and postgraduate degrees and 4 had earned undergraduate degrees. Rates of active commuting among participants who had earned graduate and postgraduate degrees were significantly different (higher) than that of participants who had earned undergraduate degrees only (Pearson chi square uncorrected for continuity = 4.46; p = 0.035) (Figure 3).

Similarly, rates of active commuting among males who had earned graduate and postgraduate degrees were significantly different (higher) than that of males who had earned undergraduate degrees only (p = 0.012) (Figure 4).

The same trend was observed among female respondents; however, no significant difference was observed (Figure 5).

In an attempt to explain why there was no significant difference between commuting style and education level among female respondents, we hypothesized that the lack of significance might be attributable to the notion that women might be generally
Figure 3. Percent active commuting between participants who had earned graduate and postgraduate degrees and those that had earned an undergraduate degree as their highest level of education. Chi square = 4.5 ($p = 0.035$).

Figure 4. Percent active commuting between males who had earned graduate and postgraduate degrees and males whose highest level of education was an undergraduate degree. Fisher Exact Probability Test ($p = 0.012$).
Figure 5. Percent active commuting between females who had earned graduate and postgraduate degrees and females whose highest level of education was an undergraduate degree.

more concerned about their appearance as compared to men. Therefore, women might be less likely to participate in active commuting when compared to men, taking into consideration the fact that active commuting has the potential to interfere with personal appearance. To test this hypothesis, we selected three questions from the lifestyle evaluation that had something to do with personal appearance (Questions 7, 10, and 33). After graphing and analyzing these data, we observed a difference in the proportion of women who answered almost always to these three questions, as compared to men. A higher proportion of women answered “almost always” to the three questions as compared to men, except to question # 7 between men and women who had earned graduate degrees, where the opposite trend was observed. Although there was a trend in these data, the only significant difference was observed in question # 10 between males and females who had earned undergraduate degrees (Figure 6).
Figure 6. Question # 10. Percentage of male and female respondents who answered “almost always” to maintaining a healthy body weight among those whose highest level of education was an undergraduate degree. Fisher’s Exact Probability Test ($p = 0.03$).

Our control question, question # 2, was designed to control for confounding variables that might influence a person’s decision to commute actively or non-actively. Question # 2 asked if the participant would commute actively in the future, given ideal circumstances. When comparing percentages of those who currently participated in active commuting to percentages of those that would participate in active commuting under ideal circumstances, there were statistical differences among women and men (Pearson’s chi square = 39.79; $p < 0.0001$ for females) (Figure 7), and Pearson’s chi square = 11.28; $p = 0.0008$ for males (Figure 8).

Proportional data revealed certain trends among active and non-active commuters in regards to lifestyle. However, no significant differences were observed.

In regards to exercise and fitness, proportional data revealed that active commuters reported “almost always” at a higher rate when asked about regular
Figure 7. Percent female active commuters vs. percent female respondents who reported that they would commute actively under ideal circumstances. Pearson’s chi square = 39.79 ($p < 0.0001$).

Figure 8. Percent male active commuters vs. percent male respondents who reported that they would commute actively under ideal circumstances. Pearson’s chi square = 11.28 ($p < 0.0008$).
participation in aerobic exercise (Figure 9), and muscular strength and endurance type exercise when compared to non-active commuters (Figure 10). The opposite trend was observed when commuting style was compared to leisure time physical activity (Figure 11). Additionally, non-active commuters reported “almost always” at a higher rate when asked about maintaining a healthy body weight when compared to active commuters (Figure 12).

![Graph](image)

*Figure 9.* Percentage of respondents who answered “almost always” to engaging in regular aerobic type exercise. Active vs. non-active commuters.

Regarding nutrition, non-active commuters reported a higher rate of answering “almost always” to eating a variety of foods each day including seven or more servings of fruits and vegetables (Figure 13). The same trend was observed regarding limiting the amount of total, saturated, and trans fat in the respondent’s diet (Figure 14), avoiding skipping meals (Figure 15), and limiting the amount of salt and sugar that the respondent eats (Figure 16).
Figure 10. Percentage of respondents who answered “almost always” to engaging in regular muscular strength and endurance training. Active vs. non-active commuters.

Figure 11. Percentage of respondents who answered “almost always” to participating in leisure-time physical activity. Active vs. non-active commuters.
Figure 12. Percentage of respondents who answered “almost always” to maintaining a healthy body weight. Active vs. non-active commuters.

Figure 13. Percentage of respondents who answered “almost always” to eating a variety of foods each day, including 7 or more servings of fruits and/or vegetables. Active vs. non-active commuters.
Figure 14. Percentage of respondents who answered “almost always” to limiting the amount of total fat, saturated fat, and trans fat in their diets. Active vs. non-active commuters.

Figure 15. Percentage of respondents who answered “almost always” to avoiding skipping meals. Active vs. non-active commuters.
Figure 16. Percentage of respondents who answered “almost always” to limiting the amount of salt and sugar they eat. Active vs. non-active commuters.

commuters (Figure 17). However, a higher percentage of non-active commuters reported that they did not use, or no longer use tobacco as compared to active commuters (Figure 18).

Figure 17. Percentage of respondents who answered “almost always” to avoiding using tobacco. Active vs. non-active commuters.
In regards to alcohol and drug use, a higher proportion of active commuters reported “almost always” avoiding alcohol, or limiting their drinks to one to two drinks per day for women and men, respectively (Figure 19). The same trend was observed when asked about avoiding using alcohol and other drugs as a way of handling stressful situations and problems in their lives (Figure 20). However, more non-active commuters reported almost always avoiding alcohol when contraindicated (while taking medications, or when pregnant) as compared to active commuters (Figure 21). Similarly, when asked about reading and following the label directions when using prescribed and over the counter drugs, a higher percentage of non-active commuters reported “almost always” as compared to active commuters (Figure 22).

In the emotional health category, more active commuters reported “almost always” when asked if they enjoy being a student, or if they have a job or other work that they enjoy (Figure 23). The same trend was observed when respondents were asked if they find it easy to relax and express their feelings freely (Figure 24), and if they have
Figure 19. Percentage of respondents who answered “almost always” to avoiding exceeding the recommended daily amount of alcohol. Active vs. non-active commuters.

Figure 20. Percentage of respondents who answered “almost always” to avoiding alcohol or other drugs as a way of handling stressful situations. Active vs. non-active commuters.
Figure 21. Percentage of respondents who answered “almost always” to being careful not to drink alcohol when contraindicated. Active vs. non-active commuters.

Figure 22. Percentage of respondents who answered “almost always” to reading and following the label directions when using prescribed and over the counter drugs. Active vs. non-active commuters.
Figure 23. Percentage of respondents who answered “almost always” when asked if they enjoy being a student, or if they had a job or other work that they enjoy. Active vs. non-active commuters.

Figure 24. Percentage of respondents who answered “almost always” when asked if they find it easy to relax and express their feelings freely. Active vs. non-active commuters.
close friends, relatives, or others to talk to about personal matters and to call upon for help when needed (Figure 25). Despite these trends, however, non-active commuters answered “almost always” at a higher rate when compared to active commuters when asked if they manage stress well (Figure 26), and if they participate in group activities (such as community or church organizations) or hobbies that they enjoy (Figure 27).

In regards to safety, a higher proportion of active commuters compared to non-active commuters answered “almost always” when asked if they read and follow the instructions on potentially harmful products or substances, such as household cleaners, poisons, and electrical appliances (Figure 28). However, more non-active commuters as compared to active commuters answered “almost always” when asked if they wear a safety belt while riding in a car (Figure 29), if they avoid driving while under the influence of alcohol or other drugs (Figure 30), if they obey the traffic rules and speed limit while driving (Figure 31), and if they avoid smoking in bed (Figure 32).

Figure 25. Percentage of respondent who answered “almost always” when asked if they had close friends, relatives, or others whom they can talk to about personal matters and call on for help when needed. Active vs. non-active commuters.
Figure 26. Percentage of respondents who answered “almost always” when asked if they manage stress well. Active vs. non-active commuters.

Figure 27. Percentage of respondents who answered “almost always” when asked if they participate in group activities (such as community or church organizations) or hobbies that they enjoy. Active vs. non-active commuters.
Figure 28. Percentage of respondents who answered “almost always” when asked if they read and follow the instructions on the labels of potentially harmful products or substances. Active vs. non-active commuters.

Figure 29. Percentage of respondents who answered “almost always” when asked if they wear a safety belt while riding in a car. Active vs. non-active commuters.
Figure 30. Percentage of respondents who answered “almost always” when asked if they avoid driving under the influence of alcohol or other drugs. Active vs. non-active commuters.

Figure 31. Percentage of respondents who answered “almost always” when asked if they obey traffic rules and the speed limit while driving. Active vs. non-active commuters.
Finally, in regards to disease prevention, a higher percentage of active commuters compared to non-active commuters answered “almost always” when asked if they practice monthly skin and breast/testicle self exams (Figure 33). Additionally, more active commuters answered “almost always” to the question which asked if they were not sexually active, or if they have sex with only one mutually faithful uninfected partner, or if they always engage in safer sex, and if they do not share needles to inject drugs (Figure 34). Contrary to these findings, however, more non-active commuters compared to active commuters reported “almost always” to knowing the warning signs of cancer, heart attack, and stroke (Figure 35), avoiding overexposure to the sun and using sunscreen (Figure 36), and getting recommended medical screening tests (Figure 37).
Figure 33. Percentage of respondents who answered “almost always” when asked if they practice monthly skin and breast/testicle self exams. Active vs. non-active commuters.

Figure 34. Percentage of respondents who answered “almost always” when asked if they are not sexually active, or if they practice safe sex and abstain from sharing needles to inject drugs. Active vs. non-active commuters.
Figure 35. Percentage of respondents who answered “almost always” when asked if they know the warning signs of cancer, heart attack, and stroke. Active vs. non-active commuters.

Figure 36. Percentage of respondents who answered “almost always” when asked if they avoid overexposure to the sun, and use sunscreen. Active vs. non-active commuters.
Figure 37. Percentage of respondents who answered “almost always” when asked if they get recommended medical screening tests. Active vs. non-active commuters.
CHAPTER V

DISCUSSION

The purpose of this study was to investigate the relationship between active commuting and education level. A secondary purpose of this study was to investigate the relationship between commuting style and lifestyle. We hypothesized that people who had earned graduate and professional degrees would report active commuting at a different rate as compared to people who had earned undergraduate degrees.

There was an observed significant difference between active commuting and education level ($p = 0.035$). Furthermore, this difference was also observed in males ($p = 0.012$). In both groups, the difference revealed a higher rate of active commuting among those who had earned graduate and postgraduate degrees as compared to those who had earned undergraduate degrees only. The same trend was observed in female respondents, however, no significant association was observed.

A significant difference (higher) was observed between those that said they currently participate in active commuting and those that would commute actively under ideal circumstances. This difference was observed among males ($p = 0.0008$), and females ($p < 0.0001$).

In an attempt to explain why there was no significant difference observed between active commuting and education level in female respondents, selected lifestyle evaluation questions having something to do with physical appearance (# 7, 10, and 33)
were selected and analyzed for trends and statistical differences. Our hypothesis was that females might be more concerned about their physical appearance, and given that active commuting might interfere with personal appearance, women might be less likely to commute actively. After data analysis, a trend towards being more concerned about physical appearance was observed in questions 7, 10, and 33, when comparing females to males. Specifically, a higher proportion of women responded “almost always” to these questions, when compared to men. The trend was observed in all three comparisons, except in question # 7 when comparing males and females who had earned graduate and postgraduate degrees, where the opposite trend was observed.

No significant differences were observed between active and non-active commuters in regards to lifestyle. However, proportional data revealed certain lifestyle trends among active and non-active commuters.

In the exercise and fitness category, a higher rate of active commuters reported “almost always” to engaging in regular moderate aerobic type exercise and muscular strength and endurance training, while a higher rate of non-active commuters answered “almost always” to participating in leisure time physical activity, and maintaining a healthy body weight.

In regards to nutrition, a higher rate of non-active commuters answered “almost always” to eating a variety of foods each day including seven or more servings of fruits and vegetables, limiting the amount of total, saturated, and trans fat in their diets, avoiding skipping meals, and limiting the amount of salt and sugar that they eat.

Interestingly, in the tobacco use section, a higher percentage of active commuters reported that they “almost always” avoid using tobacco, while a higher
percentage of non-active commuters reported that they did not use, or no longer use tobacco.

In the alcohol and drug use section, a higher proportion of active commuters reported “almost always” to avoiding alcohol, or limiting their alcohol intake to one to two drinks per day. The same trend was observed when respondents were asked if they avoided using alcohol and drugs as a way of handling stressful situations and problems in their lives. However, a higher proportion of non-active commuters reported “almost always” to avoiding alcohol when contraindicated, and to reading and following the label directions when using prescribed and over the counter drugs.

In regards to emotional health, a higher percentage of active commuters reported “almost always” when asked if they enjoyed being a student, or if they have a job or do other work that they enjoy. The same trend was seen when respondents were asked if they find it easy to relax and express their feelings freely, and if they have close friends, relatives, or others to talk to about personal matters and to call upon for help when needed. However, a higher percentage of non-active commuters answered “almost always” when asked if they manage stress well, and when asked if they participate in group activities or hobbies that they enjoy.

In regards to safety, a higher percentage of active commuters answered “almost always” when asked if they read and follow the instructions on potentially harmful products or substances. However, more non-active commuters answered “almost always” when asked if they wear a safety belt while riding in a car, if they avoid driving while under the influence of alcohol or drugs, if they obey the traffic rules and speed limit while driving, and if they avoid smoking in bed.
In regards to disease prevention, more active commuters answered “almost always” when asked if they practice monthly skin and breast/testicle self-exams. The same trend was observed in among respondents when asked if they were not sexually active, or if they have sex with only one mutually faithful uninfected partner, or if they always engage in safe sex, and if they do not share needles to inject drugs. Despite these findings however, a higher percentage of non-active commuters reported “almost always” to knowing the warning signs of cancer, heart attack, and stroke, to avoiding overexposure to the sun and using sunscreen, and to getting recommended medical screening tests.

This study has produced several results. The relationship between active commuting and education level was examined, and furthermore, this relationship was investigated among men and women. An attempt to explain why women might be less likely to participate in active commuting was performed. An assessment of the prevalence of active commuting among college graduates was carried out, with an attempt to control for confounding variables that might prevent people from participating in active commuting. Finally, the relationship between commuting style and lifestyle was examined.

In regards to active commuting and education level, the results of this study concur with findings from previous studies which have demonstrated a positive association between higher education level, and an increased prevalence of active commuting (Agrawal, & Schimek, 2007; Boone-Heinonen et al., 2009; Gordon-Larsen et al., 2009; Kruger et al., 2008). However, the results of this study conflict with studies
that have demonstrated the opposite trend (Bauman et al., 2011; Bopp et al., 2012; Kwasniewska et al., 2010b; Merom et al., 2008).

The attempt to explain why no significant difference was observed in commuting style between women with and without graduate degrees gives us a window into the determinants of commuting activity and how physical appearance might affect a person’s decision to commute actively. To the best of my knowledge, this was the first study that has attempted to explain this discrepancy with this hypothesis. However, it has been suggested that esthetics might be a possible influence on commuting style (Craig, Brownson, Cragg, & Dunn, 2002 as cited in Bopp et al., 2012). There are many determinants and correlates of commuting activity, and given our results, concerns about physical appearance should be one influence that should be investigated more thoroughly.

The attempt to control for confounding variables in this study has demonstrated promising results. Question # 2, asked, “Under ideal circumstances, do you think that you will commute to work or school by walking or riding a bicycle in the future? (Including weather, climate, geographical landscape, safety, and proximity to work).” An observed significant difference (higher) was demonstrated between rates of respondents who answered yes to question # 2 when compared to rates of respondents who answered yes to question # 1, which asked, “Do you currently commute to work or school by walking or riding a bicycle?” The significant difference was observed among males and females. Given these findings, it seems as if variables such as weather, climate, geographical landscape, safety, and proximity to work, in addition to other variables, play a significant role in the decision to commute actively or non actively. This is not a new concept, however, but these data do help us to better understand the significance of these
types of variables and their role in the decision making process to commute by means of active or non active transportation.

The lifestyle evaluation used in this study has demonstrated mixed results throughout. However, specific trends among data between active and non-active commuters are worthy of discussion. Lifestyle evaluation data from the exercise and fitness category, the nutrition category, and the tobacco use category deserve particular attention.

Data from the exercise and fitness category of the lifestyle evaluation revealed a higher percentage of active commuters reporting “almost always” to engaging in regular moderate aerobic type exercise, and regular muscular strength and endurance training as compared to non-active commuters. These data, although not significant, are similar to findings reported elsewhere, which have suggested an association between active commuting and participation in other bouts of physical activity (Roth et al., 2012). Contrary to these findings, however, are additional data from the lifestyle evaluation revealed a higher percentage of non-active commuters reporting “almost always” to participating in leisure-time physical activity, when compared to active commuters. The same trend was observed among active and non-active commuters when asked if they maintain a healthy bodyweight, which conflicts with findings from scholarly articles that suggest an association between active commuting and reduced levels of overweight, and obesity (Lindstrom, 2007; Wen et al., 2006; Wen, & Rissel, 2008).

Data from the nutrition category of the lifestyle evaluation are also of particular importance. In our study, data revealed that a higher percentage of non-active commuters participated in healthy nutrition practices as compared to active commuters.
Specifically, a higher proportion of non-active commuters answered almost always to all of the questions regarding nutritional practices as compared to non-active commuters. Non-active commuters reported that they “almost always” eat a variety of foods each day including 7 or more servings of fruits and/or vegetables, that they limit the amount of total fat, saturated fat, and trans fat in their diets, that they avoid skipping meals, and that they limit the amount of salt and sugar that they eat at a higher rate than active commuters did. These results conflict with data from Landsberg et al. (2008) which demonstrated no difference in “dietary patterns” between active and non-active commuting children and adolescents. Although there are differences in this study population and the population studied by Landsberg and colleagues, the opposing trends in these data comparing commuting style and nutrition suggest that future research into the area of nutritional practices and commuting style should be investigated.

Data from the tobacco section of the lifestyle evaluation revealed that a higher proportion of active commuters reported “almost always” to avoiding using tobacco as compared to non-active commuters, but a higher proportion of non-active commuters reported that they never or no longer use tobacco when compared to active commuters. Gordon-Larsen et al. (2009) found that a higher percentage of active commuters reported that they never smoked, and moreover, a higher percentage of non-active commuters reported being current smokers when compared to active commuters (Gordon-Larsen et al., 2009). Although these results were not significant, a trend was apparent. Landsberg et al. (2008) found that active commuters were significantly less likely to smoke. However, the difference in the demographics of the study population in this study and the population studied by Landsberg et al. (2008) are likely to demonstrate mixed results. In
regards to tobacco use, the results from this study are somewhat conflicting in themselves and compared to other studies. Therefore, the topic of commuting style and nutrition deserves further investigation.

This study was limited in the following areas. First, this study was limited to University Alumni who studied at a rural residential type campus. The traditional university environment is conducive to active commuting and furthermore Chico, California is a community that encourages walking and bicycling for transportation. Second, this study was limited in the sense that the majority of respondents were living in the United States at the time of response. Third, the age of the participant was not controlled for. Although we attempted to control for variables such as weather, climate, safety, geographical landscape, and proximity to work, our control question was general and broad. These limitations deserve further consideration.

Future research should investigate the association between active commuting and education level in Alumni from other universities. Commuter type campuses in which the students commute to school primarily by automobile should be included in these future investigations, as well as other residential type campuses. Additionally, research in countries outside of the United States should be done as well. Future research should also investigate the gender discrepancy in commuting style. Given the results of our studies and the results of previous studies demonstrating such a discrepancy, further investigation is justifiable. Qualitative research such as open-ended interviews investigating variables that influence commuting activity and lifestyle would provide a great wealth of information to contribute to the scientific literature on the relationship between active commuting, lifestyle, and education.
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