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Examining Correlations with Frequency of Walking Trips In Metropolitan Areas

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EXAMINING CORRELATIONS WITH FREQUENCY OF WALKING TRIPS IN METROPOLITAN AREAS

by

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ABSTRACT

Examining Correlations With Frequency Of Walking Trips In Metropolitan Areas

This research assessed correlations between funding for pedestrian facilities, presence of walkways, and daily and weekly walking trips in a sample of United States residents living in metropolitan areas. The purpose of the research was to identify factors at the policy and environmental level which are associated with a greater frequency of walking trips, and therefore may influence physical activity levels. Data from the U.S. Federal Highway Administration's 2001 National Household Travel Survey and the Thunderhead Alliance's 2007 Benchmarking Report: Bicycling and Walking in the U.S. were combined to provide variables for the number of daily and weekly walking trips, perceived lack of walkways, age, distance to work, housing unit density for each household, household income, and per capita federal and non-federal funding for pedestrian facilities for each metropolitan area. Correlation analysis and analysis of variance was conducted to test for associations with walking trip frequency and lack of walkways. The results suggested that increased walking trips were associated with increased non-federal funding but not with increased federal funding; and that increased federal funding was associated with reduced lack of walkways (but not increased non-federal funding), especially for lower-income respondents. These associations were statistically significant but not strong. Very little research has been conducted on the health effects of funding for pedestrian facilities; this research showed that more extensive study in this area is needed and that further integration of public health into transportation planning is in order.

Keywords: physical activity, pedestrian, policy, transportation, built environment, urban

This document is dedicated to

my mother, F. Elaine Jarman,

and my father, Allan H. Marcus

for always believing in me.

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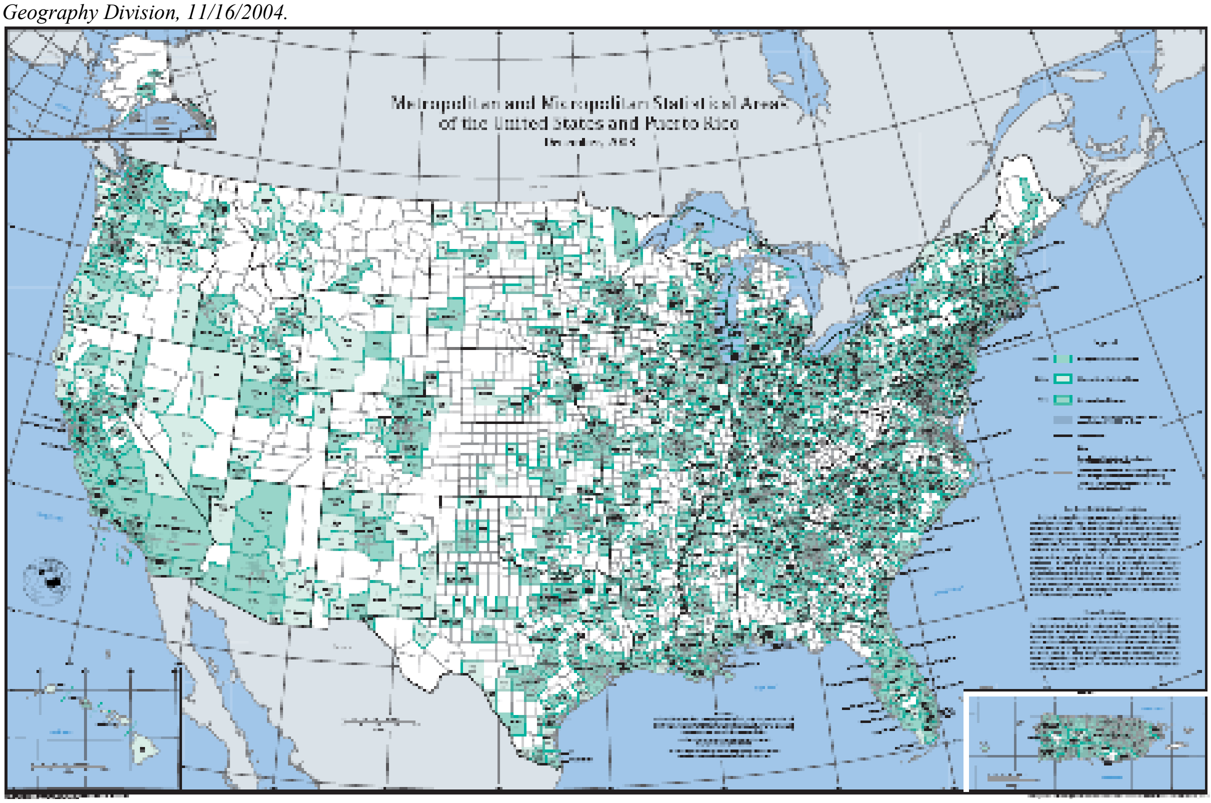
DEFINITIONS

Metropolitan Statistical Areas (MSAs): MSAs are geographical entities described by the U.S. Office of Management and Budget. They are defined as a core area of at least 50,000 residents plus surrounding areas (typically counties or parts of counties) that are highly integrated with the core area. Integration is defined by the percentage of residents that commute to the core area for work. The 2000 decennial national census and the American Community Surveys contribute the population and commuting figures used to compute MSA qualification. There are also Micropolitan Statistical Areas, which have a core area with a population under 10,000, and Combined Statistical Areas, which describe two or more integrated Metropolitan or Micropolitan Statistical Area. It is worth noting that MSA codes were changed in 2008.

Figure 1: Map of the Metropolitan and Micropolitan Statistical Areas of the U.S. as of 12/6/2003.
Image credit U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau; prepared by the Geography Division, 11/16/2004.



Walking: Excluding infants and individuals with disabilities or similar limitations, humans universally engage in walking on a daily basis. However, the type and extent can vary widely. Many researchers categorize walking as 'utilitarian walking' and 'recreational walking'. Recreational walking is done intentionally for pleasure or exercise when it is not otherwise necessary to walk. Utilitarian walking is all the walking done for the sake of moving from one place to another for some primary purpose, and it includes walking for transportation. Both types of walking may occur indoors or outdoors. In some cases the purpose of walking may be both recreational and utilitarian.

Walkways: Walkways refer to any paved linear path intended for general pedestrian use. It is the most comprehensive term and includes sidewalks provided along a roadway, walking trails or pathways that diverge from the roadway to pass through a natural area or between buildings, paths across a campus or complex, plazas that provide a connection between routes, pedestrian bridges and underpasses, and even some multiple-use paths that also allow for bicycles or horses. However, it does not include unpaved pathways, roadway shoulders, courtyards, or paved paths on private individual property such as the front walk of a single family home. Walkways compose one component of pedestrian infrastructure.

Pedestrian Infrastructure, or Pedestrian Facilities: All permanent or semi-permanent provisions for pedestrian travel, including walkways but also crosswalks, pedestrian traffic signals, curb ramps, streetscape components such as planting zones and aesthetic features, pedestrian bridges or underpasses, and lighting. Pedestrian infrastructure has been described in the literature as "the built and planted features that provide pedestrian amenities or that affect pedestrian mobility, safety, interest and comfort" (Forsyth et al. 2008, p. 1977).

Density: Density, in relation to urban form, describes the ratio of usage to area. It may refer, for example, to dwelling units per acre, persons per square mile, or retail businesses per square mile. As discussed in Chapter II, density has been found to have a strong correlation with travel patterns. As density increases, the number of potential destinations –i.e. homes or stores – to which an individual can walk in a short period of time also increases.

Connectivity: Connectivity, in relation to urban form, describes the ratio of transportation linkages to area. As applied to street layout, it commonly refers to the number of intersections per square mile. Regarding pedestrian travel, the street layout plus any trails or footpaths may be used to measure connectivity. As connectivity increases, the amount of time required to travel between two points, by any private travel mode, decreases.

Mode Share or Modal Split: These terms refer to the relative proportion of travel modes (such as bicycling, walking, or driving) utilized during a defined period of time, such as a day, hour, or year. A modal split that is highly skewed rather than balanced can result in further skewing due to inefficiencies.

Trip: Travel that has an origin and a destination, even if the destination is the same as the origin, or if the destination is not the final destination. However, use of multiple travel modes may occur during a single trip.

CHAPTER I: INTRODUCTION

BACKGROUND

The expression "Healthy People in Healthy Places" exemplifies the efforts of the public health discipline. The overriding goal is to create healthy environments which provide a setting for the population to engage in a high incidence of healthy behaviors. Individuals with higher levels of physical activity consistently have better health indicators and reduced morbidity and mortality, which means that facilitating physical activity is an important public health goal. Physical activity helps prevent obesity, cardiovascular disease, depression and mood disorders, joint and bone disorders, sleep disorders, and some cancers (*Chronic Disease - Nutrition and Physical Activity - At A Glance* n.d.). Even for those who have an elevated Body Mass Index (BMI), regular moderate physical activity improves health and reduces mortality.

However, public health initiatives have not resulted in a physically active population. Rather, physical inactivity has become a serious public health crisis in the United States of America (U.S.) and seems to be getting worse. The U.S. Centers for Disease Control and Prevention (CDC) has issued a recommendation for adults to get at least 30 minutes of moderate physical activity five days a week (*Physical Activity for Everyone: How much exercise do I need? | DNPAO | CDC* n.d.). Since 1985, the CDC's Behavioral Risk Factor Surveillance System (BRFSS) has tracked changes in physical activity and BMI for the U.S. In that time, physical activity has continuously declined and the obesity rate has nearly tripled in most states. Obesity now affects approximately 30% of the population. Obesity and overweight contribute to as much as 20% of all US deaths each year. The Healthy People 2010 report identified that only 15% of the US population met the CDC's recommendations for 30 minutes of moderate physical activity five times weekly prior to the year 2000. The goal is to increase that to 30% by 2010 (U.S. Department of Health and Human Services - Office of Disease Prevention and Health Promotion 2000).

Walking or bicycling, either for exercise or transportation, provides moderate physical activity and is linked to improved health. Additionally, these forms of activity are very affordable and easily adopted, even by individuals with poor health (Frank and Engelke 2001). However, Americans do not walk or bicycle frequently, and this is an important factor in physical activity levels. Walking and bicycling appear to be influenced by behavioral and environmental factors. Physical activity patterns may be changed by changing the built environment, (Frumkin 2003; Jackson and Kochtitzky 2001). Community design that is supportive of alternative methods of transportation (such as walking and bicycling) and recreational opportunities is linked to increased physical activity. The Task Force on Community Preventive Services has concluded that "Creation of or enhanced access to places for physical activity combined with informational outreach activities", "Street-scale urban design and land use policies and practices", and "Community-scale urban design and land use policies and practices" are effective approaches to increasing physical activity (*The Community Guide - Physical Activity* n.d.). This suggests that large-scale urban policy changes may be more effective at increasing moderate physical activity levels than classic health education programs, but further research, such as conducted here, is necessary to guide the changes.

Existing pedestrian conditions have been assessed, both objectively and subjectively, in dozens of studies. From these studies, it appears that pedestrian infrastructure, land use, and other factors that affect walking conditions (such as traffic volume) can vary widely throughout the U.S. This provides a natural opportunity to examine how the availability of pedestrian facilities impacts walking behavior on a broad scale, and to try to connect the availability of pedestrian infrastructure to policies of the local jurisdiction (i.e. the city, county, or metropolitan planning organization) such as funding, maintenance, and installation practices. There has been minimal research at the policy level to date, so the process may begin with gathering evidence and developing ways to evaluate, measure, and compare aspects of policy and funding.

Purpose of the Research

To move from generalities into specific policy recommendations to improve public health, researchers need to investigate not only the aspects of urban design that correspond with sufficient physical activity, but also to discover what causes the physical environment to take on particular attributes. While environmental supports for walking are clearly important, there is little widespread data regarding the existing pedestrian environment, and even less information about how policy impacts the pedestrian environment. Without this data, public health professionals are hesitant to recommend policy changes that could improve the pedestrian environment. What are the regional policies, funding priorities, or initiatives that result in a community which can be traveled conveniently and comfortably on foot? Where can public health professionals intervene to create a more healthful environment, and what evidence do they have for doing so?

What factors are associated with higher frequency of walking trips? This study looks specifically at presence of sidewalks and at funding for pedestrian facilities for their relationship with frequency of walking trips. The study is limited by the use of secondary data which may not be precisely suited to this investigation. For instance, additional information about other aspects of the pedestrian environment or about socioeconomic status or health status may be relevant, but is not available. The way survey questions were phrased could not be tested for validity relative to the information sought, or changed if they did not test well. Also, funding data combines bicycle and pedestrian funding and does not provide further detail regarding funding use. Nonetheless, the large number of cases and the availability of key pieces of data which have not been rigorously analyzed to date provides an opportunity to look for evidence of the relationship between transportation policies and walking frequency. Therefore, it should be of interest to public health researchers.

RESEARCH QUESTION

Drawing from prior research and behavioral theory, as detailed in the following section, walking trips may be influenced by availability of walkways and other pedestrian facilities. Pedestrian facilities, in turn, may be affected by national and local investment, or funding levels. This concept can be explored using data on frequency of walking, presence or lack of walkways, funding for pedestrian projects, and some potential confounders – age, income, distance to work, and housing density. Age, income, and distance to work are expected to have a negative association with walking trips, while density is expected to have a positive relationship.

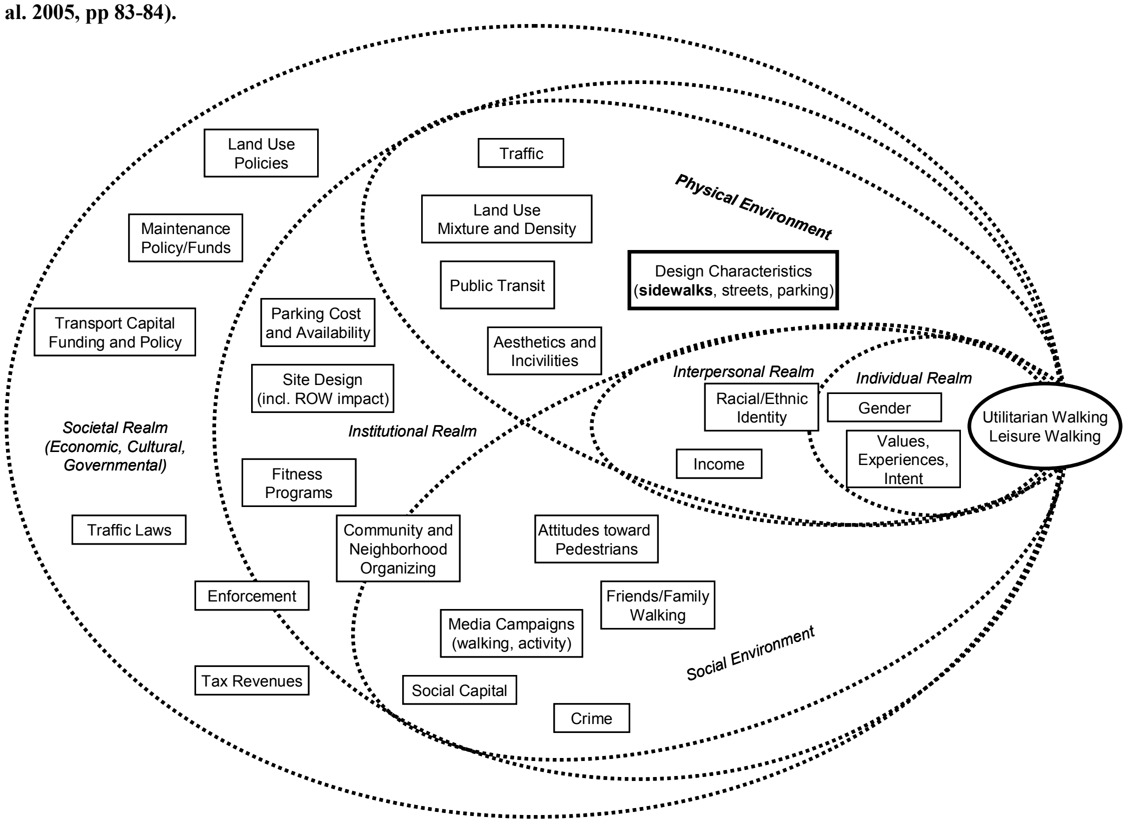
In order to enhance understanding of these issues, this research proposes to analyze the correlations between funding for pedestrian and bicycle facilities, lack of perceived walkway coverage, and the frequency of walking trips. Under the null hypothesis, there would be no correlation between pedestrian funding, pedestrian facilities, and walking trips. The alternative hypothesis, to be explored here, is that more per capita funding (Federal funding levels or total funding levels that include local contributions, by metropolitan statistical area) will reduce problems related to lack of walkways, and that the greater availability or continuity of these (and other) pedestrian facilities will increase the number of walking trips per person. Since walkways are just one of the pedestrian facilities that may be supported with pedestrian and bicycle funding, the analysis will look for positive associations between funding and walkways, walkways and walking trips, and directly between funding and walking trips. The unit of measurement will be individuals and entire metropolitan statistical areas (MSAs).

CHAPTER II: REVIEW OF THE LITERATURE

ENVIRONMENTAL DETERMINANTS OF BEHAVIOR

Local environmental factors have repeatedly been shown to have a strong correlation with the behaviors of individuals who live, work, or travel in that location (Hoehner et al. 2005; Li et al. 2008; Moudon and Lee 2003; Pikora et al. 2006; Saelens and Handy 2008). Badland and Schofield (2005) reviewed several dozen published studies which associate aspects of the environment with regular physical activity. Aspects of the environment are thought to act on perceived comfort and safety of walking, social norms relating to walking, and the sheer feasibility and reasonableness of attempting to walk out-of-doors in the public right-of-way. Figure 2 represents the Social Ecological Model theory of behavior for walking.

Figure 2: Social Ecological Model theory of behavior for walking, adapted from (Pikora et al. 2003, p 1694) and (Koplan et al. 2005, pp 83-84).



HISTORY OF THE LITERATURE

In 1998, Sallis, Bauman, and Pratt described the need to incorporate accepted health promotion principles to physical activity-oriented programs, and employed the ecological model of health behavior in order to describe the many determinants of physical activity levels (Sallis, Bauman, and Pratt 1998). This led them to conclude that environmental and policy considerations must be addressed as determinants of physical activity. In 1999, Finnegan, Viswanath, and Hertog noted that campaigns aimed at individual-level changes were being replaced with interventions that included environmental-level changes (Finnegan, Viswanath, and Hertog 1999). By 2002, Humpel, Owen, and Leslie identified 33 studies on the subject, although only four connected objectively-measured environmental variables to resulting levels of physical activity (Humpel, Owen, and Leslie 2002). However, their literature search was conducted entirely on medical and health literature databases, and failed to identify relevant materials which had been published in journals which focused on urban planning or engineering.

In an exploratory article by Frank (2000), the proposal that land use could impact individual behavior at all was still highly contested. In that article, Frank also noted that health promotion had begun to focus on active living rather than intentional exercise, and that the Centers for Disease Control and Prevention (CDC) had embraced this concept. In 2001, Frank and Engelke noted that urban planning was still oriented toward the movement of cars, and included health research in an article written for a planning-oriented journal (Frank and Engelke 2001). In the years following, research into urban design has expanded to focus not only on accommodating non-motorized travel, but also on factors that can modify human behavior, such as travel choice, housing choice, and crime, in order to improve health and quality of life. Unfortunately, due to the scale and complexity of built environments and their relationship to physical activity, this evidence may not be available or fully understood for years, even decades.

RELATIONSHIP OF PEDESTRIAN TRAVEL TO PEDESTRIAN INFRASTRUCTURE

Age and walking

Age is part of the individual realm of the Social Ecological Model of walking. Ross (2000) noted a significant correlation between age and walking, in that increasing age decreased the likelihood of walking. As discussed, there is a multi-faceted combination of attributes that seem to impact walking likelihood; for older adults, perceptions of personal safety (including physical incivilities such as graffiti and trash), weather, and traffic safety are given more weight. In youth, distance and safety appear to be governing factors for younger children (Seagle, Moore, and DuBose 2008; Kerr et al. 2006; McDonald 2008).

Household income and walking

Research has suggested that lower economic status is associated with less recreational walking but more utilitarian walking, while the highest income levels are frequently associated with more recreational walking and less utilitarian walking. This aspect would fall into the individual realm of the Social Ecological Model of walking, and to some extent the social environment realm. Miles et al. (2008) evaluated two neighborhoods with a large percentage of African-American residents but different average socio-economic levels, and found that there was considerably more walking for transport in the lower-income neighborhood even though these residents reported less safe or pleasant walking conditions. The higher-income neighborhood had somewhat higher levels of walking for recreation, although neither neighborhood was exhibiting the recommended levels of physical activity.

Ross (2000) found a weak positive association (.057, $p < 0.10$) of walking with education level, but no significant association with income. Zhu and Lee (2008) analyzed sidewalk completeness around elementary schools using GIS; they found that a higher proportion of student poverty was positively associated with more complete sidewalk coverage near the school (standardized beta coefficient = 0.344, $p < 0.01$), although this relationship was mediated by the proportion of Hispanic students. After considering other factors thought to impact walkability, such as traffic volume, connectivity, and amenities like shade trees, the researchers concluded that the street environment was worse for walking in high poverty areas which are home to lower-income households. However they did not provide a reason for this disparity (Zhu and Lee 2008). Moudon et al. (2007) reported an association between household income and walking. Cerin and Leslie (2008) found a positive association between household income over $77,999 and recreational walking, and also noted that subjects this income bracket were less likely to report physical barriers to walking (which includes lack of walkways). Kelly et al. (2007) found that medium and high neighborhood poverty rates were more strongly associated with sidewalk obstructions and unevenness as compared to low poverty rate neighborhoods; while they did assess the presence of a sidewalk or not, this data was not presented.

Population density, household density, and walking

Walking trips generally appear to increase as density increases. This aspect would fall into the physical environment designation of the Social Ecological Model of walking, and somewhat into the social environment as well since greater concentration of households relates to a more intense social setting. Cerin et al. (2006) gave residential density a factor of 0.80 out of 1 relative to walking for transport at the block group level for their Neighborhood Environment Walkability Scale (NEWS). Chatman (2008) found a correlation of non-work walking or cycling trips with population density (termed ‘network load density’ in his research) and with presence of sidewalks. Cervero (1996) detected a strong correlation between residential density and walking/bicycling, with number of household automobiles affecting the curve, and reported that transit use and residential density had a similar relationship (elsewhere, Besser and Dannenberg (2005) determined that transit use increases daily walking). Moudon et al. (2007) also found an association between density (by parcel) and walking.

Distance to work and walking

This aspect would fall into the physical environment designation of the Social Ecological Model of walking. In theory, it should reduce walking trips. Badland, Schofield, and Garrett (2008) found an inverse correlation between distance to work and physical activity level. No other studies could be located that specifically addressed distance and travel mode. Distance to work could be considered a particular manifestation of total (residential and business) density and land use.

Walkway presence and walking

Evaluating the relationship between walkway presence and walking behavior requires the accurate measurement of walkways and walking behavior, as well as some link indicating that users actually perceive the walkways as being present and usable. Walkway presence can be assessed as an objective measure relative to condition or coverage, and there are a number of audit tools which measure one or both. There are also several reviews or meta-analyses that compare multiple audit tools. Walkway presence may also measured subjectively through a survey of perceived condition or presence. Walkways appear to be positively correlated with walking, although the correlation is much stronger if other aspects of pedestrian infrastructure are present and in good condition as well. This aspect would fall into the physical environment designation of the Social Ecological Model of behavior for walking.

Reviews and Meta-Analyses

Alfonzo (2005) reviewed twenty published studies and identified "feasibility" (whether it is possible to walk in a given place or route) as the most important pedestrian need, and "accessibility" (the ease of walking there) as second most important, based on results of her review. Moudon and Lee (2003) evaluated 31 instruments designed to audit the pedestrian and bicycle environment, of which 20 included a pedestrian component; walkway presence and condition was a variable of interest but was not assessed for any association with pedestrian behavior. Clifton, Livi Smith, and Rodriguez (2007) assessed seven different pedestrian audit instruments. All seven included sidewalk presence as a factor; however, the Clifton team did not find these instruments satisfactory and created the Pedestrian Environment Data Scan (PEDS). This instrument tests for sidewalk presence; sidewalk presence scored well in inter-rater agreement, suggested that the method of measurement in the PEDS tool is reasonably accurate.

Audits

Pikora et al. (2006) used an audit instrument and a survey to determine that suitable walkways increased the likelihood of walking for recreation or transport, although other aspects – such as traffic safety and aesthetics – ranked more highly. In developing this instrument, Pikora and colleagues used a three-round Delphi study (an iterative process in which subject matter experts are repeatedly surveyed to build consensus on a particular topic) which identified the type and continuity of walking path as key components of the functional walking environment that can impact walking behaviors (impact factor 25% of the functional factor for recreational walking and 26% for transport walking) (Pikora et al. 2003).

In a different audit instrument, Cerin et al. (2006) rated the presence of sidewalks with a factor load of 0.61 out of 1 relative to individual behavior, and 0.70 at the block group level. They also rated sidewalk maintenance highly – 0.63 – at the individual level. Tan et al. (2007) created a pedestrian "level of service" (LOS) measure similar to that used for motor vehicle traffic, and applied it to pedestrian scenarios in Nanjing, China; they discovered that locations without a sidewalk received the worst ranking. They noted that women tended to give fewer sidewalks the best rating, and were more likely to assign the worst two rating levels. The "Quality of path" measure was found to have .304 bivariate correlation and .191 partial correlation at a significant level with walking (Tan et al. 2007). Cervero (2002) found that the ratio of sidewalk miles to road miles, at both trip origin and destination, had a significant ability to reduce drive-alone trips. Forsyth, Hearst et al. (2008) found significant correlation of sidewalk length (relative to area and to road length) with transport walking and with total walking, based on diary or survey results. They presented significant, positive correlates of sidewalk length per unit area to walking for transport as measured by survey (Pearson's 0.4866) and by travel diary (Pearson's 0.6224), and of sidewalk length divided by road length to walking for transport as measured by survey (Pearson's 0.5282) and by travel diary (Pearson's 0.5945), but a negative correlation between sidewalk length divided by road length and leisure walking (Pearson's –0.3318) (Forsyth et al. 2008).

Condition

Walkway presence is not purely a function of whether a paved surface has ever been constructed for pedestrians at a certain place. The facility must continue to function as a usable route, which requires some reasonable degree of construction quality, continuity, and maintenance (including repairs and routine removal of debris) (Ayres and Kelkar 2006; Cerin et al. 2006; Clifton, Livi Smith, and Rodriguez 2007; Pikora et al. 2003; Booth, Pinkston, and Poston 2005; Lee and Moudon 2006; Michael, Green, and Farquhar 2006; Pikora et al. 2006).

Perception

In order for the presence of walkways to influence walking behavior, current and potential users must perceive that the walkway is present and usable. Some researchers have investigated the correspondence between perceived and objective sidewalk attributes. Leslie et al. (2005) found good reliability (76%) of pedestrian infrastructure perception among neighbors. Several researchers have noted that perceived sidewalk presence and usability is correlated with walking behaviors (Frank et al. 2007; Jago, Baranowski, and Baranowski 2006; Moudon et al. 2007). Craig et al. (2002) presented a positive correlation between walking to work and survey respondents' perceptions of the walking routes, system, and pedestrian facilities available to them.

PEDESTRIAN INFRASTRUCTURE FUNDING

Much of the published research relating to built environment and walkability invokes the social ecological model as their theoretical basis, and may make brief allusion to the role that economic and political influences play in creating the physical environment of cities. However, only one item was found in the peer-reviewed literature that explicitly discusses the role of governmental funding for pedestrian facilities. Brennan Ramirez et al. (2006) clearly incorporate both a "Macro Policy Level" (which refers to regulations and legislation at the federal and state setting) and a "Political and Economic" level (which lists "Availability of local government and highway funds for sidewalks and bike lanes") in their theoretical framework (Brennan Ramirez et al. 2006, page 517). Using a Delphi process to create an importance-changeability matrix, this study ascertained that policies, ordinances, and funding that impacted pedestrian facilities ranked in the highest tertile of importance (that is, they have the largest impact on health) and in the third highest of twelve ranks of changeability. This means that these items ought to be a major focus of research and intervention development.

From sources outside of the peer-reviewed journals, a report published on behalf of the National Center for Bicycling and Walking, an advocacy group, noted that federal funding for pedestrian projects is underreported, due to many construction items which are lumped into larger roadway projects, and under-allocated, due to conflicts from local agencies and competing projects (Cerreño and Nguyen-Novotny 2006). Additionally, the Thunderhead Alliance, a national not-for-profit bicycle and pedestrian advocacy organization, surveyed officials and local advocates regarding funding and policies that targeted bicycle and pedestrian facilities and programs in U.S. states and cities. The results of their research are utilized in this work and described in further detail in the section on the 2007 Benchmarking Report: Bicycling and Walking in the U.S. Their report compares funding and policy levels by metropolitan statistical area, and looks at factors that influence walking trips, but does not compare the two directly. Funding is placed in the societal (economic, political, and legal) realm of the Social Ecological Model of walking.

RELATIONSHIP OF WALKING WITH PHYSICAL ACTIVITY AND HEALTH OUTCOMES

The 1996 Surgeon General's report on physical activity and health concluded that moderate physical activity can reduce substantially the risk of developing or dying from heart disease, diabetes, colon cancer, and high blood pressure (U.S. Department of Health and Human Services 1996). Addy et al. (2004) also concluded that access to sidewalks, and good lighting, was related to increased physical activity. Frank et al. (2007) concluded that living in the most walkable neighborhoods and walking more frequently were associated with reduced body mass index (BMI), a measure of overweight or obesity.

MEASUREMENT

Ultimately, reliable results in this area depend on accurate measurement of walking habits and accurate measurement of the physical environment. To this end, numerous tools and methods have been developed. In order to measure walking, the researcher may use a survey, diary, pedometer, accelerometer, or direct observation. However, these studies must take place in their natural setting – the subject's residence and daily routine. This makes direct observation implausible and other measurement instruments only as good as the subject's recall ability or adherence to study protocol, and inaccurate data may lead to misleading study results.

For instance, Forsyth, Hearst et al. (2008) used three different tools – an accelerometer, a survey instrument, and a travel diary – and obtained different results for the same research sample over the same period. Self-reported trip information is particularly problematic. For one, nearly every trip involves some walking, even if the majority of the distance traveled in that trip was by a different mode (such as walking from a parking lot to the office or store, walking from a house to a transit stop, and so forth), even if the walking segment constituted a measurable amount of distance or time. However, those trips are typically classified by the mode that provided the greatest distance of travel – car or transit in the cases mentioned. Therefore, some walking will be omitted. The other problem in quantifying walking is for very short trips, especially if trip-chaining (making several stops on the way to an ultimate destination) is involved.

Likewise, there are multiple ways to evaluate sidewalks. A physical audit, aerial photography, acquisition of GIS package containing sidewalk data, or questionnaire administered to subjects are the most common methods. There is also more than one way to quantify sidewalks, including total length or length in ratio to total area or to roadway measurements. Few of the audit tools that have been developed and tested, such as NEWS, SPACES, and PEDS (all described previously), have actually quantified sidewalk coverage. However, there are some innovative techniques which may be useful in future sidewalk measurements.

Chin et al. (2008) compared street networks with pedestrian networks in Perth, Australia. The street network referred to the system of streets which served all forms of traffic. Pedestrian networks included sidewalks, which follow the street network, and footpaths, which diverge from the street network and often serve to connect streets that do not have a vehicular connection. To calculate the pedestrian network, they used high-resolution aerial photography. The research was conducted in four neighborhoods which represented two different types of neighborhood design (traditional/walkable and conventional suburban). Overall, the conventional neighborhoods had lower connectivity ratings than the traditional ones. Including the pedestrian networks – both sidewalks and footpaths – into connectivity ratings typically improved the rating. It had a larger effect in the conventional neighborhoods, and showed a larger effect using the pedshed and pedestrian route directness measurements.

Mediating Factors in Walkability

One thing that is clear from the literature is that sidewalks alone are not enough to determine walking. The strongest correlations with walking tendencies belong to mixed land use (the proximity or intermingling of residential units with office and commercial uses), density (residential or all uses), and connectivity of street networks (short blocks and few dead-end or cul-de-sac streets). Cervero and Kockelman (1997) originally described these as the “3Ds: Density, Diversity, and Design.” However, they included pedestrian infrastructure in the design component, and they generated a model for determining walking propensity as a function of several household variables (income, vehicle ownership, employment, number of children in household, and drivers license) and several built environment characteristics (distance to destination, non-residential parking distribution, intensity (an alternate term for density), walking quality (which factored sidewalks, planting zone, block length, terrain, and lighting), and sidewalk width. In this model, walking quality was a highly significant determinant of walking and carried the second largest coefficient relative to the other determinants. In more recent literature, the mixed-use, density, connectivity attributes seem to be receiving a very large proportion of attention to the detriment of funding and pedestrian infrastructure analysis (Frank, Andresen, and Schmid 2004; Frank et al. 2008).

Some research has actually elicited a statistically significant negative correlation between sidewalk presence and walking (Humpel et al. 2004; Gauvin et al. 2005; Hoehner et al. 2005; Lovasi et al. 2008). It is highly unlikely that greater presence of sidewalks actually results in less walking. Rather, in these cases sidewalk coverage may be acting as a proxy for other factors, such as the age of the neighborhood, political clout of local residents, or compensation provided to the community in exchange for impacts of large-scale projects. Alternately, these studies may have failed to control for other negative factors on walking, such as those related to traffic safety, crime, poor connectivity, narrow sidewalks, number of children per household, or land use. Or, there may be a bias in reporting or measurement of walking due to some factor in these settings.

For instance, Hoehner et al. (2005), who found non-significant negative trends relating to sidewalk presence and self-reported walking and a significant negative correlation between good sidewalk condition and self-reported walking, did not use any demographic or land use data to explain this difference, although such data was collected. Gauvin et al. (2005) found that pedestrian infrastructure had a negative correlation with walking, but a positive correlation with income. Similarly, Suminski et al. (2008) found higher levels of walking correlated with a larger percentage of "defective" sidewalks, but they did not control for other demographic or environmental characteristics.

The National Household Travel Survey

As described in the "Methods" section, this research employs data from the 2001 National Household Travel Survey (NHTS). The 2001 NHTS has served as a basis for other research as well. Following the release of the NHTS data, key findings regarding walking behavior were published. One such publication by Agrawal and Shimek (2007) looked at walking trips and their association with density, car ownership, income, and racial or ethnic identification. In their discussion, they critiqued the NHTS failure to account for very short walking trips which might be made from a parking area to the person's final destination, and pointed out that more than one-third of respondents had made no walking trips at all, and that of those who did more than three-quarters were less than 8 blocks (approximately one mile). They found that only 20% of walking trips were recreational and that White respondents were more likely to walk for recreation or utility.

Zlot and Schmid (2005) investigated MSA-level differences in the predecessor to the 2001 NHTS, the National Personal Travel Survey conducted in 1995. They used that data in combination with the 1996 and 1998 BRFSS and information from the Trust for Public Land to assess the relationship of walking and bicycling, either for utilitarian or recreational purposes, with proximity to parkland. Their analysis found a significant relationship between utilitarian walking and bicycling and park acreage.

Pucher and Renne (2003) conducted a socioeconomic analysis of the 2001 NHTS figures. They examined race and ethnicity, age, gender, geographic, and income or employment-related differences in travel. In their analysis, they looked at the relationship of these factors to travel mode, trip purpose, and car ownership, and additionally framed these figures over time. They noted that mode share as reported in the 2001 NHTS differs from U.S. Census findings. Overall, walking trips composed 8.6% of all daily travel. This was the highest proportion of walking trips since the 1969 NPTS; in 1995 walking trips had dropped to just 5.4% of trips. Pucher and Renne also reported that walking trips were most commonly made for "Social and Recreation" reasons (12.7%) and least likely to be made for work trips (3.4%) in the 2001 data. In 2001, walking was more common in New England, Middle Atlantic, and Pacific regions of the U.S. than in other parts of the country.

In the 2001 NHTS data, Pucher and Renne detected that households with income under $20,000 per year were almost twice as likely to walk as higher-income households; they were markedly less likely to own an automobile and less likely to travel by car. Low-income households also made fewer total trips per day and traveled fewer miles. White respondents were less likely to walk than other racial identities, and children between 5 and 15 were more likely to walk. (Pucher and Renne 2003)

Other analyses of the 2001 NHTS and its predecessors have looked at travel patterns of older adults (Collia, Sharp, and Giesbrecht 2003) or school-age children (McDonald 2008). Their results showed that low-income and minority children walked more than their counterparts, and that older adults walked more than those under age 64.

The data have also been used to examine historical patterns on non-motorized commuting (Plaut 2005).

Many researchers, such as those represented in the Delphi process conducted by Brennan Ramirez, Hoehner et al. (2006), believe that government funding and policies is likely to play an important role to improve pedestrian facilities and increase walking, and thus to increase physical activity. However, very little evidence is available to support this belief. This research seeks to provide evidence regarding the proposed relationship between funding, pedestrian facilities, and walking, and to identify areas where futher research is needed.

CHAPTER III: METHODS

DATA SOURCES

The 2001 National Household Travel Survey

The Federal Highway Administration (FHWA), a division of the U.S. Department of Transportation (DOT), has conducted nationwide surveys of personal transportation habits, and related demographic and transport data, since 1969. The surveys have been conducted somewhat irregularly, in 1969, 1977, 1983, 1990, 1995, and 2001. The next survey is being conducted in 2008. Prior to the 2001 survey, these efforts were called the National Personal Transportation Survey, or NPTS. Naturally, there have been changes over time in the type of data collected and in the sampling and collection methods. Also in 2001, questions from the 1995 American Travel Survey (ATS) regarding long distance travel was incorporated into the National Household Travel Survey (NHTS). The 2001 NHTS collected data from March 2001 through June 2002. It was co-sponsored with the Bureau of Transportation Statistics (BTS) and the National Highway Traffic Safety Administration (NHTSA), both of which are also DOT agencies. Two professional surveying firms were contracted to conduct the data collection segment: Westat and Morpace.

The 2001 NHTS included nine "add-on" areas – state DOTs and regional Metropolitan Planning Organizations (MPOs) which purchased additional sampling of the population within their geographical boundary. The add-on areas were the states of Hawaii, Kentucky, New York, Texas, and Wisconsin, and the MPOs for Oahu, Des Moines, Baltimore, and Lancaster. Over 100,000 households were surveyed, but not all of the data collected was complete and useable. Once the problematic or incomplete surveys were eliminated, there remained 69,817 valid households – 26,038 nationally and an extra 43,779 households in add-on areas.

Westat, which conducted the national, New York, and Wisconsin interviews, used a clustered systematic sampling frame. First, they clustered telephone numbers into "banks" of 100 numbers in which only the last two digits were unique. This ensured that all of the numbers would be from a certain geographical vicinity, as the numbers would have the same area code and exchange. Next, they systematically sorted and selected numbers for the sample. A complex sorting process, based on U.S. Census, county, and MSA boundaries was employed. Interviewers were trained before the interview process and monitored throughout. Most households received a small cash incentive.

Telephone numbers were selected via random digit dialing (RDD) technology. The address that corresponded to the selected telephone number was obtained through directory services (it was available for about 86% of sample households), and an informational packet was mailed to that address. About one week later, the household was contacted by telephone. The researcher attempted to speak with each adult household member. Participants were queried about other telephones in their household to reduce the chance of contacting the same household more than once. They were each asked questions about their travel, as well as information regarding their age, gender, and other relevant personal information using Computer-Assisted Telephone Interviewing (CATI) technology. After the household interview, a travel diary was mailed to that address along with instructions and an assigned day on which to complete the diary (the "travel day"). The day after the assigned travel day, the household was contacted again by telephone. Each person who had completed the travel diary was queried for their diary information using the CATI technology. Interviewers continued to contact the household until all members had been interviewed for their diary information, for up to six days after the travel day. A proxy was required for individuals under 16 unless they were emancipated. The travel diary asked participants to record every trip they made on the travel day – when and why they took it, by which mode(s), with whom, and where they went.

There are some threats to validity of the data. Institutional settings, hotels and motels, and households with more than ten unrelated members were excluded, which may have introduced a sampling error by excluding very low income households (some of which reside in low cost motels or share a residence between several families or many workers). There may have been language barriers that excluded other participants, including the lack of a spanish language option in the Hawaii, Kentucky, Oahu, Des Moines, Baltimore, and Lancaster add-on datasets. The events of September 11th, 2001 may have affected some people's travel behaviors, as could later concerns regarding anthrax exposure. Some multi-modal trips may have not been recorded properly. Calculated travel times are highly suspect as they are based on distance and use a standardized speed for each mode.

These data have been made available online. For the research presented here, the datasets were downloaded from http://nhts.ornl.gov/download.shtml in SAS transport file format. They were converted into SAS long file format using the Format.sas and Import.sas files provided on the NHTS website and then opened and saved into .sav format using Statistical Package for Social Sciences (SPSS) version 15.0 for Windows. Non-MSA and Micropolitan cases were eliminated using the command "Select Cases…

If HHC_MSA>=100000". No weighting was used in this analysis. Variables were recoded for analysis as described below. The Person data formed the basis of the analysis dataset, with additional variables imported from the Travel Day dataset and from a spreadsheet available from Thunderhead Alliance 2007 Benchmarking Report.

2007 Benchmarking Report: Bicycling and Walking in the U.S.

Thunderhead Alliance, a national not-for-profit bicycle and pedestrian advocacy organization, has published research in a document entitled "2007 Benchmarking Report: Bicycling and Walking in the U.S." This document was downloaded from the website http://www.thunderheadalliance.org/site/index.php/site/comments/2007_benchmarking_report/. Thunderhead Alliance sent surveys to local Thunderhead branches, city, regional, and state officials, and advocates in the 50 largest U.S. cities and all 50 states in December 2006. Individuals at the local Thunderhead organizations helped administer the surveys to government officials. This appears to have increased response rates but could have adversely impacted accuracy of the data received if these individuals were not sufficiently trained in use of the surveys. Surveys were completed by Thunderhead leaders, Department of Transportation staff, Metropolitan Planning Organization staff, and city officials. Thunderhead Alliance staff also obtained information from 2001 to 2006 from the Federal Highway Administration's Fiscal Management Information System, which contains federal transportation funding records at the federal, state, county, and congressional district levels.

VARIABLES

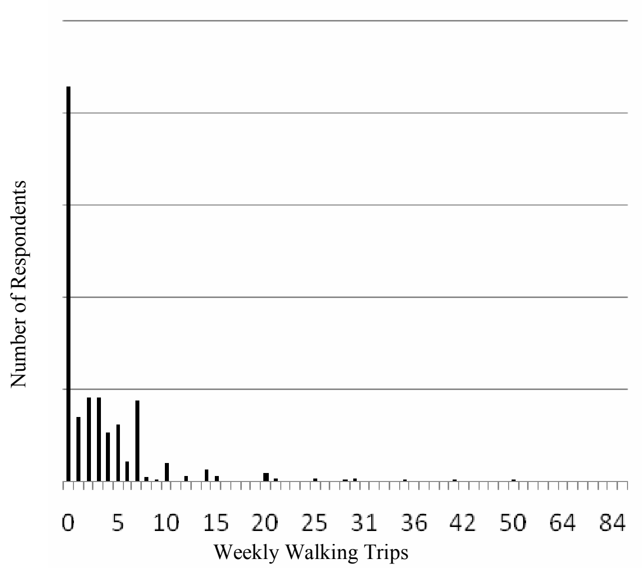
Dependent Variables:

Number of walking trips in last week (Week-Walk), taken by individual.

This item is from the NHTS dataset. Survey participants were asked, "In the past week, how many times did [you/SUBJECT] take a walk outside including walks for exercise?" Walking on a treadmill was excluded. The response was coded as an integer on a numeric ratio scale and provided in the Person dataset. There were 17,259 valid responses, which ranged from zero to 90 trips; median value was 4. Negative codes were employed to indicate a refusal, skip, unknown response, or out of parameter response. These signifiers were recoded as 'system-missing' values to permit analysis.

The weekly walking trip variable showed a great degree of variability, extreme outlier values, and failure to correspond to other variables to which it is theoretically related. In particular, it appears that respondents estimated the number of walking trips, in that the raw data trends towards multiples of five (and seven, the number of days in the week) as seen in Figure 3. This variable may be suspect; error could have been introduced in the way the question was asked to NHTS respondents or as a function of recall bias (inaccurate recollection of events that have happened in the past).

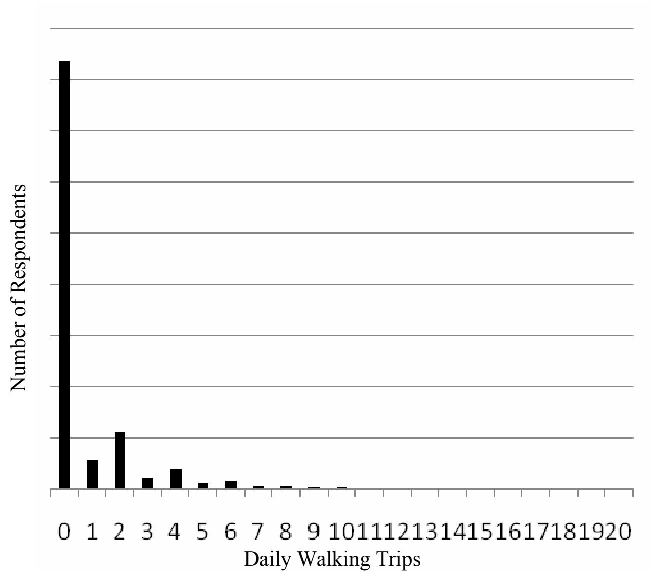
Figure 3: **Distribution and clustering tendency of weekly walking trips (Week-Walk variable) in the 2001 National Household Travel Survey (MSA respondents only)**



Number of walking trips made on travel day (Day-Walk).

This item is from the NHTS dataset. Travel day data was available in the Travel Day dataset. These data were extracted from several fields, a primary travel mode field and 10 fields used by NHTS data collectors to account for multi-modal trips when the primary travel mode was public transit. It did not account for multi-modal trips where a private vehicle was used for the primary travel mode, which may have missed some walking trips, such as from a parking facility to final destination. The walk responses (indicated by code '26') were counted and summed. They were then aggregated by Person ID (the unique identifier for each person who was surveyed) and merged into the primary dataset. Responses ranged from zero to twenty trips. The responses did not appear to follow a normal distribution and exhibited a high degree of outlying values. One reason for anomalies in distribution may be that walking trips are taken in pairs, once to the destination and once to return from the destination. This possibility is supported by the variable's distribution graph, seen in Figure 4.

Figure 4: Distribution and clustering tendency of daily walking trips (Day-Walk variable) in the 2001 National Household Travel Survey (MSA only)



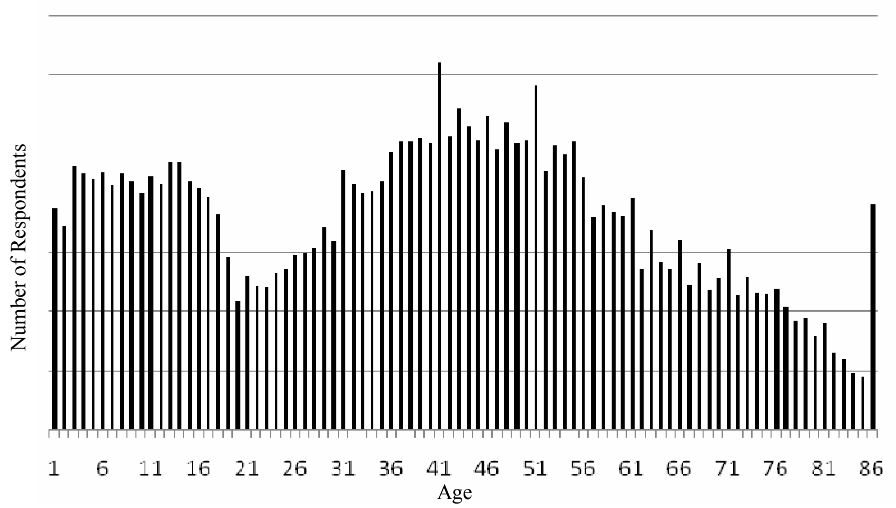
Both the Week-Walk and Day-Walk variables were combined into categories to mitigate the effect of abnormal distribution and outliers. Categorization was performed in two manners. In once instance, the variables were categorized into ‘walking’ or ‘no walking’ which simply distinguished those cases which had zero walking trips from those which had one or more walking trip (applied to both Week-Walk and Day-Walk). This is referred to as the two-value format. In the second instance, they were divided into three or four categories that relate to the amount of walking, guided by walking tendencies as discerned from the literature. In Week-Walk, they were recoded as ‘non-walkers’ (0 trips), ‘infrequent walkers’ (1-3 trips), ‘regular walkers’ (4-7 trips), and ‘frequent walkers’ (8 or more trips). In Day-Walk, they were recoded as ‘non-walkers’ (0 trips), ‘moderate walkers’ (1 trip), or ‘frequent walkers’ (2 or more trips). This is referred to as the multi-value format, which is distinct from the continuous original data format.

Independent Variables:

Individual's age (Age)

This item is from the NHTS dataset. There were 158,359 original valid responses. In the MSA restricted dataset, there were 61,872 valid responses which ranged from zero to 88. Of valid responses, 21.6% were under 16, 2.5% were 16-18, and 14.8% were 65 or older. It appears that young adults (age 18 to approximately age 30) may have been under-represented. Regarding age, it is important to note that children under the age of 16 were not interviewed directly; an adult in the household served as a proxy except in emancipated households. Also, overall mobility is fairly steady across adulthood until the age of 65. Figure 5 shows the distribution of ages.

Figure 5: Distribution of respondents' ages in the 2001 National Household Travel Survey (MSA only)



Individual's household income (HH-Income)

This item is from the NHTS dataset. NHTS data provided "Total household income last 12 months" in levels from less than $5,000 to greater than $100,000 by $4,999 increments, shown in Figure 6. There were 12,329 invalid responses signified by a negative integer. The valid responses were distributed unevenly. Income level was combined into four categories as shown in Figure 7: under $24,999, $25,000-$49,999, $50,000-$74,999, and over $75,000 to make the data more accurate to test. These categories are consistent with findings from the literature which indicate that households earning less than $25,000 or more than $75,000 have significantly different travel mode tendencies.

Figure 6: 2001 NHTS income distribution from original data

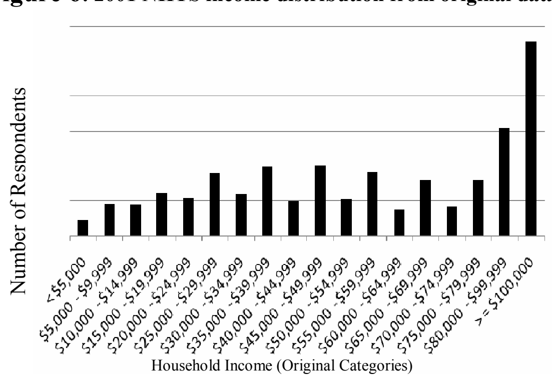
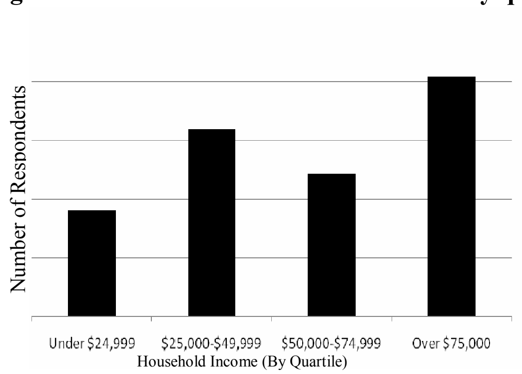


Figure 7: 2001 NHTS income distribution by quartile.



Block group density (housing units per square mile), for household (Density)

This item is from the NHTS dataset. Census Block Groups (BGs) are geographically defined areas which subdivide Census tracts. BGs have a target population of 1,500 residents, although they may range from 300 to 3,000 residents if that results in more logical boundaries. Their boundaries should follow logistical boundaries such as streets, railroad tracks, or city limits. The BG density variable was derived by NHTS processors using the household address, GDT Dynamap 2000 (from Census 2000

TIGER/Line files), and data from Claritas. The actual densities were combined into six levels which ranged from 25 housing units per square mile to 6,000 housing units per square mile; only 48 cases were unavailable. The Density variable can also be categorized into three levels: low refers to a density less than 1,700 housing units per square mile, medium refers to density between 1,700 and 3,500, and high refers to density over 3,500.

Distance to work (Distance)

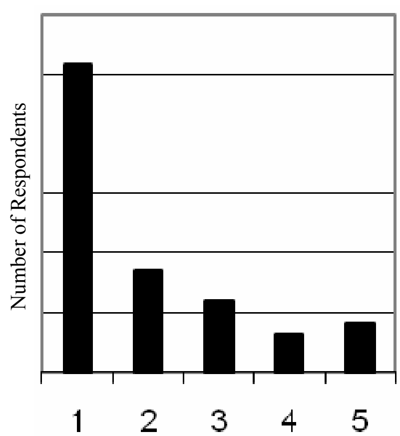
Respondents were asked, "What is the one-way distance from [your/SUBJECT'S] home to [your/his/her] [primary] workplace?" Interviewers could enter the numeric response and then identify whether that number specified blocks or miles. In the final presented data, this item was transformed into two variables – distance to work in miles or distance to work in blocks. There were 71,366 valid responses in the "Distance to work" variable, ranging from 0 to 925 miles. Due to variance in the original data, this measure was recoded into five categories with cut points at 0, 1, 2.5, 10, and 30 miles.

Lack of walkways (Walkways)

This item is from the NHTS dataset. Survey respondents were asked, "Thinking about your day-to-day travel, please tell me how much of a problem each of the following issues is for you. Use a number between 1 and 5, where 1 means it is not a problem for you at all, and 5 means it is the worst travel problem it could be for you. On a scale from 1 to 5, how much of a problem is… Lack of walkways or sidewalks?" Answers were coded as 1=Not a problem; 2=A little problem; 3=Somewhat of a problem; 4=Very much of a problem; 5=A severe problem; or as a -1, -7, -8, or -9 to indicate different types of out-of-parameter response, such as refusal to answer the question. For sake of analysis, such signifiers were recoded to 'system-missing'. Although 27,323 of the MSA respondents were coded as a 'legitimate skip', there does not seem to be any bias in skips compared to valid responses. Responses did not follow a fully normal curve. For analysis, correlations were examined using the original scale and also using a two-value format in which '1' and '2' responses were recoded as "Lack of walkways is not a problem" and all other valid responses other recoded as "Lack of walkways is a problem". Figure 8 indicates the distribution of valid responses.

Compared with other surveys that have been used to assess sidewalk conditions, this question may not elicit the desired response. In one interpretation, it could be asking how common poor sidewalk conditions are in the places where the respondent travels. But in an equally valid interpretation, it could be asking whether the respondent has found a way, such as driving, taking transit, or selecting a different walking route, to avoid problematic sidewalks.

Figure 8: Distribution of valid responses for lack of walkways in 2001 NHTS



Survey responses:
1 = lack of walkways is not a problem
5 = lack of walkways is a serious problem

Funding for Bicycle and Pedestrian projects at the MSA level

These data are adapted from the Thunderhead Alliance 2007 Benchmarking Report. They include the variables "Total Annual Federal Funds for Bike/Ped (6-year average) (obligated funds)", "Fedeal Funding per capita per year (6 year average) (obligated funds)" [sic], "Total Annual Funding for Bike/Ped (6-year average federal + other funds)", "Total Funding per capita per year (6-year average, federal + other funds)," and a calculated figure (Other Bike/Ped Funding) representing the Bicycle and Pedestrian Facilities category funding from the federal Transportation Enhancement Funds for 2003 through 2005. The six year averages provided are from years 2001 through 2006. The analysis assumes that funding levels for these years do not differ drastically from per capita funding levels in previous years, prior to NHTS data collection. Federal funding through 2003 was based on funding formulae established in federal legislation known as TEA-21 (Transportation Equity Act for the 21st Century) which was adopted in 1998, which may provide consistency during the study timeframe. The analysis assumes that funding levels are consistent.

The difference between items that refer to federal funding as opposed to those that refer to total funding is the addition of bicycle and pedestrian funding from non-federal sources as reported by the city or MPO. The total funding variables may not represent actual total expenditures on bicycle and pedestrian facilities due to accounting methods that vary from one governmental entity to another. Additionally, a Ratio variable representing the ratio of total to federal-only per capita funding was computed to see if this figure, theoretically representing the degree of local investment, was relevant. Since the population of MSAs varies considerably, per capita values were used rather than absolute values.

The MSA values for Dallas-Fort Worth, Phoenix-Mesa, San Francisco-Oakland-San Jose, and Washington-Baltimore were computed from two or more figures for their multiple MPOs. These data are analyzed as per capita figures. All of the funding variables were entered into SPSS for their MSA and the "Merge Files" command was used to integrate the variables into the primary dataset. For correlation analysis, the funding variables were divided into three equal categories labeled low, medium, and high.

The average (arithmetic mean) per capita federal funding level was $2.84, with a range from $0.22 in Miami to $9.52 in Atlanta. Six cities had received zero federal funding and data was not available for another fifteen cities. The average per capita total funding level was $4.93, ranging from $0.26, again in Miami, to $11.69 in Atlanta. The average ratio of total to federal funding was 2.15 and ranged from 1.05 in Las Vegas to 3.51 in the New York MSA for the cities for which data was available. See Appendix A for funding, lack of walkway responses, and walking trips by MSA.

Household MSA (MSA)

This item is from the NHTS dataset. This variable was derived by NHTS processors using the household address, GDT Dynamap 2000 (from Census 2000 TIGER/Line files), and data from Claritas. 31,745 households were not in an MSA and 65,881 households had their MSA suppressed because it was smaller than one million residents. The MSA code is a four-digit number that translates to a metropolitan region which may be defined by a single large city and its suburbs, or several cities with a high level of integration, as depicted in Figure 1.

Individual Variables Versus MSA Variables

The funding variables are the same across each entire MSA. When variables from the NHTS dataset are analyzed in relation to the funding variable, they are effectively comparing the MSAs against each other. Therefore, it was ultimately found unnecessary to aggregate walking trips and other variables by their respective MSA as this did not provide any enhancement to the funding analysis. Excluding analyses relating to MSA by name or relating to funding level, all analyses are performed at the national level with individual respondents as the unit of measure. All ages are included in analysis except where otherwise specified.

Nationally, 78% people did not walk at all on their travel day. The New York--Northern New Jersey--Long Island MSA had the fewest number of respondents who did not walk at all, at 63 percent. The Oklahoma City MSA had the highest number of non-walkers, 89 percent. The average walking trip lasted 15.03 minutes according to calculations by NHTS processors, or 13.89 minutes according to self-reported figures. The mean number of walking trips was 0.7 per person per day from the daily walking trip variable, and 3.2 per person per week according to the weekly walking trip variable

Table 1: Frequencies of individual-level variables from original 2001 NHTS data

		Weekly Walk Trips	Daily Walk Trips	Age	Density	Distance to Work	Lack of Walkways	Income
N	**Valid**	55226	48936	61122	62977	27055	8975	57635
Mean		0.711	3.159	39.207	2262.725	13.711	-	-
Std. Deviation		1.639	5.558	22.419	2016.490	18.162	1.316	-

ANALYSIS

The Statistical Package for Social Sciences (SPSS) version 15.0 for Windows has been used to run the recoding and analysis. Some of the key variables utilized in the analysis were presented in ordinal scale, including income (HH-Income), block group density (Density), and lack of walkways (Walkways). In the case of Walkways, this was determined by the original Likert scale used in the survey. For HH-Income and Density, the original figures have been categorized by NHTS processors. For instance, incomes were placed into categories of >$5,000, $5,000-$9,999, and so on. Age (AGE), distance to work (Distance), number of walking trips (Week-Walk and Day-Walk), and all of the funding variables were originally available in an interval scale. However the distribution of the original data presented challenges to analysis due to erratic distribution or a large number of outliers. Some of the ordinal data had distribution issues as well. As a result, variables have been categorized for final analysis. For instance, PCFF, PCTF, and RATIO were recoded into high, medium, and low categories equally by tertile.

Normal distribution was not assumed. Therefore, the analyses were performed with respect to non-parametric ordinal data. Spearman's rank correlation coefficient was selected as the appropriate statistic in the majority of the comparisons testing for correlation between variables. This coefficient can indicate a positive or negative (inverse) relationship between two ordinal variables and the strength of the relationship on a scale from -1 to 0 to 1; statistical significance of the relationship is also derived. Regarding MSA-level assessment, one-way analysis of variance (ANOVA) was utilized on the original interval scale walking trip data, indicating whether true differences exist among groups; Kruskal-Wallis one-way ANOVA was utilized to test difference of ordinal variables by MSA and also to test differences in walking trip frequency without concern for the distribution of the original data. The HH-Income variable was found to behave as a nominal variable in relation to the other variable; Cramér's V was used as the most suitable test in this case.

The two walking trip variables (Walking Trips in Last Week from the Person dataset (Week-Walk) and Travel Mode from the Travel Day dataset (Day-Walk)) were tested for validity – that is, for accurate representation of likelihood of walking for a given individual – using a Pearson product-moment correlation coefficient to see if the two interval-scaled walking variables were strongly correlated with each other. In other words, this asks whether someone's reported frequency of walking in the past week (prior to their travel day) predicted their frequency of walking on the travel day, or vice versa, and therefore, is it likely to be a good predictor of walking trips for other individuals placed in the same environment. A .291 correlation value was obtained, suggesting that the walking variables themselves are only partially accurate in predicting total walking frequency for any given individual.

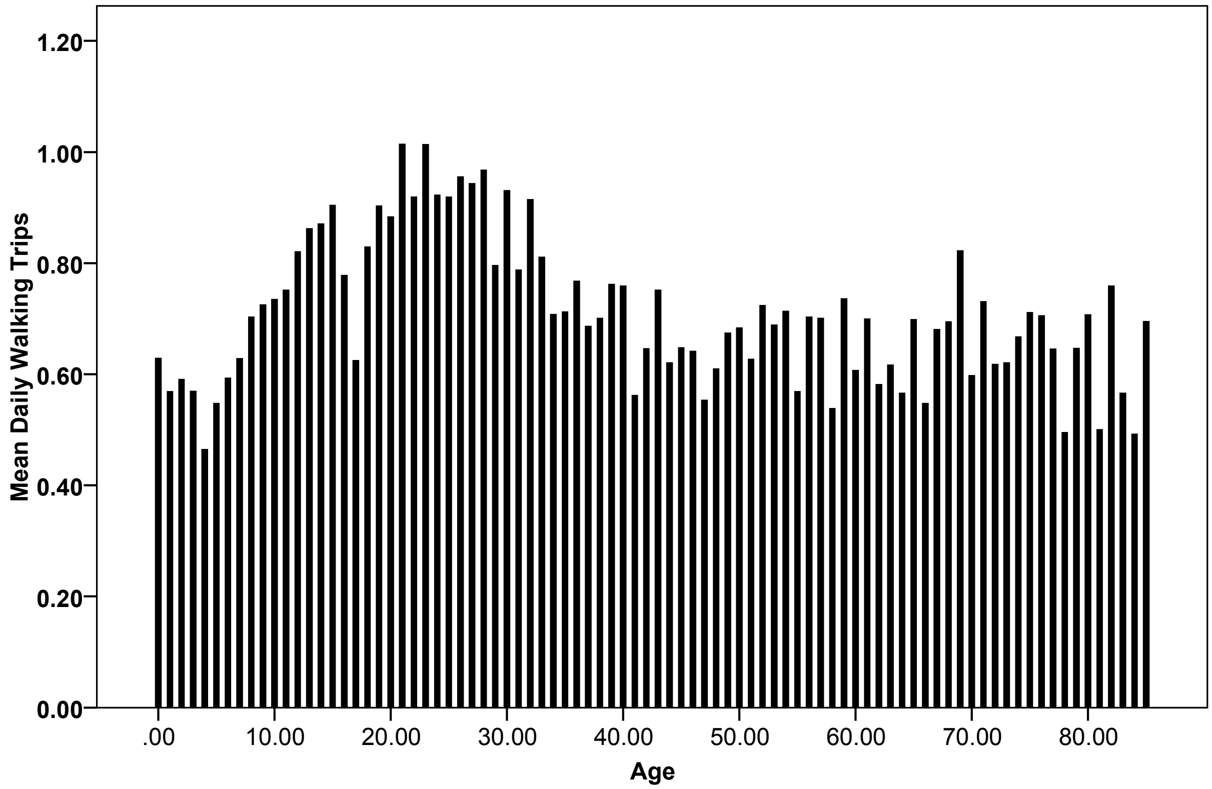
CHAPTER IV: RESULTS

Results are presented first as single variables in association with walking trips, and then in relation to each other. Income and age are presented first since these variables are the least changeable. Density and distance to work are presented next, as modifiable variables which are not the focus of this research. Finally, lack of walkway correlation with walking and funding levels correlation with walking is reported, including consideration of confounding factors. Since all data is cross-sectional, none of these results can indicate causality.

AGE AND WALKING

Association with age was detected, but it was not linear or as predicted. In general, children walk somewhat less frequently, especially when they are under the age of 10. Young adults walk somewhat more frequently than other adults. Contrary to published studies, there was not a strong effect for elderly adults (over the age of 65). Figure 9 demonstrates the distribution of walking trips by age. This distribution suggests that children under age 5 likely walk with their parents and thus walk as frequently as they do; from age 5 to age 16, children may be walking on their own with increasing frequency as they become more independent; the dip in walking frequency from age 16 to 19 is most likely due to obtainment of a driver's license; over age 20, individuals seem to walk with the greatest frequency in their early 20s, when they may be in college or just entering the workforce, but this gradually declines with increasing age; there appears to be a final jump in walking trips from approximately age 65 through 79 when driving skills may have declined but individuals are still capable of walking.

Figure 9: Average frequency of daily walking trips by age in the 2001 National Household Travel Survey (MSA respondents only)



HOUSEHOLD INCOME AND WALKING

Household income appears to be correlated with walking trips. However, the correlation is different for weekly versus daily walking. As seen in Figure 10 and Figure 11, the relationship between income and walking trips was not linear, and therefore may be best analyzed as a nominal variable. As such, there was a weak positive relationship with weekly walking, and a stronger relationship with daily walking, as shown in Table 2. Individuals with a household income under $25,000 walk, on average, twice as frequently as higher income families, as expected based on reviewed literature and theory, particularly on a daily basis. It was also noted that income was associated with the lack of walkways variable (Figure 12) and with density (Figure 13). The income variable could have a confounding effect with other variables.

Table 2: **Correlation of income level and walking trips in the 2001 National Household Travel Survey**

HH-Income (multi-value)	Daily Walking Trips (multi-value)	Weekly Walking Trips (multi-value)	Daily Walking Trips (two-value)	Weekly Walking Trips (multi-value)	Walkway (two-value)	Density
Cramér's V	.111	.027	.139	.041	.042	.152
p-value	.000	.000	.000	.000	.002	.000

Figure 10: **Mean daily walking trips by household income in 2001 National Household Travel Survey**

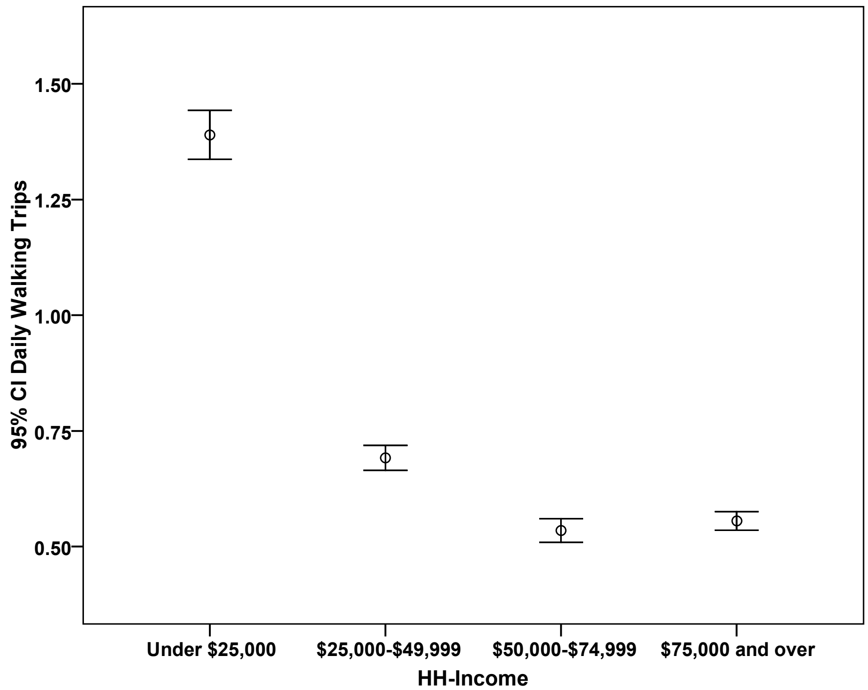


Figure 11: **Mean weekly walking trips by household income in the 2001 National Household Travel Survey**

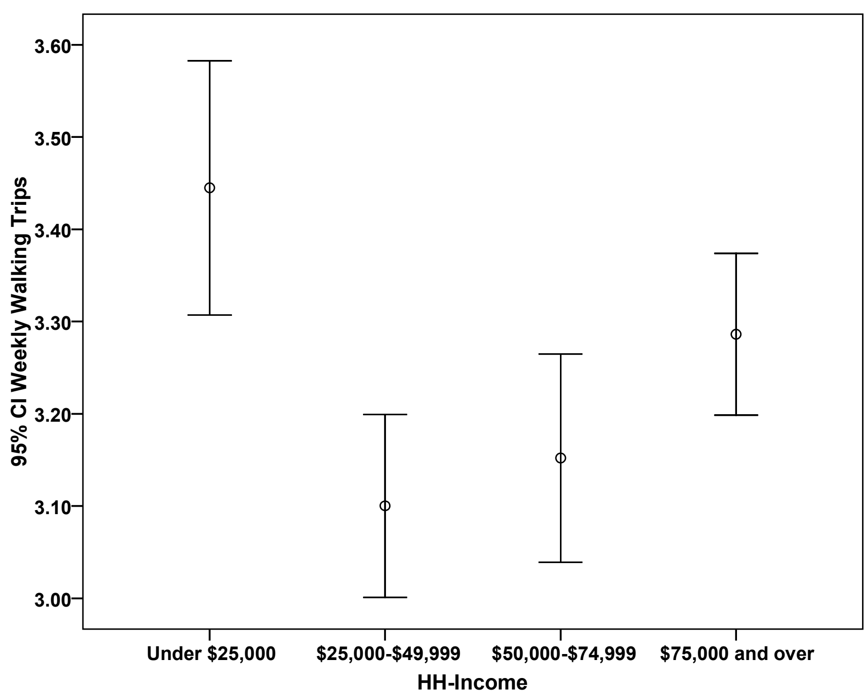


Figure 12: **Average density by income in the 2001 National Household Travel Survey**

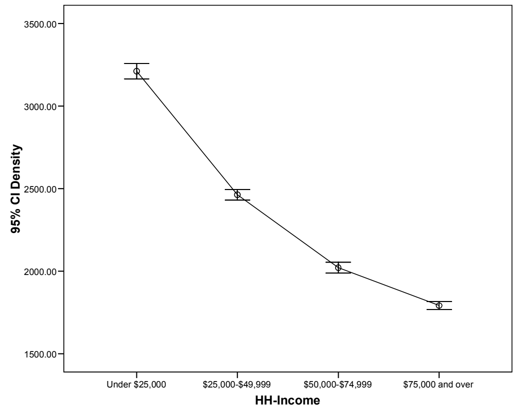
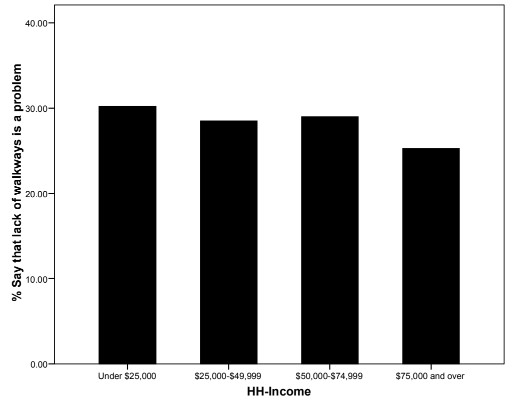


Figure 13: **Average percent who say lack of walkways is a problem, by income in the 2001 National Household Travel Survey**



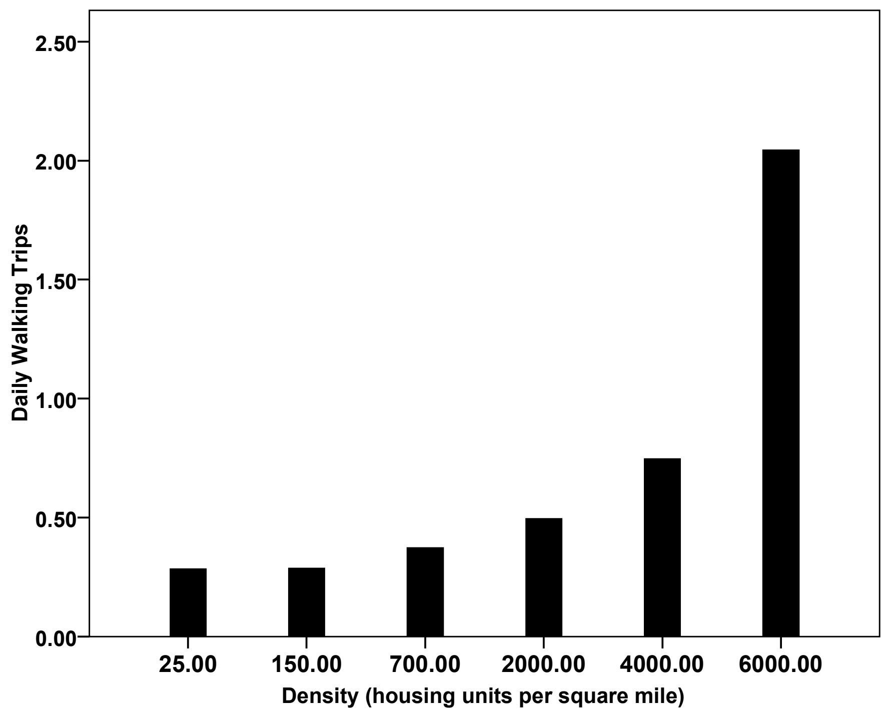
<u>POPULATION DENSITY AND WALKING</u>

Based on reviewed literature, it was expected that density would be positively associated with walking to a strong degree. According to this analysis of 2001 NHTS data, population density was significantly positively correlated with daily and weekly walking trips, but more strongly with daily trips. The Kruskal-Wallis one-way ANOVA is quite telling for the relationship between Density and walking trips, particularly daily walking trips (Day-Walk). Figure 14 shows that at the highest density category, the frequency of walking trips per person is strikingly higher than any other category. Overall, there was a relatively strong correlation (.252, p = .000) between density and daily walking (two-value variable).

Table 3: **Kruskal-Wallis one-way analysis of variance for original Density categories and original walking trip data in the 2001 National Household Travel Survey**

	Density	N	Mean Rank	Asymp. Sig.
Daily Walking Trips	25.00	2495	24325.28	.000
	150.00	7249	24498.28	
	700.00	12665	25295.36	
	2000.00	17982	26406.19	
	4000.00	5737	28317.60	
	6000.00	9088	36145.62	
Weekly Walking Trips	25.00	2211	25900.84	.000
	150.00	6152	24304.69	
	700.00	10814	24061.23	
	2000.00	15896	23766.74	
	4000.00	5229	24271.92	
	6000.00	8624	26113.15	

Figure 14: **Walking trips by density category in the 2001 National Household Travel Survey**



DISTANCE TO WORK AND WALKING

Based on previous studies, it was expected that distance to work would have a negative correlation with walking trips. The analysis showed did show this relationship, with people who lived less than one mile from their work walking twice as often as those who lived more than ten miles from work. Trends are indicated in Figure 15, and ranking values are shown in Table 4. Correlation values for Distance were -.049 for weekly walking and -.109 for daily walking (p = .000) Also as expected, Distance was negatively associated with Density (Table 5).

Table 4: **Kruskal-Wallis one-way analysis of variance for categorized Distance to work in miles and original walking trip data in the 2001 National Household Travel Survey**

	Distance to Work	N	Mean Rank	Asymp. Sig.
Daily Walking Trips	0 to <1 miles	2396	14889.44	
	1 to < 2.5 miles	1714	13622.20	
	2.5 to < 10 miles	9858	12670.26	.000
	10 to < 30 miles	9207	12271.06	
	30 miles or more	2382	12462.75	
Weekly Walking Trips	0 to <1 miles	2546	14666.79	.000
	1 to < 2.5 miles	1791	14033.11	
	2.5 to < 10 miles	10318	13367.23	
	10 to < 30 miles	9670	13001.02	
	30 miles or more	2502	13485.04	

Figure 15: **Distance to work and average number of daily walking trips in the 2001 National Household Travel Survey**

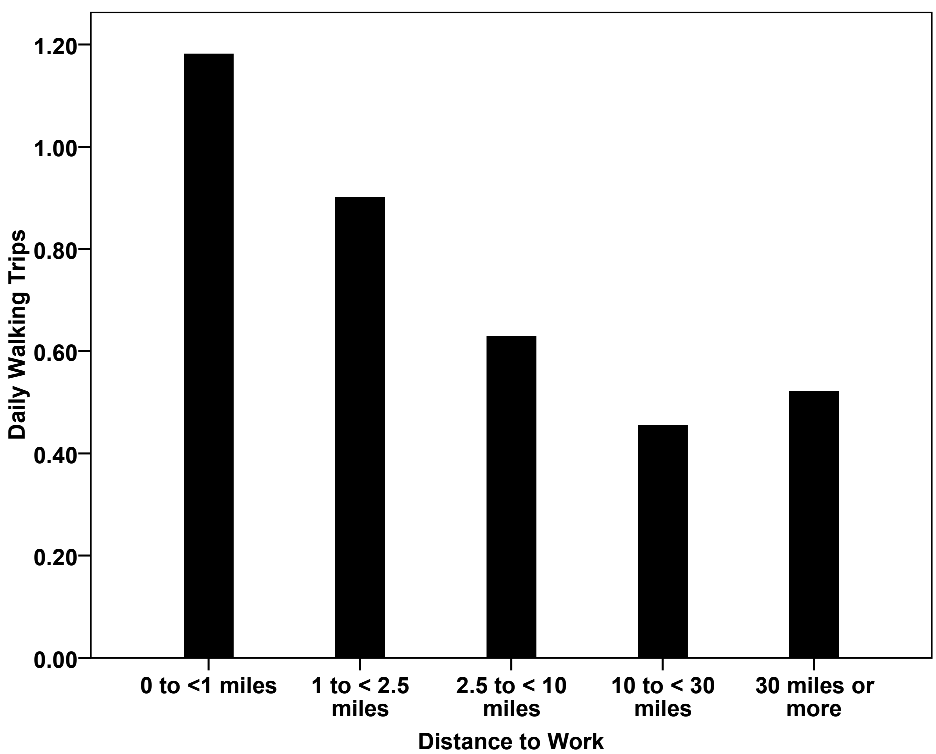


Table 5: **Correlation between categorized Distance to work in miles and Density in the 2001 NHTS**

	Distance to Work and Density
r_s	-.224
p-value	.000

<u>FUNDING AND WALKWAYS</u>

The alternative hypothesis proposed that higher levels of funding would improve the condition pedestrian infrastructure, measured in this study by the Walkway variable. On initial analysis, PCFF had a weak positive, significant association with the two-value Walkway variable, PCTF had an even weaker association, and RATIO had a negative association. Controlling for income, this relationship became much stronger for the income category "Under $25,000" but weaker for other income levels; and was even stronger for low-income respondents who did not walk. These figures are shown in Table 6. These results only support the hypothesis that funding is associated with presence of walkways for federal funding. The hypothesis is not supported regarding additional sources of funding. The federal funding relationship appears to be more important for lower-income households. Also, whether the person fell into the Frequent Walker category for daily walking appeared to influence whether they rated lack of walkways as a problem relative to their MSA's funding levels.

Table 6: Correlation between multi-value funding variables with two-value Walkway

		PCFF &Lack of Walkway	PCTF & Lack of Walkway	RATIO & Lack of Walkway
All Categories	r_s *p*-value	**.047** **.000**(a)	.010 .364(a)	**-.055** **.000**(a)
Income: Under $25,000	r_s *p*-value	**.108** **.000**(a)	**.056** **.052**(a)	**-.115** **.000**(a)
$25,000-$49,999	r_s *p*-value	**.044** **.050**(a)	.013 .567(a)	-.038 .115(a)
$50,000-$74,999	r_s *p*-value	**.056** **.034**(a)	.012 .647(a)	**-.068** **.016**(a)
$75,000 and over	r_s *p*-value	.017 .406(a)	-.022 .276(a)	-.035 .100(a)
Within Income Under $25,000 Daily No Walk	r_s *p*-value	**-.130** **.001**	-.068 .094	**.116** **.008**
Daily Walk	r_s *p*-value	**-.099** **.050**	-.066 .191	**.116** **.027**
Weekly No Walk	r_s *p*-value	**-.119** **.010**	-.069 .136	**.143** **.005**
Weekly Walk	r_s *p*-value	.070 .057	-.022 .550	.067 .081

a = Based on normal approximation. Entries in bold font are significant above .05.

WALKWAYS AND WALKING

It was expected that lack of walkways, as tested in the 2001 NHTS, would be negatively associated with walking trips. However, the Walkways variable appeared to have a positive association with daily and weekly walking trips (Day-Walk and Week-Walk) using Kruskal-Wallis one-way ANOVA, as indicated by higher mean rank values for the "Lack of walkways is a problem" category in Table 7. A slight negative correlation was found using contingency tables to analyze these variables in their two-value format as seen in Table 8 and Table 9. Without additional information about the pedestrian environment or validity of the Walkways variable, it cannot be concluded from this data that presence or lack of walkways is associated with increased walking.

Table 7: Kruskal-Wallis one-way analysis of variance for two-value Walkways with original Week-Walk and Day-Walk values

	Walkways (two-value format)	N	Mean Rank	Asymp. Sig.
Weekly Walking Trips	Lack of walkways is not a problem	4889	4325.25	.000
	Lack of walkways is a problem	4051	4645.80	
	Total	8940		
Daily Walking Trips	Lack of walkways is not a problem	4409	3993.55	.001
	Lack of walkways is a problem	3695	4122.84	
	Total	8104		

Table 8: Correlation of Walkways (two-value) and Week-Walk (two-value)

		Weekly Walking Trips		
		No Walk	Walk	Total
Walkways	Lack of walkways is a problem	1380	2671	4051
	Lack of walkways is not a problem	1995	2894	4889
Total		3375	5565	8940

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal	Spearman Correlation	-.069	.011	6.559	.000(c)

a Not assuming the null hypothesis.
b Using the asymptotic standard error assuming the null hypothesis.
c Based on normal approximation.

Table 9: Correlation of Walkways (two-value) and Day-Walk (two-value)

		Daily Walking Trips		
		No Walk	Walk	Total
Walkways	Lack of walkways is a problem	2701	994	3695
	Lack of walkways is not a problem	3368	1041	4409
Total		6069	2035	8104

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal	Spearman Correlation	-.038	.011	3.404	.001(c)

a Not assuming the null hypothesis.
b Using the asymptotic standard error assuming the null hypothesis.
c Based on normal approximation.

PEDESTRIAN INFRASTRUCTURE FUNDING AND WALKING

It was hypothesized that funding levels would be positively associated with walking trips. Per capita federal funding (PCFF), per capita total funding (PCTF), and the ratio of PCTF to PCFF (RATIO) were tested for association with walking. While the associations were significant to .000, they did not necessarily behave as predicted. Specifically, PCFF showed a negative association with daily (-.057) and weekly (-.153) walking trips, meaning that increased federal funding was associated with less walking. This does not support the alternative hypothesis relative to federal funding. PCTF had a very slight positive association with Week-Walk (.033) but a slight negative association with Day-Walk (-.067). These results may be too weak to draw any conclusion. RATIO, however, demonstrated a positive association with daily walking (.121) and with weekly walking (.265). The association between RATIO and weekly walking was the strongest detected in this research. This result supports the alternative hypothesis relative to funding from other, non-federal sources. Tables 10, 11, and 12 show the Kruskal-Wallis mean rankings for the funding variables, while Figures 16 and 17 depict the relationship between the RATIO variable and daily and weekly walking.

Table 10: Kruskal-Wallis one-way analysis of variance for multi-value PCFF with original Week-Walk and Day-Walk values

	PCFF	N	Mean Rank	Asymp. Sig.
Weekly Walking Trips	Low	26759	24598.16	.000
	Medium	5205	22632.68	
	High	15961	23331.97	
	Total	47925		
Daily Walking Trips	Low	23696	22699.48	.000
	Medium	4462	23405.96	
	High	14321	18150.26	
	Total	42479		

Table 11: Kruskal-Wallis one-way analysis of variance for multi-value PCTF with original Week-Walk and Day-Walk values

	PCTF	N	Mean Rank	Asymp. Sig.
Weekly Walking Trips	Low	16546	22525.20	.000
	Medium	15893	26014.30	
	High	15486	23394.00	
	Total	47925		
Daily Walking Trips	Low	14593	20041.73	.000
	Medium	13970	25732.57	
	High	13916	17986.56	
	Total	42479		

Table 12: Kruskal-Wallis one-way analysis of variance for multi-value RATIO with original Week-Walk and Day-Walk values

	RATIO	N	Mean Rank	Asymp. Sig.
Weekly Walking Trips	low	19446	19721.89	.000
	medium	5923	19530.24	
	high	16063	22358.00	
	Total	41432		
Daily Walking Trips	low	17406	15368.66	.000
	medium	5139	19663.88	
	high	14109	21491.00	
	Total	36654		

Figure 16: Correlation of RATIO and Weekly Walking Trips using data from the 2001 NHTS and Thunderhead Alliance Benchmarking Report.

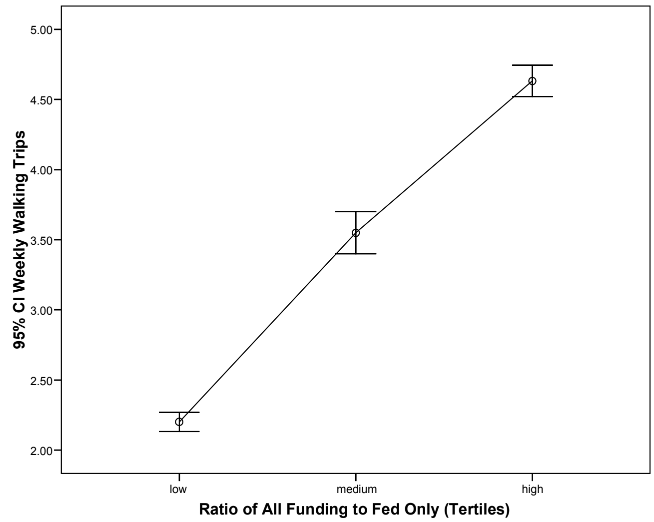
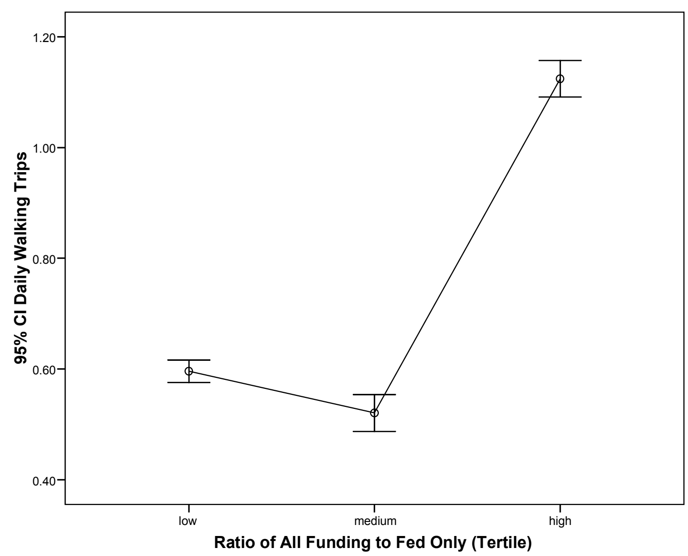


Figure 17: Correlation of RATIO and Daily Walking Trips using data from the 2001 NHTS and Thunderhead Alliance Benchmarking Report.



CORRELATES OF WALKING

Table 13 provides all of the correlates of daily and weekly walking trips. Weekly walking trips appeared to be most likely to increase as the RATIO variable increases, suggesting that state and local investment in pedestrian infrastructure may be an effective way to increase walking trips on a weekly basis. Density also had a small positive effect, but federal funding, total funding, distance to work, and elderly status had a negative effect. Presence of walkways also had an negative effect when looking at the average of all cases. Daily walking trips showed the strongest positive relationship with density, a fairly strong positive correlation with the RATIO variable, and a small positive association with total funding. Daily walking also demonstrated a negative relationship with distance to work, federal funding, and presence of walkways. Considering the effect of age, income, and density, the same correlation analysis was conducted on certain populations, by excluding some age groups, excluding the highest or lowest income categories, and excluding low density areas.

Table 13: Correlates of walking: All (all cases) using data from the 2001 NHTS and Thunderhead Alliance Benchmarking Report.

		PCFF	PTFF	RATIO	Walkways	Density	Distance	Over 65		HH-Income
Weekly Walking (multi)	r_s *p*-value	-.163 .000	-.064 .000	.276 .000	-.065 .000	.027 .000	-.049 .000	-.081 .000	Cramér's V *p*-value	.027 .000
Daily Walking (multi)	r_s *p*-value	-.057 .000	.036 .000	.121 .000	-.036 .001	.263 .000	-.109 .000	-.019 .000	Cramér's V *p*-value	.111 .000
Weekly Walking (two-value)	r_s *p*-value	-.153 .000	-.067 .000	.265 .000	-.069 .000	.010 .023	-.049 .000	-.081 .000	Cramér's V *p*-value	.041 .000
Daily Walking (two-value)	r_s *p*-value	-.057 .000	.033 .000	.121 .000	-.038 .000	.252 .000	-.109 .000	-.019 .000	Cramér's V *p*-value	.139 .000

CHAPTER V: DISCUSSION AND CONCLUSION

This research was initiated to determine whether walking trips might be increased through greater availability of sidewalks or through more funding for pedestrian facilities, and whether more funding for pedestrian facilities related to greater availability of sidewalks. While this research question was partially answered by the findings, many new questions were generated. Federal funding and non-federal funding (funding from other sources) behaved very differently from each other. A negative association was hypothesized between funding and perceived lack of walkways, yet the analysis showed that this association was negative for federal funding but positive for non-federal funding. Also, a positive association was hypothesized between funding and walking trips. In the results, however, non-federal funding appeared to have a positive association with walking trips, especially weekly walking trips, while federal funding demonstrated a negative association. Finally, a negative association was expected between lack of walkways and walking trips, but the results were inconclusive. While none of the correlations were very strong, this was expected, as there are so many variables that appear to impact walking behavior.

These results raise several questions. Why does federal funding appear to have a negative relationship with walking trips? Is more of this funding allocated to areas that are lagging in pedestrian facilities? Is it more likely to be used for projects that will receive low usage, either because they are implemented in less populated areas or because they do not address other needs of walkability such as traffic safety, density, or pedestrian amenities? Similarly, why does non-federal investment in pedestrian facilities appear to be associated with increased walking trips, and how can this association be utilized to increase physical activity through walking?

Regarding the relationship between funding and presence of walkways, it seems that federal funding is important. It appears that federal funding may improve the pedestrian environment for lower-income households. However, non-federal funding seemed to exacerbate problems with lack of walkways, a result which also calls for further investigation. It is possible that funding from other sources is more likely to be used in affluent areas or that it is being misallocated in some way. Finally, the weekly and daily walking trip variables seemed to respond differently, and may represent walking trips made for different purposes.

MSA of residence was significantly correlated with number of daily and weekly walking trips in general, suggesting that there are other aspects of the city environment which impact walking rates in addition to funding and walkways. For instance, this could be traffic enforcement, weather, or other factors. It was also noted that there was a wide range of funding levels and average density by MSA, and that funding levels did not seem to correspond to other aspects of walkability such as density. There may be other factors such as traffic safety, single-use land development, and lack of public transit service involved as well.

LIMITATIONS

Overall, the variables that were available for analysis were somewhat limited. Important variables such as connectivity, weather, traffic concerns, crime, sidewalk maintenance, mixed-use development, and pedestrian amenities such as shade trees simply were not available. The analysis was cross-sectional, so causality cannot be determined. There may be some causal effect in both directions. For instance, a city that has very low rates of walking may have a hard time justifying major investment in pedestrian infrastructure, while other metropolitan regions may seek more funding because there is more pedestrian travel and thus more demand. On the other hand, a metropolitan area which has invested in pedestrian infrastructure for many decades may be able to have lower funding levels now while maintaining a good pedestrian environment based on their existing infrastructure.

There may be inaccuracies in the data sources as well. As mentioned previously, the NHTS excluded hotels, dormitories, and households with more than ten unrelated members which may have left out some low income households, college students, and other populations. Some walking trips may have been left out since multi-modal data was not collected for trips unless transit was the primary travel mode; this excludes the walking phase of a driving trip, such as from a parking lot to the final destination. There were likely some problems with the Lack of Walkways survey question as well. It used a smaller sample (this question was asked only asked one quarter of the time), and it may have been phrased to elicit ‘not a problem’ response from individuals who do not walk for other reasons. Self-reported walking trips, especially weekly walking could have contained some inaccuracies. Lastly, the Thunderhead Alliance data collection may have been incomplete as their scope was quite ambitious.

IMPLICATIONS FOR PUBLIC HEALTH

One question which impacts the utility of this research is, how much walking is sufficient? Given the recommendations for a total of at least 2.5 hours of moderate physical activity per week, a desirable level of walking would be one that makes up the difference between current and recommended levels of physical activity. As described regarding the Week-Walk and Day-Walk variables, the number of individuals who may be classified as walking frequently is not high. According to the Travel Day dataset, the average walking trip took 15.03 minutes (as calculated by NHTS processors; self-reported walking travel trip average was 13.89 minutes). An individual would need to take ten or more walking trips a week (an average of 1.4 trips per day) to meet physical activity recommendations exclusively through walking. Of course, walking is just one of many forms of physical activity available to Americans, but it is one of the easiest and most affordable – if the physical environment allows it.

Nationally, the average number of walking trips was low. There was an average of only 0.7 walking trips per person per day (half of the number of daily trips suggested here), or only 3.2 walking trips per person per week (one third of the number of weekly trips suggested here). Nationally, 78% people reported that they did not walk at all on the travel day. The percentage of respondents who did not walk on the travel day ranged from 63% in the New York MSA to 89% in the Oklahoma City MSA. There clearly appear to be some metropolitan areas which have a higher average number of walking trips than others. Some factors in walking, such as age or income, cannot be changed and others, such as density, may be extremely slow to change – thirty years or more. On the other hand, provision of pedestrian facilities can be enacted within several years. If pedestrian funding and facilities are going to be used by public health professionals to promote walking trips, the questions raised by this research will need to be answered.

The opportunity afforded by active transportation – particularly walking and bicycling – to increase physical activity and prevent chronic diseases is large and the crisis of physical inactivity is severe. Furthermore, it is not an issue where small interventions will suffice. While local efforts and regional policy can begin to shift the urban design, the influence of federal funding and policies is enormous. From 2005 through 2009, $180 billion of federal transportation funding was disbursed. Out of that money, what proportion is supporting non-motorized transport? Where and how was it used? Do the resulting projects creating ideal walking environments or do they continue to skew towards motor vehicle travel?

In 2009, the current federal transportation bill (Safe, Accountable, Flexible, Efficient Transportation Equity Act: a Legacy for Users, or SAFETEA-LU) will be up for reauthorization. This could present a prime opportunity for public health researchers to make a case for more balanced funding relative to mode and for policies that support non-motorized transport. However, lawmakers will not want to base new funding formulae or other politically risky decisions on inconclusive evidence. As Brownson et al. (2006) note, there is still a significant disjunct between research and practice. Members of the public health field must reach out to transportation planners and government staff at the local, state, and federal level; such a relationship will be essential to obtain comprehensive policy and funding information and to ensure that public health goals are considered in transportation policies and funding practices.

FUTURE RESEARCH

Future research will need to focus on three areas: better assessment of transportation policies and funding, better measurement of walking rates, and more comprehensive assessment of the factors that influence walking rates. Regarding transportation funding, next steps in research would be to conduct a more rigorous analysis similar to that prepared by the Thunderhead Alliance. This research will need to compare the types of projects funded by federal or local sources, where they were located relative to demographic and land use factors, and how effectively they were implemented. Regarding measurement, information about walking trips is still unreliable as discussed above. Data from a one-day travel diary appears to be more accurate than self-reported historical information, but it is still subject to error. For future public health planning, we will need to continue developing, improving, and testing walking measurement tools. This includes ways to survey or measure individual transportation tendencies and ways to measure all transportation modes reliably (such as the amount of hourly pedestrian, bicycle, or motor vehicle traffic along a given street segment). Finally, survey instruments to understand individual motivation for selecting one route or mode over another, audit tools to assess the physical environment, and audit tools to assess the fiscal and policy environment need to be further developed to understand the complete environment in which travel behaviors are being conducted.

Comparing more and less successful regions, researchers must look for the policies and fiscal investments that are leading to a greater number of per capita walking trips on a daily or weekly basis. This analysis should also be repeated over several years, if historical data can be obtained, to begin linking mode share changes with new plans, policies, and funding sources. The results from such an analysis must then be applied in the development or prioritization of particular governmental transportation programs. It may be one of the largest-scale physical activity interventions that can be undertaken on a national level in a relatively short amount of time.

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APPENDIX A: MSA VALUES

MSA	Population (2000)	Federal Funding	Per Capita Federal Funding	Total Funding	Per Capita Total Funding	Ratio of Total to Federal Funding		Age	Distance to Work	Walking Trips (Daily)	Walking Trips (Weekly)	% Rated Walkways as a Problem
Atlanta	4,548,344	$3,762,752	$9.53	$4,615,360	$11.69	1.23	N	822	361	736	626	60%
							Median	37	12	0	1	
							Mean	36.08151	14.95486	0.269022	1.129393	
							SE Mean	0.765526	0.621016	0.023812	0.037169	
Austin--San Marcos	1,249,748	$1,710,698	$2.52	$2,455,988	$3.62	1.44	N	646	308	592	512	58%
							Median	36	8	0	0	
							Mean	36.45511	11.51218	0.246622	0.525391	
							SE Mean	0.858194	0.546585	0.026081	0.037385	
Boston--Worcester--Lawrence	7,298,695	$0	$0.00	$0	$0.00	N/A	N	1345	619	1223	1030	51%
							Median	39	9	0	1	
							Mean	37.60446	13.52446	0.404742	1.131068	
							SE Mean	0.619554	0.558605	0.021652	0.029547	
Buffalo--Niagara Falls	1,254,066	[no data]	[no data]	[no data]	[no data]	[no data]	N	1380	614	1232	1084	41%
							Median	41	8	0	1	
							Mean	39.88551	10.56251	0.309253	1.127306	
							SE Mean	0.633032	0.566166	0.019576	0.029192	
Charlotte--Gastonia--Rock Hill	1,897,034	$0	$0.00	$0	$0.00	N/A	N	301	121	281	226	49%
							Median	35	12	0	1	
							Mean	35.701	12.67672	0.281139	1.154867	
							SE Mean	1.321477	0.839888	0.038527	0.062962	
Chicago--Gary--Kenosha	9,312,255	$3,065,415	$1.13	$4,675,680	$1.73	1.53	N	1798	799	1594	1416	44%
							Median	38	9	0	1	
							Mean	37.96051	13.42045	0.436637	1.142655	
							SE Mean	0.541457	0.434913	0.019945	0.025795	

MSA	Population (2000)	Federal Funding	Per Capita Federal Funding	Total Funding	Per Capita Total Funding	Ratio of Total to Federal Funding		Age	Distance to Work	Walking Trips (Daily)	Walking Trips (Weekly)	% Rated Walkways as a Problem
Cincinnati--Hamilton	2,050,175	[no data]	[no data]	[no data]	[no data]	[no data]	N	416	189	364	346	34%
							Median	40	8	0	1	
							Mean	40.41346	12.18507	0.326923	1.098266	
							SE Mean	1.10658	0.820375	0.037123	0.054199	
Cleveland--Akron	2,945,831	$0	$0.00	$0	$0.00	N/A	N	684	328	628	539	39%
							Median	38	10	0	1	
							Mean	37.96053	14.87219	0.297771	1.007421	
							SE Mean	0.865999	2.024343	0.0272	0.040937	
Columbus	1,835,189	$0	$0.00	$0	$0.00	N/A	N	312	160	281	256	43%
							Median	41	8	0	1	
							Mean	39.25641	10.56948	0.355872	1.078125	
							SE Mean	1.254062	0.720909	0.041943	0.056235	
Dallas--Fort Worth	5,487,956	$1,042,420	$0.75	$2,159,940	$1.31	1.74	N	1428	551	1249	1101	40%
							Median	39	13	0	0	
							Mean	37.59524	15.98428	0.205765	0.64396	
							SE Mean	0.594188	0.850442	0.016339	0.026217	
Denver--Boulder--Greeley	2,629,980	$633,338	$1.16	$1,657,330	$3.04	2.62	N	628	299	582	495	40%
							Median	38	9	0	1	
							Mean	37.42357	11.42893	0.362543	1.143434	
							SE Mean	0.871641	0.624426	0.030009	0.041286	
Detroit--Ann Arbor--Flint	5,357,538	$1,278,147	$1.53	$1,727,558	$2.07	1.35	N	1133	442	1026	872	46%
							Median	39	10	0	1	
							Mean	38.38129	14.13184	0.318713	1.082569	
							SE Mean	0.697459	0.635997	0.022082	0.032456	
Grand Rapids--Muskegon--Holland	1,254,661	[no data]	[no data]	[no data]	[no data]	[no data]	N	299	125	274	215	34%
							Median	38	8	0	1	
							Mean	36.36455	11.51382	0.29927	1.055814	
							SE Mean	1.321538	0.988695	0.041279	0.071213	

MSA	Population (2000)	Federal Funding	Per Capita Federal Funding	Total Funding	Per Capita Total Funding	Ratio of Total to Federal Funding		Age	Distance to Work	Walking Trips (Daily)	Walking Trips (Weekly)	% Rated Walkways as a Problem
Greensboro--Winston-Salem--High Point	1,414,656	[no data]	[no data]	[no data]	[no data]	[no data]	N	305	147	285	241	35%
							Median	40	8	0	1	
							Mean	38.91148	20.18296	0.238596	1.20332	
							SE Mean	1.274994	6.357249	0.035807	0.06588	
Hartford	1,257,709	[no data]	[no data]	[no data]	[no data]	[no data]	N	227	116	221	201	38%
							Median	47	10	0	1	
							Mean	44.65198	13.62308	0.298643	1.154229	
							SE Mean	1.484167	1.537221	0.044038	0.065832	
Honolulu	876,156	$0	$0.00	$0	$0.00	N/A	N	4225	1745	3702	3410	46%
							Median	41	8	0	0	
							Mean	40.07266	10.57934	0.362237	0.095015	
							SE Mean	0.357356	0.36815	0.01236	0.005418	
Houston--Galveston--Brazoria	4,815,122	$1,316,938	$0.68	$1,999,694	$1.03	1.52	N	1331	586	1150	1046	42%
							Median	40	11	0	0	
							Mean	37.91811	15.48652	0.184348	0.604207	
							SE Mean	0.599674	0.673315	0.015825	0.027425	
Indianapolis	1,843,588	$1,304,947	$1.71	$1,526,855	$2.00	1.17	N	387	186	338	308	35%
							Median	39	8	0	1	
							Mean	38.30491	11.281	0.284024	1.123377	
							SE Mean	1.151025	0.782813	0.037094	0.055885	
Jacksonville	1,122,750	$257,018	$0.33	$775,168	$1.01	3.02	N	255	118	230	191	50%
							Median	41	10	0	1	
							Mean	37.41961	16.30932	0.23913	1.204188	
							SE Mean	1.315975	3.053614	0.040372	0.071019	
Kansas City	1,901,070	$0	$0.00	$0	$0.00	N/A	N	435	215	378	364	49%
							Median	44	9	0	1	
							Mean	41.84138	11.46597	0.230159	0.950549	
							SE Mean	1.09532	0.686923	0.030776	0.047099	

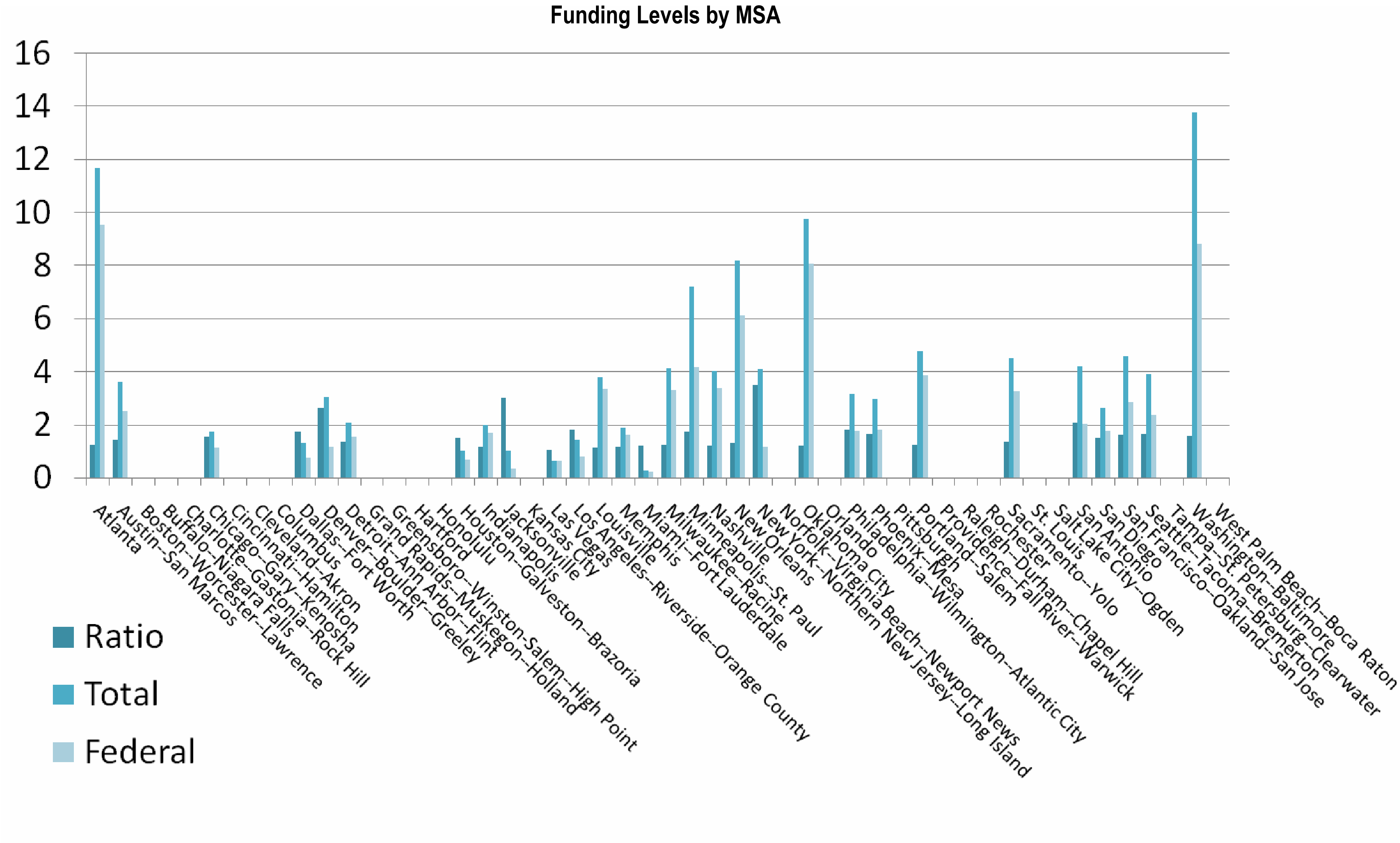
MSA	Population (2000)	Federal Funding	Per Capita Federal Funding	Total Funding	Per Capita Total Funding	Ratio of Total to Federal Funding		Age	Distance to Work	Walking Trips (Daily)	Walking Trips (Weekly)	% Rated Walkways as a Problem
Las Vegas	1,408,250	$336,580	$0.62	$351,902	$0.65	1.05	N	315	142	282	257	36%
							Median	40	9	0	1	
							Mean	40.03175	11.15669	0.315603	1.229572	
							SE Mean	1.299346	1.04758	0.040645	0.060831	
Los Angeles--Riverside--Orange County	17,755,322	$2,890,851	$0.77	$5,271,098	$1.41	1.82	N	2582	1034	2363	2001	43%
							Median	37.5	10	0	1	
							Mean	36.94965	15.518	0.433347	1.176412	
							SE Mean	0.43593	0.802108	0.01623	0.020939	
Louisville	1,292,482	$1,840,961	$3.36	$2,076,218	$3.79	1.13	N	208	93	198	169	41%
							Median	41	8	0	1	
							Mean	40.85096	10.99074	0.207071	0.95858	
							SE Mean	1.567955	1.078468	0.040668	0.072857	
Memphis	1,205,194	$1,034,478	$1.61	$1,206,863	$1.88	1.17	N	222	93	188	171	53%
							Median	39	10	0	1	
							Mean	38.01351	11.90562	0.239362	0.923977	
							SE Mean	1.570597	0.968948	0.044054	0.070384	
Miami--Fort Lauderdale	5,007,988	$78,793	$0.22	$93,639	$0.26	1.19	N	541	220	477	431	44%
							Median	40	10	0	1	
							Mean	40.04436	13.96606	0.322851	1.088167	
							SE Mean	0.979416	1.502385	0.031847	0.044479	
Milwaukee--Racine	1,689,572	$1,846,706	$3.32	$2,308,382	$4.14	1.25	N	2585	1235	2283	2018	35%
							Median	40	8	0	1	
							Mean	38.44642	10.89723	0.286903	1.076313	
							SE Mean	0.446504	0.304599	0.01389	0.021066	
Minneapolis--St. Paul	3,271,888	$1,456,644	$4.16	$2,526,333	$7.21	1.73	N	966	497	873	749	45%
							Median	37	11	0	1	
							Mean	35.95342	14.49294	0.315006	1.089453	
							SE Mean	0.701621	1.152747	0.023555	0.033666	

MSA	Population (2000)	Federal Funding	Per Capita Federal Funding	Total Funding	Per Capita Total Funding	Ratio of Total to Federal Funding		Age	Distance to Work	Walking Trips (Daily)	Walking Trips (Weekly)	% Rated Walkways as a Problem
Nashville	1,381,287	$1,774,554	$3.40	$2,103,421	$4.02	1.19	N	250	119	234	213	51%
							Median	41.5	10	0	1	
							Mean	40.316	13.40798	0.282051	1.046948	
							SE Mean	1.395288	1.146137	0.043965	0.065466	
New Orleans	1,360,436	$2,683,515	$6.14	$3,582,235	$8.19	1.33	N	273	110	235	210	59%
							Median	39	6.5	0	1	
							Mean	37.5348	10.21742	0.348936	1.266667	
							SE Mean	1.366865	1.074066	0.046983	0.072558	
New York--Northern New Jersey--Long Island	21,361,797	$9,259,362	$1.16	$32,501,977	$4.09	3.51	N	13877	5803	12339	10933	50%
							Median	39	10	0	1	
							Mean	38.31232	15.41577	0.672745	1.34309	
							SE Mean	0.192205	0.224162	0.008228	0.009681	
Norfolk--Virginia Beach--Newport News	1,576,917	[no data]	[no data]	[no data]	[no data]	[no data]	N	337	143	300	274	49%
							Median	42	10	0	1	
							Mean	39.30564	12.92622	0.32	1.160584	
							SE Mean	1.197294	1.013224	0.040795	0.05628	
Oklahoma City	1,160,942	$4,159,358	$8.06	$5,043,477	$9.78	1.21	N	169	71	155	121	48%
							Median	35	12	0	1	
							Mean	34.42012	13.70736	0.174194	0.950413	
							SE Mean	1.749665	1.358952	0.042095	0.086125	
Orlando	2,191,081	[no data]	[no data]	[no data]	[no data]	[no data]	N	295	116	261	234	58%
							Median	41	10	0	1	
							Mean	39.97288	16.36858	0.337165	1.15812	
							SE Mean	1.33172	4.308201	0.043824	0.062818	
Philadelphia--Wilmington--Atlantic City	6,207,223	$2,476,243	$1.76	$4,451,272	$3.164978	1.80	N	1139	506	1060	907	45%
							Median	42	9	0	1	
							Mean	40.30992	12.24126	0.422642	1.241455	
							SE Mean	0.675229	0.656347	0.024038	0.032126	

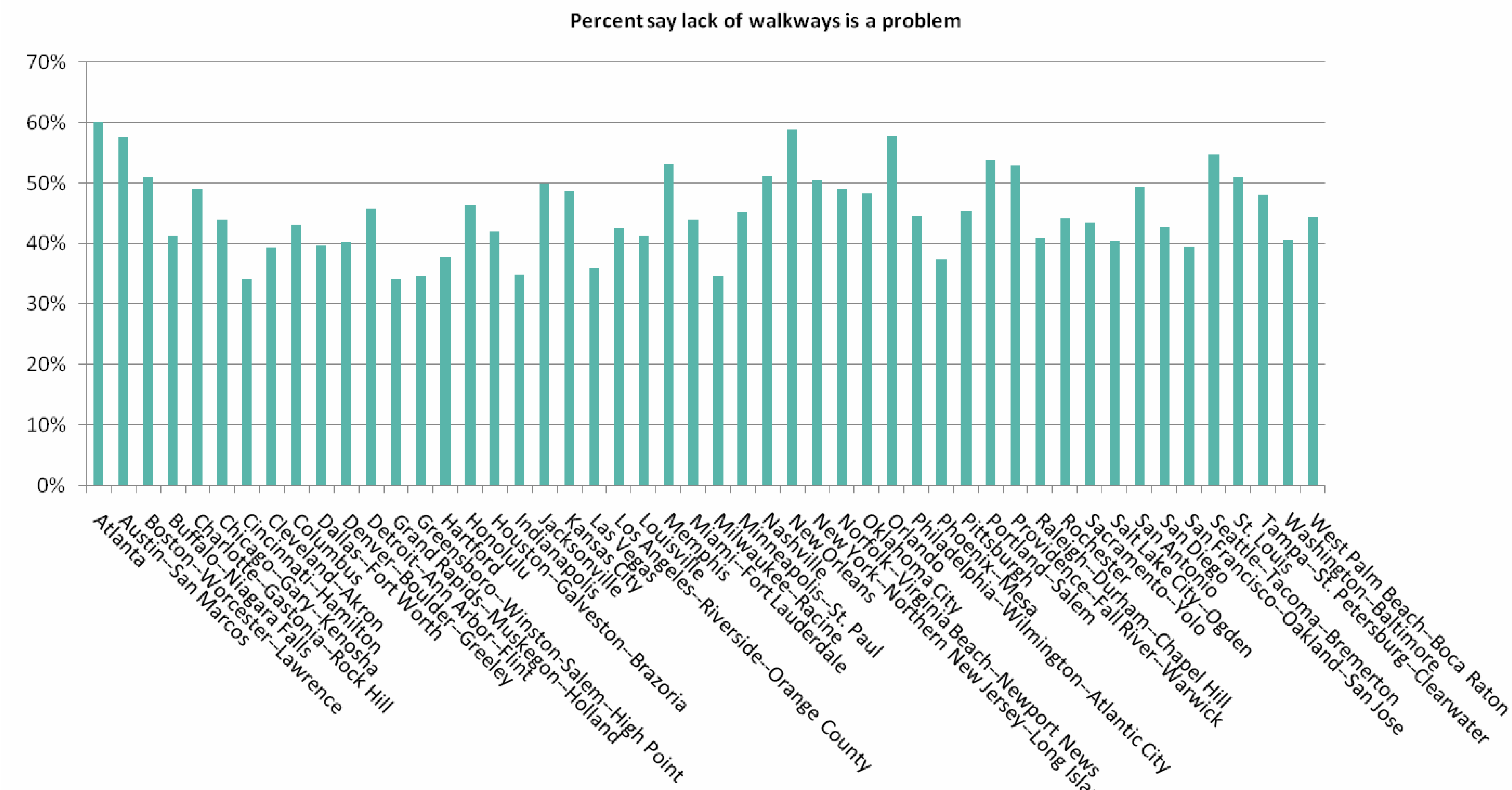
MSA	Population (2000)	Federal Funding	Per Capita Federal Funding	Total Funding	Per Capita Total Funding	Ratio of Total to Federal Funding		Age	Distance to Work	Walking Trips (Daily)	Walking Trips (Weekly)	% Rated Walkways as a Problem
Phoenix--Mesa	3,251,876	$3,250,672	$1.79	$5,406,318	$2.97	1.66	N	731	283	648	558	38%
							Median	37	10	0	1	
							Mean	38.28317	14.51058	0.41821	1.12724	
							SE Mean	0.897003	1.526383	0.030172	0.039704	
Pittsburgh	2,525,730	[no data]	[no data]	[no data]	[no data]	[no data]	N	597	258	515	474	45%
							Median	43	7	0	1	
							Mean	41.42714	10.65588	0.454369	1.21519	
							SE Mean	0.964084	0.969315	0.035183	0.045495	
Portland--Salem	1,927,881	$1,993,907	$3.88	$2,454,410	$4.78	1.23	N	549	232	472	420	54%
							Median	40	8	0	1	
							Mean	37.69035	15.63142	0.324153	1.145238	
							SE Mean	0.951431	3.148826	0.032953	0.046964	
Providence--Fall River--Warwick	1,582,997	[no data]	[no data]	[no data]	[no data]	[no data]	N	234	101	217	188	53%
							Median	40	9	0	1	
							Mean	40.60684	14.41436	0.207373	1.18617	
							SE Mean	1.554919	1.435962	0.039645	0.068401	
Raleigh--Durham--Chapel Hill	1,314,589	[no data]	[no data]	[no data]	[no data]	[no data]	N	321	151	289	248	41%
							Median	39	11	0	1	
							Mean	36.94081	13.82796	0.221453	1.245968	
							SE Mean	1.185451	1.007595	0.033575	0.05799	
Rochester	1,037,833	[no data]	[no data]	[no data]	[no data]	[no data]	N	2123	974	1908	1663	44%
							Median	40	8	0	1	
							Mean	38.33585	11.35095	0.298218	1.117859	
							SE Mean	0.483418	0.416901	0.01535	0.023519	
Sacramento--Yolo	2,069,298	$1,462,088	$3.28	$2,001,994	$4.50	1.37	N	456	200	409	361	43%
							Median	38	8	0	1	
							Mean	37.41009	11.16183	0.403423	1.301939	
							SE Mean	1.032302	0.811807	0.037161	0.051902	

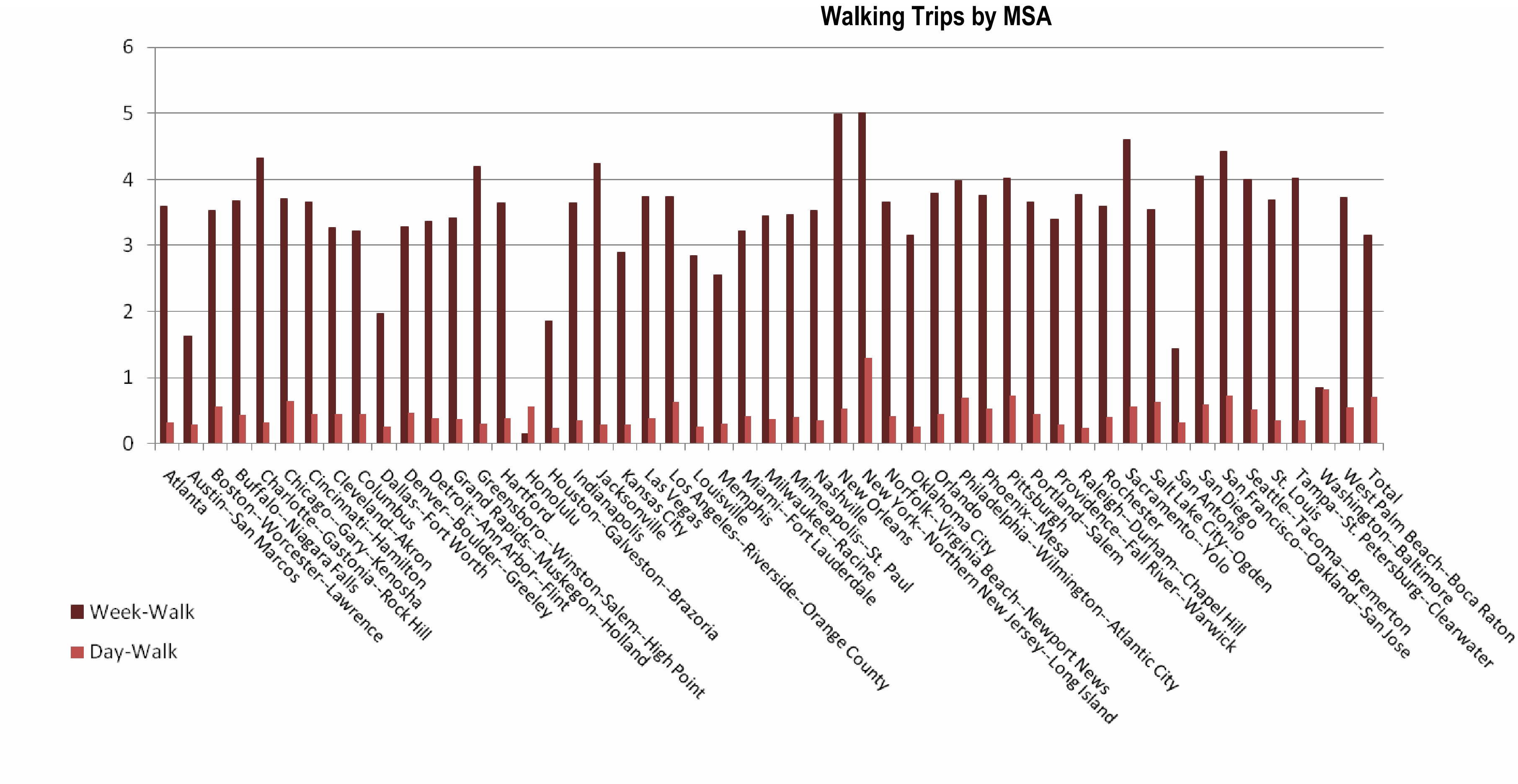
MSA	Population (2000)	Federal Funding	Per Capita Federal Funding	Total Funding	Per Capita Total Funding	Ratio of Total to Federal Funding		Age	Distance to Work	Walking Trips (Daily)	Walking Trips (Weekly)	% Rated Walkways as a Problem
St. Louis	2,754,328	[no data]	[no data]	[no data]	[no data]	[no data]	N	314	132	283	232	41%
							Median	35	9.5	0	1	
							Mean	35.7293	13.64588	0.45583	1.181034	
							SE Mean	1.330845	2.27195	0.046451	0.062657	
Salt Lake City--Ogden	1,469,474	[no data]	[no data]	[no data]	[no data]	[no data]	N	626	246	549	489	49%
							Median	42	10	0	0	
							Mean	39.89776	12.8512	0.23133	0.451943	
							SE Mean	0.937627	1.314522	0.026143	0.036911	
San Antonio	1,711,721	$2,453,828	$2.04	$5,038,609	$4.19	2.05	N	562	242	508	416	43%
							Median	37	10	0	1	
							Mean	35.47865	13.23437	0.395669	1.194712	
							SE Mean	0.945352	0.807766	0.033525	0.04736	
San Diego	2,813,833	$2,115,664	$1.75	$3,189,030	$2.64	1.51	N	1342	630	1205	1083	40%
							Median	40	8	0	1	
							Mean	39.08346	13.13209	0.483817	1.33518	
							SE Mean	0.615916	0.533445	0.023467	0.028821	
San Francisco--Oakland--San Jose	7,092,596	$4,943,678	$2.85	$8,192,369	$4.58	1.61	N	976	392	888	741	55%
							Median	36	10	0	1	
							Mean	36.3627	13.44018	0.36036	1.198381	
							SE Mean	0.715492	0.674157	0.024341	0.035055	
Seattle--Tacoma--Bremerton	3,707,144	$1,271,213	$2.37	$2,092,026	$3.90	1.65	N	600	261	546	461	51%
							Median	37	11	0	1	
							Mean	36.99833	13.36948	0.261905	1.127983	
							SE Mean	0.940224	0.667043	0.027163	0.044155	
Tampa--St. Petersburg--Clearwater	2,396,013	[no data]	[no data]	[no data]	[no data]	[no data]	N	499	189	441	428	48%
							Median	49	8	0	1	
							Mean	46.39479	11.82963	0.283447	1.165888	
							SE Mean	1.061397	1.028747	0.031091	0.048236	

MSA	Population (2000)	Federal Funding	Per Capita Federal Funding	Total Funding	Per Capita Total Funding	Ratio of Total to Federal Funding		Age	Distance to Work	Walking Trips (Daily)	Walking Trips (Weekly)	% Rated Walkways as a Problem
Washington--Baltimore	7,572,647	$10,507,593	$8.84	$16,380,159	$13.77	1.56	N	9631	4490	8569	7839	41%
							Median	41	10	0	0	
							Mean	40.11754	14.60669	0.483487	0.311519	
							SE Mean	0.228544	0.222445	0.009043	0.007508	
West Palm Beach--Boca Raton	1,131,184	[no data]	[no data]	[no data]	[no data]	[no data]	N	192	63	165	168	44%
							Median	50	7	0	1	
							Mean	47.64583	9.922222	0.442424	1.142857	
							SE Mean	1.728504	1.249109	0.062795	0.073743	



Funding Levels by MSA
16
14
12
10
8
6
4
2
0
Atlanta
Austin--San Marcos
Boston--Worcester--Lawrence
Buffalo--Niagara Falls
Charlotte--Gastonia--Rock Hill
Chicago--Gary--Kenosha
Cincinnati--Hamilton
Cleveland--Akron
Columbus
Dallas--Fort Worth
Denver--Boulder--Greeley
Detroit--Ann Arbor--Flint
Grand Rapids--Muskegon--Holland
Greensboro--Winston-Salem--High Point
Hartford
Honolulu
Houston--Galveston--Brazoria
Indianapolis
Jacksonville
Kansas City
Las Vegas
Los Angeles--Riverside--Orange County
Louisville
Memphis
Miami--Fort Lauderdale
Milwaukee--Racine
Minneapolis--St. Paul
Nashville
New Orleans
New York--Northern New Jersey--Long Island
Norfolk--Virginia Beach--Newport News
Oklahoma City
Orlando
Philadelphia--Wilmington--Atlantic City
Phoenix--Mesa
Pittsburgh
Portland--Salem
Providence--Fall River--Warwick
Raleigh--Durham--Chapel Hill
Rochester
Sacramento--Yolo
St. Louis
Salt Lake City--Ogden
San Antonio
San Diego
San Francisco--Oakland--San Jose
Seattle--Tacoma--Bremerton
Tampa--St. Petersburg--Clearwater
Washington--Baltimore
West Palm Beach--Boca Raton
Ratio
Total
Federal


Percent say lack of walkways is a problem
70%
60%
50%
40%
30%
20%
10%
0%
Atlanta
Austin--San Marcos
Boston--Worcester--Lawrence
Buffalo--Niagara Falls
Charlotte--Gastonia--Rock Hill
Chicago--Gary--Kenosha
Cincinnati--Hamilton
Cleveland--Akron
Columbus
Dallas--Fort Worth
Denver--Boulder--Greeley
Detroit--Ann Arbor--Flint
Grand Rapids--Muskegon--Holland
Greensboro--Winston-Salem--High Point
Hartford
Honolulu
Houston--Galveston--Brazoria
Indianapolis
Jacksonville
Kansas City
Las Vegas
Los Angeles--Riverside--Orange County
Louisville
Memphis
Miami--Fort Lauderdale
Milwaukee--Racine
Minneapolis--St. Paul
Nashville
New Orleans
New York--Northern New Jersey--Long Island
Norfolk--Virginia Beach--Newport News
Oklahoma City
Orlando
Philadelphia--Wilmington--Atlantic City
Phoenix--Mesa
Pittsburgh
Portland--Salem
Providence--Fall River--Warwick
Raleigh--Durham--Chapel Hill
Rochester
Sacramento--Yolo
Salt Lake City--Ogden
San Antonio
San Diego
San Francisco--Oakland--San Jose
Seattle--Tacoma--Bremerton
St. Louis
Tampa--St. Petersburg--Clearwater
Washington--Baltimore
West Palm Beach--Boca Raton


Walking Trips by MSA
0
1
2
3
4
5
6
Week-Walk
Day-Walk
Atlanta
Austin--San Marcos
Boston--Worcester--Lawrence
Buffalo--Niagara Falls
Charlotte--Gastonia--Rock Hill
Chicago--Gary--Kenosha
Cincinnati--Hamilton
Cleveland--Akron
Columbus
Dallas--Fort Worth
Denver--Boulder--Greeley
Detroit--Ann Arbor--Flint
Grand Rapids--Muskegon--Holland
Greensboro--Winston-Salem--High Point
Hartford
Honolulu
Houston--Galveston--Brazoria
Indianapolis
Jacksonville
Kansas City
Las Vegas
Los Angeles--Riverside--Orange County
Louisville
Memphis
Miami--Fort Lauderdale
Milwaukee--Racine
Minneapolis--St. Paul
Nashville
New Orleans
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Pittsburgh
Portland--Salem
Providence--Fall River--Warwick
Raleigh--Durham--Chapel Hill
Rochester
Sacramento--Yolo
Salt Lake City--Ogden
San Antonio
San Diego
San Francisco--Oakland--San Jose
Seattle--Tacoma--Bremerton
St. Louis
Tampa--St. Petersburg--Clearwater
Washington--Baltimore
West Palm Beach--Boca Raton
Total