2012

Walkability at Wright State University

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Abstract

The purpose of this study was to examine walkability at Wright State University (WSU), Dayton Ohio using the Postsecondary Education Campus Walkability/Bikeability Semantic-Differential Assessment Instrument. Safety, path quality, and path temperature comfort were the categories of criteria assessed. A total of 66 path segments were assessed on main campus, 50 were assessed during the day and 16 were assessed during the night. The average walkability score was 84.9% for day assessed segments and 82.1% for night assessed segments. Path segments received an overall average grade of B. The findings in this study suggest that the WSU campus is a walkable campus. From this study, it can be concluded that there are many physical features of a built environment conducive to walking at WSU. Several of those features are wide sidewalks of at least five feet and away from the roads, a pleasant environment, and shade.

Keywords: walking, built environment, postsecondary education campus, physical activity, path segment

Walkability at Wright State University

Walkability on college campuses is a topic that has not been thoroughly examined in previous research. A college campus is a unique community due to dense variety of students residing in residential halls or apartments close to campus. Furthermore, college campuses are strategically built environments that provide easy access to students to a plethora of daily necessities. This type of environment is often tailored to students' needs. This built environment of a college campus allows for a diversity of land mix usage where students can easily do their banking, grocery shop, eat, work out, and attend class all within walking distance (Frank, Engleke, & Schmid, 2003). Students have ready access to these facilities. It has been shown that there is a correlation between walking to school and high density populations (Kerr et al., 2006b). It is typical for student housing to be close together to create residential density or to have a large number of students reside in one area. The close proximity of buildings encourages students to choose walking on their campus mainly due to its feasibility. Students tend to walk together when going to the same destination, such as the cafeteria. The design of college campuses provides students the opportunity to meet the daily recommendations for physical activity by breaking up their daily exercise into walking segments. For this reason, a college campus is a great area to carry out a community assessment regarding the built environment and its' walkability.

Statement of Purpose

The purpose of this study was to examine the walkability of college campuses. The built environment includes sidewalks, crosswalks, connectivity, safety and aesthetics are key attributes that can influence an individual's choice when deciding whether to walk or to drive. Understanding the impact that sidewalks, crosswalks, connectivity, safety and aesthetics encourage walking may help increase the understanding of walkability and help increase walking as exercise on college campuses.

Literature Review

The Benefits of Walking

Physical activity results in a multitude of healthy benefits. Weight control, disease management and prevention, and improved overall well-being are just a few of those benefits (Hunter & Eckstein, 2009). Engaging in daily physical activity is also linked to improving mental health as evident in a study conducted by De Moor, Beem, Stubbe, Boomsma, and De Geus (2006), which consisted of 12,450 participants suffering from depression. De Moor et al. (2006) reported that 6,712 of those participants turn to exercise as a means to alleviate their condition and improve their mental health. When people participate in exercise, a psychological mechanism activates and alters their current mental state and mood. In this relaxed state of mind, high levels of stress are eased and blood pressure is lowered. The relaxed state of mind can result in prevention of heart disease over a period of time (De Geus & De Moor, 2008). Physical activity also improves cardiovascular health and prevents cardiovascular diseases, specifically coronary heart disease. Heart disease is a leading cause of death in the United States. Heart disease can be alleviated through daily physical activity. Only 32% of those who suffer from heart disease receive daily physical activity (Zhao, Ford, Li, & Mokdad, 2008). The lack of daily physical activity is linked to development of other chronic diseases as well, such as diabetes.

The United States Department of Health and Human Services (2008) developed guidelines regarding the amount of physical activity necessary to maintain health based on age group. The recommendations of appropriate amount and level of exercise ranges depends on age group. The three major age groups identified are children (6 to 17 years), adults (18 to 64 years), and older adults (65-years and older). Children require the most physical activity of at least 60 minutes daily in order to maintain overall healthy body weight. Children who receive at least 60 minutes of daily physical activity will learn to continue to carry out the habit of exercise as they grow up (U.S. Department of Health and Human Services, 2008). Adults and older adults are recommended to engage in physical activity for 150 minutes per week, or 30 minutes over a span of 5 days. Individuals should engage in physical activity every day of the week. Walking 10 minutes three times per day for five consecutive days will meet the recommended 150 minutes per week for each week. That walk does not have to be on an exercise machine. A walk to the local grocery store or to the park will contribute to the recommendation. A 30 minute walk for five days a week has been demonstrated to promote longevity by approximately 1.5 years (Franco et al., 2005). Walking 15 to 30 minutes per day can burn an extra 100 calories, which will prevent a typical adult average gain of one to two pounds per year that can lead to obesity (Hill, Wyatt, Reed, & Peters, 2003). Lovasi et al. (2008) examined the correlation between a built environment and 1068 participants/walkers in western Washington State. Of those 1,068 participants, 62% walked on a daily basis between 1.4 hours and 3.6 hours per week. Where a built environment is walkable, people walked mainly for transportation rather than recreational purposes. Walkable neighborhoods that are pedestrian friendly will have people that are twice more likely to walk than those in neighborhoods that are not tailored to walking (Lovasi et al., 2008).

Many people do not engage in adequate amounts of physical activity. Approximately 15% of the U. S. population meets the daily recommendations for suggested physical activity (Schrop et al., 2006). Less than a half of Americans meet the minimal requirement of 30 minutes of physical activity a day (Centers for Disease Control and Prevention, 2003). There are several factors that restrict individual physical activity. Those factors include: not knowing what exercises to do, limited time, cost, and lack of access to appropriate exercise facilities and equipment (Schrop et al., 2006). It has been shown that the medically underserved population has one of the lowest exercise participation rates, which may be due to lack of knowledge. Schrop et al. (2006) defined the medically underserved population as individuals who receive less primary care than the general population, who by the time receives that care is in more critical health conditions, and usually consist of lower socioeconomic status populations. For those reasons, it is critically important to encourage walking as a method of exercise. Walking for transportation is a sufficient method of achieve the daily minimal physical activity requirement.

Walking is a convenient form of physical activity for all individuals, yet many do not receive adequate amounts of it due to various demographics. Schrop et al. (2006) found no association between participation in physical activity and race, chronic health problems, employment status, and marital status. Men were more likely to participate in physical activity than women (Schrop et al., 2006). Parents who have children under the age of 18 years in their household are less likely to exercise on a daily basis because of time allocated to provide child care. People with lung problems or diabetes are less likely to exercise on a regular basis because of perceptions of pain and not knowing what exercises they can perform without suffering (Schrop et al., 2006). In summary the largest barrier to exercise is the lack of knowledge that walking is a simple activity that requires no equipment. Walking is an easy activity for everybody and contributes to improved health and overall well-being.

Factors Associated with a Walkable Built Environment

The built environment plays a major influence in choosing to walk over driving to a desired destination. There are several factors that define a walkable built environment. Built environments are deemed walkable with a combination of functional and aesthetic features. Functional features induce walking, such as sidewalks. Aesthetic features create an attractive environment to encourage walking, such as landscaping. Built environments implementing a mix usage of land can create an urban atmosphere with an appealing physical appearance that encourages walking. The structure of a built environment includes a variety of diverse uses of land for different types of facilities, such as shops and restaurants as well as residential density (Larsen et al., 2009). Good street connectivity provides walkable pathways to destinations. A third contributor to the built environment is the degree to which people can usually carry out daily activities with quick access to necessary facilities (Khan, 2011).

Together, the three elements of mix land usage, aesthetics, and street connectivity in a built environment influences whether people walk in their neighborhoods. A neighborhood is defined as a 0.5-mile radius or a 10-minute walk in an area. A community is defined as a 10-mile radius or a 20-minute drive (Addy et al., 2004). Neighborhood characteristics were shown to explain 28% of the variation in reported walking in a study of 56 neighborhoods (Li, Fisher, Brownson, & Bosworth, 2005). Built environments can encourage individuals to walk for transportation and are a major contributor to daily physical activity needs (Owen, Humpel, Leslie, Bauman, & Sallis, 2004). The public generally associate walkability with variables of: residential density, mix usage of land, and street connectivity.

Land use mix and the built environment.

The function of mix usage of land in a built environment contributes to making an environment walkable for individuals. Mix land use in a developed area consists of a variety of building structures, such as banks, restaurants, apartment complexes and shopping stores for an individuals' convenience. This provides a community with access to a variety of facilities in one local area. Quick and easy access to amenities encourages patrons to walk from one facility to the next. When individuals know their desired destination is within a reasonable proximity, they will be more incline to walk instead of driving (Khan, 2011). Proximity is defined as the distance between an individual's current location to their next destination (Saelens, Sallis, & Frank, 2003). Individuals are more willing to walk when attractions, such as a mall or bakery, are within about 300 feet of one another versus a longer distance (Saelens et al., 2003). Individuals are less likely to walk if a distance is further than a mile. For distances more than a mile, people are more inclined to turn to another form of transportation such as a vehicle (Saelens et al., 2003). A built environment with variety businesses, such as restaurants, movie theaters, and shopping malls will promote walking for transportation.

Street connectivity and the built environment.

Street design in a built environment is a critical factor to influence walking. A walkable built environment is a neighborhood designed with sufficient street connectivity and sidewalk routes. Street connectivity is defined as how sidewalks are built in conjunction with main roadways to provide walkable paths for pedestrians without obstructing objects, such as walls or a dead end pathway (Saelens et al., 2003). Good street connectivity provides several pathways to one desired destination instead of limiting to one direct route and also includes proper pedestrian crossing lights (Boarnet, Day, Alfonzo, Forsyth, & Oakes, 2006). In a study of the correlates of walking in Australia, Giles-Corti and Donovan (2002) found that approximately 46% of participants who walk use sidewalks for recreational purposes and exercise. When there is a sidewalk or pathway available that leads to a desired destination, the number of walking pedestrians increased by 55.2% (Brownson, Houseman, & Brown, 2004). Street connectivity integrated with mix land use not only provides pedestrians a safe environment to walk, but also recreational activity and entertainment where walking is the main mode of transportation.

Compared to a suburban development where there may be a lack of sidewalks and cul-de-sacs with dead-ends, urban communities are often designed with many facilities within a walkable distance using street connectivity. Suburban communities are often constructed with little regard for street connectivity, few sidewalks, and dead-ends (Gallimore, Brown, & Werner, 2011). When sidewalks are strategically built with a focus on street connectivity, there will be easy access to desired destinations. People will be more willing to walk instead of taking other forms of transportation (Khan, 2011). In suburban communities, the lack of consistency in sidewalks and pedestrian safety lights limits walkability (Gallimore et al., 2011). Other studies have found that in most suburban communities, adults tend to walk less than in newer urban communities due to long distances between destinations (Zhu & Lee, 2008). If sidewalks were available in school communities 62% of school age children 11 to 13 years would be less likely to use a form of motorized transportation to school (Larsen et al., 2009). Street connectivity is an important feature for all age groups who participates in walking.

Aesthetics and the built environment.

An attractive built environment contributes to how well it will be used. Different age groups ranging from young adults to senior citizens view their exposures to the environment through different perceptions with regards to attractiveness of destinations (Brown, Werner, Amburgey, & Szalay, 2007). A younger population between the ages of 20-30 years may be attracted to an environment with various shops and upbeat activities. An older population- such as those between 45-65 years- may enjoy an environment with relaxing activities. Perceptions are also different based on gender. Men view the aesthetics of environment to be pleasing based on ease of access to walking. Women, on the other hand, perceives an environment to be attractive for walking purposes based on easy access to destinations (Humpel, Marshall, Leslie, Bauman, & Owen, 2004). A built environment must have various tasteful attractions for both men and women of different age groups. Attractive buildings have been observed as a contributing influencing for 39.8% of individuals to walk (Brownson et al., 2004). An attractive environment correlates with uplifting positive moods, lowering of blood pressure among many other health benefits (Brown et al., 2007; Hartig, Evans, Jammer, Davis, & Garling, 2003).

The cleanliness of a built environment is a contributing aesthetic that aids in promoting walking. The built environment must be kept clean with appropriate maintenance to draw in pedestrians. When an area is not appealing to individuals, it makes walking an unpleasant, undesirable, and/or even an intimidating experience (Brown et al., 2007). Litter, graffiti, and solicitation are among a few factors of fear that prevent individuals from walking (Brown et al., 2007). Built environments are conducive to walking when those factors are eliminated and appropriate property maintenance are carried out on a daily basis to keep the area clean and attractive (Lovasi et al., 2008). A clean built environment promotes walking.

Aesthetics include natural features such as trees for shade and landscaping. During the sunny and hot summer months, most individuals are not inclined to walk in the heat. Trees alongside sidewalks that provide sufficient amounts of shade may encourage walking. Trees along sidewalks in a built environment eliminate the sun’s harmful rays and heat. A randomized telephone-survey study examined the physical environments of rural and urban communities across the United States for physical activity and use of non-motorized transportation. An overall 53.9% of participants ages 18 years and older strongly agreed that they would be more likely to walk if there are trees along the sidewalks (Brownson et al., 2004). Trees also add physical color to the landscaping of a built environment. Other landscaping, such as flowers and benches, gives a built environment attractive physical features that allures walkers. When attractive scenery and landscaping are added to a built environment, 44.5% of individuals strongly agreed that it encourages them to walk (Brownson et al., 2004). Thus, trees and other modes of landscaping incorporated in a built environment will foster walking in a population.

Overall, a built environment consisting of functional and physical aesthetics encourages individuals to walk instead of using another form of transportation. A built environment that has a mixture of land use provides many opportunities of forms of entertainment appealing to various age groups from young to old. Street connectivity provides safe walkways for pedestrians to reach their desired destinations. Built environments are planned out in a manner where the location of each facility, such as a restaurant and bank, are located close in proximity for convenience. Close location between facilities influences individuals to walk to several locations rather than driving extra to reach those locations. Functional and physical aesthetics of a built environment are other dimensions that encourage individuals to walk. A location that is clean, well maintained, and has appropriate sidewalks will interest individuals who are willing to walk there.

Barriers to Walking in a Built Environment

There are several barriers that can potentially restrict walkability in a community. Barriers not only discourage individuals from walking, but also reduce the possibility of walking as an easier alternative to avoid such obstructions. Features of a neighborhood can reduce walking rates or act as a barrier to walking. Barriers are often referred to as either a macro-level environment or micro-level environment. A macro-level environment is a type of environment when routes between destinations are not within a walkable distance. Routes to destinations are often disconnected and/or indirect in suburban communities (Gallimore et al., 2011). Often, there is a lack of sidewalks in this type of environment. A macro-level environment consists of low residential density and has a little variety of land mix usage. A micro-level environment is an environment where there are not enough crosswalks or pedestrian traffic lights. A micro-level environment is often described as a specific environment setting where one carries out their daily activities such as school or work (Gallimore et al., 2011).

Barriers have a large influence on how often an individual walks. For example, when there are not an adequate number of crosswalks or pedestrian lights to support walking in a walkable area, walkers have a perception of not being safe. If an individual faces barriers they will more than likely rely on another mode of transportation other than walking. For that reason, it is important to recognize barriers in an environment to ensure that walking is used as a form of local transportation instead of a vehicle (Saelens et al., 2003).

An environment that supports walking attracts more pedestrians than one that contains obstacles. For example, in a walkable area of Portland, Oregon, individuals will take double the walking trips of about 2.1 trips per week. In an area where walking is limited, individuals tend to take smaller number of walking trips by about 0.5 trips per week (Saelens et al., 2003). Destination distance, lack of sidewalks, and safety are obstacles that limit walking. A well designed built environment is crucial to indicating cues and providing walking opportunities for any population (Giles-Corti & Donovan, 2002). Thus, it is crucial to strategically dissipate those barriers of a built environment to further the success of encouraging walking. In the San Francisco Bay area, Saelens et al. (2003) found that individuals in highly walkable communities will make an average of 6.8 walking trips per week compared to 1.1 walking trips for individual who live in low walkable communities. Communities where barriers are eliminated have more walkers than those who have not already done so.

Traffic safety as a barrier to walkability.

Traffic concerns are barriers in a built environment that restrict walking. Between 1996 and 2006, over 54,000 pedestrians have been killed due to traffic accidents (Khan, 2011). Brownson et al. (2004) observed that 52.8% of individuals strongly agreed that when there is too much on-going traffic, safety is a concern when it comes to walking. Moreover, 49.5% of individuals agree that most drivers exceed the posted speed limit in areas where there are pedestrians (Brownson et al., 2004). Despite concerns about safety, 49.6% of respondents in the study agreed that there were a sufficient number of pedestrian crossings and lights to aid in crossing streets with heavy traffic (Brownson et al., 2004). Heavy vehicle traffic poses a safety concern for pedestrians. Overcoming traffic and safety related barriers will potentially make walking more convenient than relying on vehicular transportation (Dannenberg, Cramer, & Gibson, 2005).

When a street network infrastructure provides the public with direct routes to desired destinations and traffic is consistently busy, individuals are less inclined to walk to those destinations due to safety concerns. With appropriate walkways, pedestrian traffic lights, and pedestrian crossings walkers have better opportunities to walk with improved safety. As a built environment becomes congested with vehicle traffic, many may conclude that walking is not only beneficial to their health but it may also reduce the stress of being caught in a traffic jam (Giles-Corti et al., 2011; Timperio et al., 2004). Even after installing pedestrian lights, drivers need to abide to laws in order for pedestrians to walk safely.

Crime as a barrier to walkability.

Crime rates are another second barrier to a walkable environment. Individuals who walk are alert to their surroundings both during the day and at night. However, crime rates influence whether or not an individual will walk regardless of time of day. Overall, neighborhoods with high crime rates reported to have fewer walkers. Approximately 63.1% of individuals reported that high crime rates in their neighborhood affect their walking (Brownson et al., 2004). High crime rate of a neighborhood suggests behavior changes with regards walking. Crime rates influences whether or not individuals chose to walk as a mode of transportation. Unsafe walking conditions at night due to crime influences 59.7% of individuals to not walk (Brownson et al. 2004). High crime rates during the day were taken into consideration for 63.1% of individuals who choose to walk. Eliminating or reducing crime in neighborhoods could contribute to increasing the number of walkers.

Tools Used to Measure Walkability

Various studies have utilized different methods to measure the walkability of certain built environments. Some common tools used to measure walkability were: surveys and questionnaires, geographic information systems (GIS), and audits. Different tools are implemented to measure different environmental variables and aesthetics that contribute to walking. For example, the Irvine Minnesota Inventory audit serves as a purpose to assess walkable route segments (Brown et al., 2007). The Irvine Minnesota Inventory provides physical information and data that are rarely available in GIS databases, such as benches and crosswalks (Boarnet, Forsyth, Day, & Oakes, 2011). The Irvine Minnesota Inventory was implemented to learn whether walking is more prominent when streets are marked with crosswalks (Boarnet et al., 2011). Most walkability studies use similar techniques and methods of capturing walking rates among populations, environmental features, and the actual built environment.

Walkability audits.

Audits are a tool that measures various walkability features of a particular environment. There are many types of audits. The Irvine Minnesota Inventory is an audit used to measure the accessibility, pleasure, and perceived safety of a given environment. Brown et al. (2007) conducted a study investigating the walkability of undergraduate college students' environment using the Irvine Minnesota Inventory to measure features in the environment that supported walkability. Participants were asked to complete a walk of two different segments with different surroundings and environment on a college campus to provide information regarding what they thought about that route. Each audit lasted approximately two hours. A comparison of all audit tools by the Robert Johnson Foundation (2010) found the Irvine Minnesota Inventory to be the most extensive because the assessment includes the most variables that influence walking.

Furthermore, an audit tool by Horacek et al. (2012) called Postsecondary Education Campus Walkability/Bikeability Semantic-Differential Assessment Instrument was used. This tool specifically examines walkability on any given college campus based on a set of criteria. The main criteria this audit tool focused on were safety, path quality, and temperature comfort. In this study, a sample of path segments were taken from a sample of fifteen different college campuses to assess whether or not they supported walking and biking. It was found that this tool is useful to provide campus planning with walkability scores in order for planners have an overview of the features that supports walking on a college campus (Horacek et al., 2012).

Another reliable audit tool that has been used to assess characteristics and features of walkable street segments is the Analytical Audit Tool (Robert Wood Johnson Foundation, 2010).

This tool provides an overall street assessment. A similar audit, Bikeability and Walkability Evaluation Table (BiWET), was found to be time efficient and accurate in providing information of 15 characteristics of any street segments up to 10 meters (Hoedl, Titze, & Oja, 2010). Audits of this type are is also very useful for examining correlations between a built environment and walkability (Hoedl et al., 2010). In general, audits are used to measure features in an environment that are conducive to its walkability (Boarnet et al., 2006; Day, Boarnet, Alfonzo, & Forsyth, 2006)

Questionnaires and surveys.

Questionnaires are one-self report method to measuring walkability of an environment. Surveys and questionnaires are often used to evaluate specific environments to determine whether they are conducive to walking (Brownson et al., 2004). Surveys provide information about whether individuals walk for exercise. Lovasi et al. (2008) conducted a study using questionnaires to examine whether or not a built environment would be sufficient in predicting walking for that particular area. Lovasi et al. (2008) found that 62% of participants from a randomized population walked for exercise in western Washington State. The Lovasi questionnaire uses mostly opinions and perceptions of individuals and their view of a walkable environment in order to evaluate the aesthetics that attracts most walkers (Lovasi et al., 2008).

The Neighborhood Environment Walkability Survey (NEWS) is type of questionnaire used in several studies to evaluate environmental characteristics that influence walking (Brown & Cropper, 2001; Kerr et al., 2006a). This questionnaire consists of 98 questions that allow analysts to better comprehend how a specific environment correlates to physical activity. Questionnaires regarding commuting patterns were also used to examine physical activity of individuals who commute to their universities (Moczulski, McMahan, Weiss, Beam, & Chandler, 2007).

Multiple types of questionnaires are available to measure perceptions of a walkable environment. Brownson et al. (2004) conducted a telephone survey using three different questionnaires: San Diego Instrument, South Carolina Instrument, and St. Louis Instrument. The purpose of each of those three questionnaires was to measure the perception of neighborhood designs (San Diego Instrument), physical/social environment (South Carolina Instrument), and influences of physical activity (St. Louis Instrument) (Brownson et al., 2004). During this telephone survey experiment, subjects were selected based on a randomized selection. Half resided in a rural community and half resided in an urban community. Participants who responded to the telephone surveys were asked to complete the survey again in 1 to 3 weeks. The purpose for such extended time frame was to ensure that participants did not remember questions asked from the surveys. The response rate for the first telephone calls was 36.3% and the response rate for the second administration of the surveys was 63.9% (Brownson et al., 2004). Answers to survey questions varied based on whether participants resided in a rural or urban area. There were many variables in each type of environment that contributes to walkability, mainly distance to destinations. Overall, these three telephone surveys used for the study were deemed reliable for further research experiments despite the time it took for completion (Brownson et al., 2004).

The Pedestrian Environment Data Scan Tool (PEDS) is another type of questionnaire tool that measures environmental variables attributed to walking (Robert Wood Johnson Foundation, 2010). The walking environment must be taken into consideration and compared (Lake, Townshend, Alvanides, Stamps, & Adamson, 2009). Brown et al. (2007) conducted a study following this method. Undergraduate students were recruited for the study from a state university social science class and divided into two experimental groups for each of the two street routes chosen. One experimental group consisted of 26 subjects and the second group consisted of 20 subjects. Each group was taken on one of the two street routes and was asked to answer several questions pertaining to the environment and walkers' experience during their walks. Comments they had were tape recorded. At the end of this study, a five-point Likert scale was used to rate the routes and open-ended comments were recorded (Brown et al., 2007). Similarly, another study used the five-point Likert scale to assess different elements of walkability, such as: pedestrian facilities, traffic conflicts, and accessibility (Dannenberg et al., 2005). Both of these studies came to a conclusion that walkers tend to find an environment more appealing with heavier traffic, a diversity of amenities with easy access, and safety measures with regards to appropriate walkways and pedestrian traffic lights (Brown et al., 2007; Dannenberg et al., 2005).

Other surveys or questionnaires, such as the Walking Suitability Assessment were implemented to obtain students' ratings of walkability on their college campus (Sisson, McClain, & Tudor-Locke, 2008; Emery, Crump, & Bors, 2003). Studies that conduct surveys use questionnaires that generally assess environmental characteristics and how they relate to walkability. Sisson, McClain, and Tudor-Locke (2008) carried out a study that examined walkability between campuses at two Arizona colleges. Pedometers were provided for participants recruited for the study, which they wore for a period of seven days. Maps were also provided for participants to mark routes to different destinations they took while walking on campus. After participants completed their contribution, Sisson et al. (2008) used the Walking Suitability Assessment to evaluate the built environment of the college campuses. The Walking

Suitability Assessment examines 11 characteristics of the environment, such as speed limit and traffic of the particular area. Sisson et al. (2008) reported that a built environment greatly influences the walkability of a college campus.

GIS tools for measuring walkability.

GIS is another tool used to assess walkability although it is not often used. GIS is a useful tool that can be used to obtain information about features in a built environment. Maps created with GIS can show features such as street connectivity, residential density and land mix use that supports walking (Gebel, Bauman, & Owen, 2009). The GIS tool was used to either determine the distance students walked on a college campus or to obtain objective variables of an environment (Sisson et al., 2008). GIS incorporates measures of dwelling density, street connectivity, and net retail area data into research. Not all perceived data collected regarding the environment are completely reliable. GIS provides more valid information for researchers (Gebel et al., 2009). Many built environment variables are objective measures that can be obtained through GIS (Gebel et al., 2009). In the study by Sission et al. (2008), GIS was used after completion of gathering data from participants to determine distances each participant had walked based on what they had described and marked on their maps. GIS is very useful in a macro-environmental setting to examine and assess population and diverse land use with regards to walkability (Hoedl, Titze, & Oja, 2010).

GIS has further been included into projects for a better comprehension of a walkable area. GIS graphically presents data of spatial distribution, sidewalks, and street segments for researchers to further understand routes used for walking. Ackerson (2005) demonstrated the use of GIS by using it to examine walking routes to school for middle school children. It was evaluated that although middle school children choose to take the shortest route to school instead of the actual route (Ackerson, 2005). GIS provides information on whether sidewalks surrounding a middle school were either complete, incomplete, or lack thereof. When used in conjunction with other tools, the evaluation of an environment and walkability measure becomes more accurate due to more details and information available.

In conclusion, audits, questionnaires/surveys, and GIS are some of the most useful types of tools used to measure the walkability of a particular environment. Using surveys and questionnaires/surveys is a quick strategy to obtain individual information regarding walking. Using audits to evaluate an environment and incorporating GIS to verify the data would further add support to information gathered by those surveys/questionnaires. These tools have all been demonstrated to effectively measure and assess the walkability of a built environment. However, some specific tools have been used more often than others, for example the Irvin-Minnesota Inventory has been used more than the Bikeability and Walkability Evaluation Table. It is necessary to examine all tools to determine which one is the best model to use for this study of walkability on college campuses. Figure 1 compares the major tools that have been most used to assess walkability of an environment.

	Analytic Audit Tool	Irvine-Minnesota Inventory	PEDS	GIS	Walking Suitability Assessment	NEWS
Unit of Analysis	Segment	Segment	Segment	n/a	n/a	n/a
Concepts Measured	Types of buildings/features, walking and cycling paths, street assessment, overall assessment.	Accessibility, pleasurability, perceived safety from traffic, perceived safety from crime.	Environment, pedestrian facilities, road attributes, walking/cycling environment, subjective assessment.	Dwelling density, street connectivity, and net retail area data.	Walkability of urban streets.	Environmental variables and aesthetics, diverse/mix use of land, street connectivity, traffic safety.
Reliability	From paper	All items in inventory with interrater reliability ≥ 70	n/a	From digital data collection.	n/a	n/a
Method of Collecting Data	Paper and Pencil (1 page)	Tablet PC and Paper and pencil	PDA, Paper and Pencil	Information system.	Paper and Pencil	Paper and Pencil
Time Required to Conduct	n/a	3-4 Hours per setting: 15-20 segments per setting. 20 minutes per segment including travel, fieldwork, data entry and proofing.	n/a	n/a	n/a	n/a

Figure 1. A comparison of various processes and tools used to measure walkability
Source: The Robert Johnson Foundation (2010)

Walkability of College Campuses

Upon entering college, students often exhibit a change in lifestyle, such as eating and physical activity levels. Other students face stressors relating to academics and frequently do not take time to participate in some form of physical activity. Studies have demonstrated that only 30% of students meet daily requirements of moderate intensity exercise requirements (Dinger, 1999). Students generally adapt adult lifestyle behaviors after entering college (Gall, Evans, & Bellerose, 2000). This can be crucial to encourage walking as a form of transportation at college campuses to engage students in daily exercise. A study found that during freshman year of college, about 29% of students reported not exercising, which resulted in weight gain of 1.10-16.98 pounds the following year (Racette, Deusinger, Strube, Highstein, & Deusinger, 2005). The lifestyle a young adult engages when in college is often carried into adulthood.

A college campus is a unique community due to dense variety of students residing in residential halls or apartments close to campus. Furthermore, college campuses are strategically built environments that provide easy access to students to a plethora of daily necessities. This type of environment is often tailored to students' needs. This built environment of a college campus allows for a diversity of land mix usage where students can easily do their banking, grocery shop, eat, work out, and attend class all within walking distance (Frank, Engleke, & Schmid, 2003). Students have ready access to these facilities. It has been shown that there is a correlation between walking to school and high density populations (Kerr et al., 2006b). It is typical for student housing to be close together to create residential density or to have a large number of students reside in one area. The close proximity of buildings encourages students to choose walking on their campus mainly due to its feasibility. Students tend to walk together when going to the same destination, such as the cafeteria. The design of college campuses provides students the opportunity to meet the daily recommendations for physical activity by breaking up their daily exercise into walking segments. For this reason, a college campus is a great area to carry out a community assessment regarding the built environment and its' walkability.

The distance college students walk per day varies based on the built environment of their college campus. Destinations on a college are often within reasonable walking distances makes it convenient for students to carry out their daily activities solely at school. A typical college student performs an average of 9,000 to 11,000 steps per day (Behrens & Dinger, 2005). During a typical week, Monday through Friday, the average college student walks approximately 11,000 to 14,000 steps per day (Behrens & Dinger, 2005). Overall, approximately 40% of college students use walking as their main mode of transportation (Balsas, 2003). Some college campuses may be compact into a small area while other college campuses may be more spread out over larger space. The majority of college students are often on a financial budget, and walking is the most economical alternative. College students generally walk more during the week compared to the weekend due to having more classes and other campus activities during the weekdays (Sisson et al., 2008).

Walking and health.

Students who commute to school instead of residing near or on their college campus walk less. Students who drive to school tend to spend less time walking or other forms of physical activities because of time spent commuting. For every extra half mile a student walks each day, they reduce their chance of developing obesity by 4.8% (Frank, Andresen, & Schmid, 2004). Conversely, for every hour a student spends driving each day, their chance of developing obesity increases by 6% (Frank et al., 2004). Compared to students who do not commute to school, 64%

of students who commute an average of 15 minutes or longer are at a higher risk for being overweight. The difference is due to time not spent walking for physical activity (Moczulski et al., 2007). It is important to promote and encourage walking within a college campus as a means of leading a healthy lifestyle and preventing potential health related issues.

Research Questions

The following questions addressed in this study are:

1. How does the construct of paths on WSU's campus provide sufficient routes for student pedestrians?
2. How does daytime walkability differ from nighttime walkability?
3. As a built environment, are there certain features on WSU's campus that influences students' walking than others?

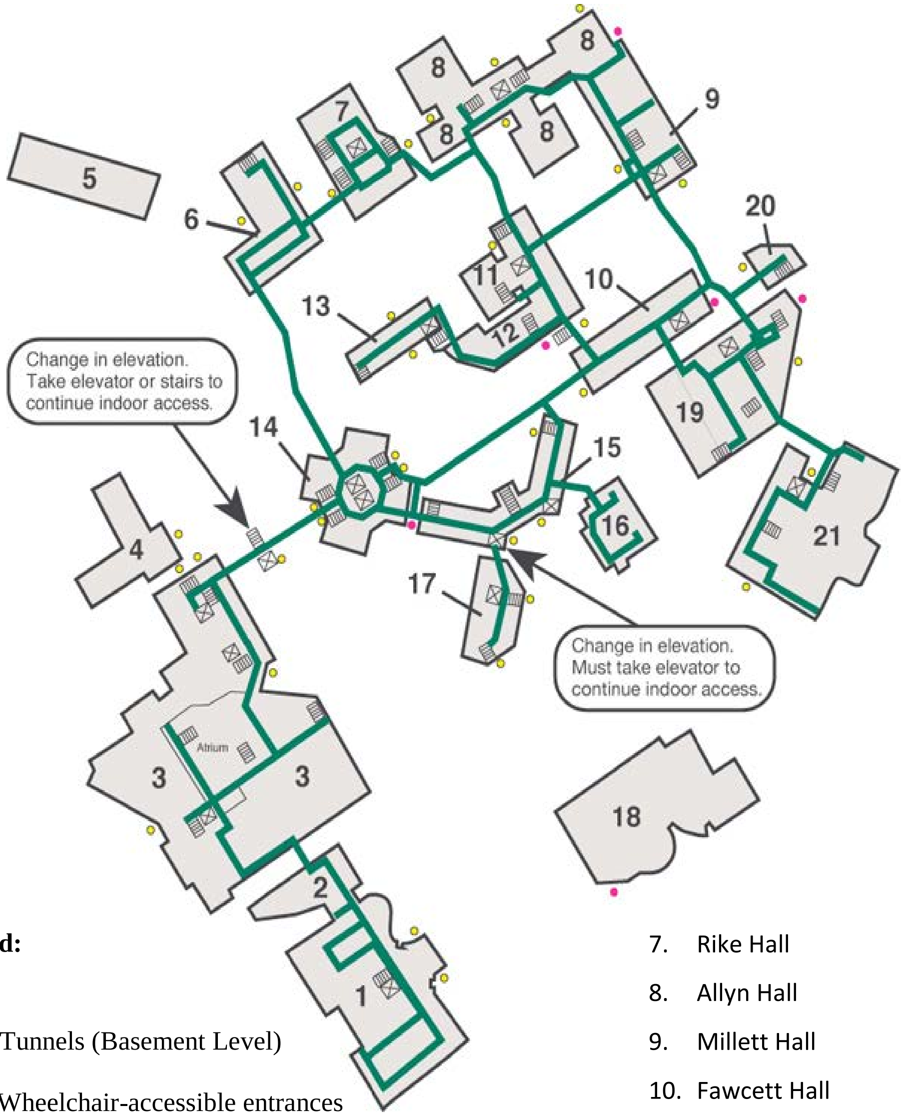
Methods

The methodology of this study was based on a bikeability/walkability study of Horacek and colleagues. Horacek et al. (2012) completed an audit at 13 different universities to examine conditions that supported biking/walking. Currently, walkability audits have not been conducted on Wright State University (WSU), Dayton, Ohio campus. No previous data are available from WSU to be incorporated into this study for comparison. The Postsecondary Education Campus Walkability/Bikeability Semantic-Differential Assessment Instrument was tool implemented in the WSU audit (see Appendix A). This tool provides criteria to survey features that either encourage or restrict walking at WSU. The audit was implemented during the Summer 2012 quarter on June 30, 2012, July 28, 2012, and August 2, 2012 by two researchers, the author and fellow MPH student Andrew Ford.

Study Setting and Sample

The setting for the study was the main campus of Wright State University (WSU) in Dayton, Ohio. WSU is located at 3640 Colonel Glenn Highway, Dayton, Ohio 45435 and covers 557 acres or 0.87 square miles. There are 25 academic and academic support buildings and 26 student residential buildings. WSU is surrounded by forest green on the North and Northeast boarders. Located to the Northwest is campus housing. Academic buildings are located southwest of main campus surrounded by Loop Road, University Boulevard, and Colonel Glenn Highway. Parking lots are located close to the center of the academic area and east of that. Areas for sports, such as a soccer field and tennis courts, are found east of campus. A layout of Wright State University is shown in Figure 2. Most academic buildings are connected via an underground tunnel as shown in Figure 3. The tunnel system does not connect to two buildings on campus, White Hall and the Community Center. The tunnels provide an alternative walking route on campus for students during inclement weather. Those tunnel routes, which were those connecting between buildings, were included in this assessment.

Figure 2. Wright State University campus map and key



Legend:

= Tunnels (Basement Level)

= Wheelchair-accessible entrances

= Electric doors

= Stairway

= Elevator

Buildings on Campus:

1. Russ Engineering Center, Fritz & Dolores
2. Joshi Research Center
3. Student Union
4. Hamilton Hall
5. Community Center
6. University Hall
7. Rike Hall
8. Allyn Hall
9. Millett Hall
10. Fawcett Hall
11. Oelman Hall
12. Brehm Laboratory
13. Mathematical and Microbiological Sciences
14. Medical Sciences
15. Biological Sciences I & II
16. Diggs Laboratory
17. Health Sciences
18. White Hall (Boonshoft School of Medicine)
19. Dunbar Library, Paul Laurence
20. Television Center
21. Creative Arts Center

Figure 3. Wright State University tunnel system

Researchers obtained copies of WSU campus maps and created enlarged copies to view path segments. Google Maps was also utilized to obtain in depth details, such as distance of various walking paths on campus not visible on campus maps as well as a one mile buffer zone around campus. The surrounding areas of WSU were also included in the survey because this is where the majority of students spend time. It was determined that the buffer area off campus will be one mile because of the entertainment offered within that area and distance. Some of which are a shopping centers, restaurants, and movie theaters. Furthermore, one mile is a reasonable walking distance and will provide adequate exercise. Path segment samples to those destinations were selected by using maps of the Wright State campus and the surrounding area. Routes directed to buildings on campus were selected, highlighted, and numbered. If multiple routes from the same starting point lead to the same building, only one of the routes was selected.

The stratified sample included a representative sample of routes on campus, to campus housing, academic buildings, and recreational areas, such as the Student Union. Study criteria stipulate that path segments be within the parameters of campus property as indicated in the maps and within the one mile buffer zone where students generally walk in order to be included in the sample. Path segments were excluded if they were not on a street or pathway/sidewalk, such as a path students have created by walking through a lawn. Each path segment sample consisted of a start and end point. Segments were marked on the campus map with a number. For example, a route may be from the Biological Sciences I building to the Student Union building will be marked with “1” on the map. Path segments that were longer than a five minute walk were divided into subdivision paths and labeled on the map. If that route from the Biological Sciences I building to the Student Union building took longer than a five minute walk, that path would be divided into “1A” and “1B”. Researchers walked throughout WSU’s campus to ensure the paths selected met this set of guidelines. A total of 66 path segments were selected for the study (see Appendix B).

Postsecondary Education Campus Walkability/Bikeability Semantic-Differential Assessment Instrument

Researchers obtained the tool used in this study through communications with the Tanya Horacek, PhD, RD of Syracuse University. The audit tool is called the Postsecondary Education Campus Walkability/Bikeability Semantic-Differential Assessment Instrument (Horacek et al., 2012). The materials provided included a web training video. The web training video provided information on how to use the tool, data collection, and calculations. Researchers completed the web training prior conducting the audit. The audit tool is a Microsoft Excel® spreadsheet that has embedded formulas to calculate walkability scores of path segments. The audit tool suggests using assessments of three evaluators to assess paths, which was adjusted to allow two researchers to assess paths because there were two students carrying out this study.

A data collection survey sheet of the Postsecondary Education Campus Walkability/Bikeability Semantic-Differential Assessment Instrument was printed out for each segment to be evaluated on campus. Researchers conducted data collection on the main campus of Wright State University, Dayton, Ohio using the data collection survey print-outs. This process took approximately 11 hours over a period of three days.

Major characteristics of the audit tool assesses include: safety, path quality, and the path temperature comfort. The components of the *safety* subscale include pedestrian facilities, crosswalk quality, pedestrian/motor vehicle conflicts, and nighttime. Pedestrian facilities indicate whether there are sidewalks on both sides or one side of a given road and if that sidewalk is located adjacent to or away from the road. Crosswalk quality examines if a crosswalk is located at an intersection with appropriate walk signals and traffic control indicators, such as a stop sign. Pedestrian/motor vehicle conflicts takes into account the traffic volume and whether or not it has potential to be a conflict for pedestrians. Nighttime safety feature accounts for emergency call boxes and other night features that would aid in the safety of pedestrians. The components of the *path quality* subscale include path maintenance, path size, buffer zone, accessibility for mobility impaired, terrain, and aesthetics. Path maintenance determines whether or not the path is free from tripping hazards and is well maintained. Path size assesses the width of the path. Buffer zone considers the space between the path and road. Accessibility for the mobility impaired consists of anything that would allow access for the handicapped. Terrain measures whether or not a path is easily walkable or if it requires some effort. Aesthetics considers whether the view is pleasing and free of trash. Shade is the criteria for *path temperature*. Path temperature is also considered a part of the path quality subscale. Shade provides protection from the sun's heat, lowers temperature, and allows a slightly more comfortable temperature to walk. Path temperature is also considered a part of the path quality subscale.

Each item was scored on a scale of 1 to 5. Guidelines set for scoring features are provided in Appendix A.1. A score of 1 is an indicator that a path segment does not support a particular walking feature and may be dangerous to pedestrians. A score of 5 indicates that a path segment is the most supportive of that particular walking and is safe for pedestrians. For example, a segment having a sidewalk on one side of the road but not both sides would be evaluated with a score of 3 based on guidelines provided. A list of path segments to be assessed was entered into a blank table as shown in Appendix A.2. Once data collection was completed, researchers entered the data into the blank Excel® table provided with formulas embedded (see Appendix A.3.) to calculate walkability scores.

Calculating Inter-Rater Reliability Score

The Inter-Rater Reliability (IRR) score was assessed to ensure data collecting was consistent. IRR is a percentage score that measure the agreement scores of researchers and indicates that researchers were highly consistent in the way they assessed path characteristics. The IRR score was determined by completing an assessment of paths off-campus. To begin the IRR score process, researchers surveyed 34 path segments that are located off campus within a one mile buffer radius. Appendix C lists the off-campus paths used to survey the routes for IRR. It was important for researchers to collect data in a consistent manner to produce plausible results.

The IRR table was modified to accommodate additional path segments by adding necessary rows and columns. After each of the two evaluators scored selected street segments using the scoring guidelines from Appendix A.1., the IRR score was calculated. This was completed by dividing the numerical higher score, known as the Highest Scoring Rater (HSR), of the two and multiplying by 100% for each separate segment. For example, if Evaluator 1's score for Street A is 4 and Evaluator 2's score for Street A is 3, the HSR is 4. Both scores would be divided by 4 HSR and multiplied by 100%, which is 75% for Evaluator 1 and 100% for Evaluator 2. The average of those two percentage scores calculated is the IRR score, which is 87.50%. Inter-rater reliability must be least 80% IRR or higher. Horacek et al. (2012) set this standard in their web training video to indicate that researchers fully understand the audit tool and how to score it in a consistent manner. If the IRR score was not at least 80%, researchers must re-survey the segments. When the IRR score is not at least 80%, path scoring is not consistent, which will cause discrepancies during the actual data collection process. The average IRR score for all segments was also calculated.

The IRR was calculated by 29 day assessed segments and 5 night assessed segments. Each researcher assessed paths on their own and then compared scores with the other researcher. When scores among researchers were different, a brief discussion took place to determine why each researcher gave a particular segment the score they did and decide which score was more plausible based on provided scoring guidelines. Components of the 34 path segments received an average High Scoring Rater (HSR) between 0.86 and 0.97. The overall Inter-Rater Reliability (IRR) was 94.2%. IRR scores for each component and the calculated IRR score can be found in Appendix D and E.

Data Collection Procedure

Sixty-six walkway segment samples were selected on WSU main campus and 34 walkway segment samples one mile off campus were selected. Each path was divided into segments to be evaluated. A segment identification list was composed for the chosen path segments to be evaluated. A list of segment number, name of street or area, start point, and end point for each segment was made (see Appendix B). To ensure that segments were evaluated in both daytime and nighttime 75% of these segments were surveyed during daytime hours and 25% were surveyed during nighttime hours. Furthermore, a list segments for the tunnels was also noted (see Appendix F). Surveying path segments during evening hours permitted researchers to assess nighttime features that may or may not be conducive to walkability of a particular segment.

All data was collected through a walking audit of the campus walking paths by two researchers. Researchers scored each segment at the same time using previously discussed scoring guidelines and then discussed reasons for those scores. See Appendix G and Appendix H for scores collected. Researchers spent three days (June 30, 2012, July 28, 2012, and August 2, 2012) collecting data. Path segments assessed during daylight hours was completed between 8:30am and 5:30pm. Path segments assessed during evening hours was completed between 8:30pm and 10:30pm.

Data Analysis

Upon completing the data collection, researchers were able to gather sufficient information for a data analysis of walkability on WSU's campus. The walkability score consists of a combination of two subscales and subscores, the high importance subscale and the medium importance subscale. Each component is weighed on a scale of one and two based on priority of importance for walkability. The high importance subscale is given a priority weight of three and includes components identified with path safety. The medium importance subscale is given a priority weight of two and includes components identified with path quality and path temperature. The score for each segment surveyed was obtained from the formulae embedded in the table supplied by Horacek, et al (2012). Scores for day and night segment assessments were calculated using the following formulae (Horacek et al. 2012):

Daytime assessment scores.

High Important Sub-Score= (pedestrian facilities + conflict + crosswalks)

Medium Important Sub-Score= (maintenance + path size + buffer + accessibility + bikeability + terrain + aesthetics + shade)

Nighttime assessment scores.

High Important Sub-Score = (pedestrian facilities + conflict + crosswalks + night)

Medium Important Sub-Score = (maintenance + path size + buffer + accessibility + bikeability + terrain + aesthetics)

Weighed sub-scores are used to calculate the walkability score. The sub-score total is divided by the total number of possible points and multiplied by a weighting factor based on the level of importance of the subscale then multiplied by 100 to provide a percentage score. The walkability scores for both day and night assessments were computed using the following formulae provided in Excel® supplied by Horacek et al. (2012):

Daytime Walkability= (((3*[pedestrian facilities + conflict + crosswalks]) + (2*[maintenance + path size + buffer + accessibility + bikeability + terrain + aesthetics] + shade)/120)*100)

Nighttime Walkability= (((3*[pedestrian facilities + conflict + crosswalks + nighttime safety]) + (2*[maintenance + path size + buffer + accessibility + bikeability + terrain + aesthetics]))/130) *100)

For ease of interpretation percent scores are converted to a letter grade as described below.

Percent Range	Letter Grade
85 to 100	A
70 to 84	B
55 to 69	C
54 and less	F

Results

The purpose of this study was to examine walkability on WSU's main campus. This allows researchers to further investigate the built environment of campus, the differences between daytime and nighttime walkability, if the constructs of those paths on campus provide sufficient walking routes. A total of 66 segments were assessed using the Postsecondary Education Campus Walkability/Bikeability Semantic-Differential Assessment Instrument.

Pedestrian facilities, pedestrian/biker motor vehicle conflicts, crosswalk quality, nighttime safety features, path maintenance, path size, buffer zone, accessibility for mobility impaired, terrain, and aesthetics are the components used to calculate walking scores.

Overall walking score grades are shown in Table 1. The 66 segments received an average waking score was 82.6 for a grade of B. Forty-one segments were given a grade of A with walking scores between 85% and 100% for an average score of 88.5%. A grade of B was given to 17 segments with walking scores between 70% and 84% with an average score of 79.4%. Six segments received a grade of C with walking scores between 55% and 69% with an average score of 67.5%. Two segments received grades of F with walking scores below 55% with an average score of 32.2%.

Table 1
Walking Score Grades

Grade Score	Segments	Walking Score (pct)
A	41	88.6
B	17	79.4
C	6	67.5
F	2	32.2
Total	**66**	**82.6**

Safety Subscale

The elements of the safety subscale consist of pedestrian facilities, pedestrian/biker motor vehicle conflicts, crosswalk qualities, and nighttime safety. Table 2 shows that the four safety elements have average assessment scores above 4. The average safety assessment score for the 66 assessed segments is 4.6. Pedestrian facilities received the highest average safety assessment score of 4.7.

Table 2
Safety Subscale Average Scores*

Criteria	Average	Std Dev
Pedestrian Facilities	4.7	0.81
Conflict	4.6	0.93
Crosswalks	4.6	0.76
Night	4.1	1.18
Safety Subscale	**4.6**	**0.84**

*High Importance Subscale

The safety element that received the lowest average assessment was nighttime safety with an average score of 4.1 and the highest variability.

Table 3 shows the average cumulative component scores for the safety subscale. These segments have an average cumulative score of 14.9. Sixty of the 66 segments that received walking scores of A or B have an average cumulative component score of 15.4 (st dev 2.01). Most of these segments were located closer to central main campus of WSU, where there are little to no traffic.

Table 3
Safety Criteria Subscale Grades and Scores*

Grade Score	Segments	Average	Std Dev
A	41	15.8	2.06
B	19	14.7	1.70
C	4	10.8	2.06
F	2	6.5	3.54
Avg		14.9	2.75

*High Importance subscale

Six segments that received walking scores of C or F have an average cumulative component score of 8.6 (st dev 2.88). The four segments of walking scores of C were located along the outer perimeters of WSU's campus property. The two segments of walking score F were located further than those of walking scores C. Segments of both walking scores C and F located along the perimeters of WSU's campus property are closer to vehicular traffic, which can affect scores.

Path Quality Subscale

The assessment scores for the medium importance sub-scale are based on the path quality components. The elements of the path quality subscale include: maintenance, path size, buffer, accessibility, bikeability, terrain, aesthetics, and shade. Table 4 shows the elements of path quality having average assessment scores ranging between 1 and 4.9 with varying variability. The average path quality assessment score for the 66 assessed segments is 3.7. Path size received the highest average path quality assessment score of 4.9. The majority of paths on WSU's campus were consistent in size, resulting in low variability. Maintenance, path size, buffer, accessibility, terrain, and aesthetics all scored at or higher than the overall path quality assessment score. This is an indication that features of those criteria are supportive of walkability at WSU.

Table 4
Path Quality Subscale Average Scores*

Criteria	Average	Std Dev
Maintenance	4.6	1.0
Path Size	4.9	0.7
Buffer	4.5	1.2
Accessibility	4.6	1.2
Bikeability	1.0	0.0
Terrain	4.2	1.1
Aesthetics	3.7	1.3
Shade	2.1	1.5
Path Quality	**3.7**	**1.7**

*Medium Importance subscale

The path quality elements that received the lowest average assessment were shade and bikeablity with average assessment scores of score of 2.7 and 1.0 respectively and were below the overall average path quality assessment score. The lack of bicycle lanes separate from sidewalks resulted in an average assessment score of 1.0 with no variability.

Table 5 shows the average cumulative component scores for the path quality subscale. These segments have an average cumulative score of 27.4. Sixty of the 66 segments that received walking scores of A or B has an average cumulative component score of 28.3 (st dev 2.87). Similar to segments assessed for the safety subscale, most segments with walking scores of A or B were located closer to central main campus of WSU, where there are little to no traffic.

Table 5
Path Quality Subscale Grades and Scores*

Grade Score	Segments	Average	Std Dev
A	41	29.5	1.08
B	19	25.7	3.73
C	4	22.8	2.63
F	2	10.0	4.24
Avg		**27.4**	**4.41**

*Medium Importance subscale

The four segments of walking scores of C were located along the outer perimeters of WSU's campus property. The two segments of walking score F were located further towards WSU's property perimeter compared to the four segments of walking score C. Segments of grade C and F located away from central WSU's main campus may not be as well maintained as those located closer to central campus property, and thus would affect path quality subscale scores and grade.

Day and Night Walkability Scores

The 66 segments assessed at WSU's 66 segments were found to be similar to one another with regards to day and night subscales, which can be seen per Table 6. The average high importance sub-score for the safety criteria was 14.2 for day segments and 17.1 for night segments. The average medium importance sub-score for the path quality criteria was 27.5 for day segments and 27.2 for night segments. The assessed path segments on WSU campus received an average walkability score of 83.1% for day segments and 81.2% for night segments, which translates to an overall average grade of B. Overall, more paths are used during the day for walking than there are for night walking.

Table 6
Daytime and Nighttime Subscale Grades and Scores

	Daytime		Nighttime	
	Avg	SD	Avg	SD
Walk score	83.1	9.07	81.2	18.30
Safety Subscale	14.2	1.58	17.1	4.25
Quality Subscale	27.5	3.97	27.2	5.74

Tunnel System Walkability Scores

The tunnel system is a unique feature that connects WSU buildings. This feature is not found on other campuses. Scoring the tunnel system is different from previous segments on campus. The system is a consistent controlled environment. As a result the scores for the 17 segments assessed in the system are the same. Table 7 shows the sub-scale average assessment and walkability scores for the tunnel system. All those segments received safety sub-score assessments of 5. The average medium importance sub-scale assessment score for the tunnel system is 4.1. The walkability score of the tunnel system at WSU scored 85.8%, which indicated that it is at the low end of excellent support for walking (see Appendix I).

Table 7
Tunnel System Subscale Grades and Score

Segments	17
Safety Subscale	
Average	5
Std Dev	0
Walk Score	85.8
Quality Subscale	
Average	4.1
Std Dev	1.2
Walk Score	85.8

Overall Walkability Scores

The findings in this study suggest that the Wright State University (WSU) campus is a walkable campus. Based on criteria provided by Horacek et al. (2012) in Appendix A.3., path segments that scored a Grade A demonstrates excellent support for walking. Segments scoring a Grade B or Grade C provided satisfying support for walking. Segments that did not provide satisfying supporting for walking received a Grade F. Daytime walkability at WSU is slightly higher than nighttime walkability. Walkability of the tunnel system is slightly higher than the campus as a whole. The average score for the 66 segments was 82.6 for a grade of B. Wright State's path system provides satisfactory walking. The average bikeability on paths was accessed at the lowest level (1.0). Sub-scale assessment scores for the safety and path quality criterion range between 1 and 5. The wide range of sub-scale assessment scores is an indication that while many elements of the path safety and quality criteria at WSU are supportive of campus walkability others need attention.

Discussion

Exercise is important to maintaining overall health. Walking is a convenient form of exercise that does not require a lot of time, money, or effort. Walking is a type of exercise that can easily be incorporated into a daily lifestyle, such as on a college campus where students often change their diet and exercise levels. College students adapt adult lifestyle behaviors after entering college (Gall et al., 2000). At this stage in life, it is important to encourage walking for exercise to meet the daily exercise recommendation of 150 minutes per week (U.S. Department of Health and Human Services, 2008). Exercising 150 minutes per week will prevent a weight gain of 1.10-16.98 pounds the following year after entering college (Racette et al., 2005). Walkability on a college campus is crucial to influencing students' physical activity level.

Wright State University was established in 1965 with a campus accommodating 3,203 students (Wright State University, 2012). As a relatively young university compared to others, WSU developed its' overall environment with more academic buildings, some landscaping, and multiple pathways for students. The location of WSU in Dayton, Ohio is unique because of the environment enclosed by Air Force base and surrounding forestry. The findings in this study suggest that the Wright State University (WSU) campus is a walkable campus. WSU received a walking score of a B with 58 of the 66 total path segments rated as grades A or B. A high walking score indicates that features at WSU supports and are conducive to walkability. Many features of safety, path quality, and path temperature comfort criteria were found to be influential for walkability on campus. Path quality and safety features received average subscale scores of 3.7 and 4.6 respectively. Examples of identified features are landscaping, sidewalks, and night lighting. Destinations to academic and residential buildings located on campus property were within walking distance. The layout of buildings WSU is beneficial to providing students with physical activity during their school schedule.

High and Medium Importance Subscales

Features assessed were of either the high importance subscale or the medium importance subscale. Elements of safety subscale are a part the high importance subscale. Similarly, elements of the path quality subscale are a part of the medium importance subscale. The purpose of the high importance subscale and the medium importance subscale is for researchers to prioritize features during the audit (Horacek et al., 2012). The safety and path quality subscales contribute to the overall walking score of WSU's campus.

Safety is a concern for many students on a college campus. When walking on campus, students need safety for security measures. Features of the safety subscale received an overall average score of 4.6. The high overall average score provides evidence that WSU is a safe campus for students to walk. WSU's safety subscale score is comparable to other college campuses. A study of fifteen college campuses received an overall safety subscale score of 3.9 (Horacek et al., 2012), which is slightly lower than WSU's overall safety subscale score. This suggests that WSU's campus is somewhat safer compared to others.

Safety subscale features received higher average assessment scores suggests that the walking environment at WSU is relatively safe for its' students. Most areas on campus had continuous sidewalks either on one side of the road or both sides of the road. Sidewalks on one side of the road or both sides of the road will alleviate congestion for both pedestrians and motor vehicles. Moreover, good visibility of sidewalks and roads prevented pedestrian and motor vehicles. Most crosswalks on WSU's campus were not a road intersection. The campus design of WSU has main roads, such as University Boulevard and Loop Road, and parking lots located towards campus property perimeter. Crosswalks at any given road intersection were clearly marked with traffic signals. Features of well-lit areas and emergency call boxes provide students protection when walking at night.

Features of the safety subscale's average assessment scores were higher than averages in a similar study by Horacek et al. (2012). All features of the safety subscale examined at WSU received average assessment scores of 4 or higher. Whereas the 15 college campuses audited by Horacek et al. (2012) received average assessment scores of 3.35 and higher, with one safety element receiving an overall assessment average score higher than 4. Nighttime safety for both WSU and those 15 campuses received the lowest average scores for the safety subscale of 4.1 and 3.35 respectively. This shows that not only WSU's campus is safe during the day, but it is also safe at night for students compared to other campuses. Safety features on WSU are a necessity to maintaining a secure walking environment for students.

Path quality is another area that affects students' walkability on a college campus that parallels safety. Path segments that are well maintained will attract more students to walk. Features of the path quality subscale received an overall average score of 3.7. Other college campus' path quality that has been audited received an overall average score of 3.5 (Horacek et al., 2012). WSU's overall path quality is very similar to the 15 college campuses examined by Horacek et al. (2012).

Path quality subscale features received a range of average assessment scores suggests that some areas on WSU's campus had better path quality than other areas. Some features on WSU's campus did not support walking because they either did not meet the standard during the assessment or the feature was not available. For example, WSU lacks a bicycle lane that is separate from roads and sidewalks, which resulted in a low assessment score of 1.0. The lack of separate bicycle lanes decreases the path quality for walking students as they share sidewalks with bicyclists. Another feature that received a low assessment score was shade with an average assessment score of 2.1. Low levels of shade on campus may be due to trees not fully matured. Shade depended on the time of day, weather, and other environmental factors. Bikeability and shade were also features that received low average assessment scores of 1.5 and 2.6 respectively in a study of fifteen campuses by Horacek et al. (2012). Compared to those campuses, WSU's campus has less bikeable paths separate from sidewalks and less levels of shade. Despite the low assessment scores for bikeability and shade at WSU's campus, other features regarding elements of path quality scored higher. Sidewalks were well maintained and were of a consistent size throughout campus. Proper sidewalk size of at least five feet and kept in good condition provides student with adequate quality paths for walking. Most paths were located away from the road, which also increases path quality.

There was little difference in daytime and nighttime walking scores at WSU. The small difference between daytime and nighttime walking scores demonstrates that overall walkability at nighttime is equally the same as daytime. However, assessment scores for nighttime features had the highest variability compared to other daytime features. The variability for nighttime walkability was 18.30 compared to the variability of 9.07 for daytime walkability at WSU. The location of nighttime feature on campus may have contributed to this variability. It was observed there were fewer nighttime safety features, such as emergency call boxes, further away from central WSU's campus. The number of well-lit areas also depended on location relative to WSU's campus. Central WSU campus was well-lit and dimmed out towards the outskirts of campus property to only lights on pathways. Throughout WSU, emergency call boxes are available for students in any cases of emergency. This feature is indicated by a bright blue light with a large call button. Emergency call boxes add to the nighttime safety on WSU, making campus more walkable at night for students. WSU's campus is safe for students to walk during both day and night.

Tunnel System

The tunnel system at WSU is unique compared to other universities. This system was originally created with the first buildings on campus with a purpose of transporting mechanical systems. The system is commonly used for walking between buildings, especially in inclement weather (Davidson, 2012). WSU's tunnel system provides alternative walking route for students throughout the year as it is a controlled indoor environment. The environment of the tunnel system is well maintained where all paths are on flat terrain, appropriately sized greater than five feet wide, and free of any vehicular conflicts. The tunnel system also provides access to majority of campus buildings for the handicapped. Such built environment contributes to both overall safety and path quality subscale average scores of 5. The tunnel system's safety and path quality average subscale score is higher than WSU's campus overall average safety and path quality average subscale score of 4.6 and 3.7. Previous research has not been conducted at other college campuses to examine underground walking paths. The tunnel system is what makes WSU unique compared to other college campuses that have been audited using the Postsecondary Education Campus Walkability/Bikeability Semantic-Differential Assessment Instrument tool. The tunnel system is a feature that influences students walk on campus year round.

Public Health Implications

Walkability of a college campus contributes to the physical health of students and public health community. Walking is the easiest method to incorporating daily physical activity students' busy school schedule. In college, students often change their lifestyles, which they will carry into their adulthood (Gall et al., 2000). Many students' physical activity levels decrease when they enter college, which results in weight gain and other health problems (Racette et al., 2005). Overtime, decreased physical activity levels will affect the health of the overall community. Physical activity provides benefits, such as weight management and disease prevention (Hunter & Eckstein, 2009). It is critical to encourage walking on college campuses.

The Postsecondary Education Campus Walkability/Bikeability Semantic-Differential Assessment Instrument tool can be implemented on other college campuses to evaluate walkability. Results from the audit can be used to synthesize interventions to promote walking as a form of physical activity. Increase in physical activity levels among college students will further aid in eliminating rising health problems, such as obesity and heart disease. Promoting walking as a cost effective form of physical activity would attract students as most college students have limited finances.

Another method to promote walking at a college campus is through a well-designed built environment. A built environment consists of feature that impacts physical activity on a college campus (Racette et al., 2005). The college campus structural design influences how often students walk. A college campus has to be planned and designed with proper sidewalks, safety features, and aesthetics to destinations in order to attract students. When this is accomplished, students will walk more, which will increase the public health of the college community. Increased walking on college campuses will have a positive impact to public health and the health of students.

Limitations

There were several limitations that arose during the course of this study. While the Postsecondary Education Campus Walkability/Bikeability Semantic-Differential Assessment Instrument tool was designed for three researchers, it was modified for two researchers for this study. The modification to accommodate two researchers can create a shift in the calculated IRR scores, which will affect how reliable data collecting was between researchers. Furthermore, the timeline for the campus assessment and the assessment for IRR was not completed in chronological. The campus day assessment was carried out first, the IRR, and then the campus night assessment. Therefore, there are some uncertainties to data collecting prior to completion of IRR.

It was also questionable as to whether a sufficient number of path segments were being assessed in the course of this study. Based on previous research, there are no specific set guidelines to the number of path segments that should be assessed in an audit. Many walking path segments are available on WSU’s campus, which may be different compared to other college campuses. Due to this, the total number of assessed segments would range from one campus to another. It is important for to assess segments in all possible areas of WSU in order to get an overall walkability score that includes pathways from all of WSU’s environments. Omitting segments from an area on campus where students walk would potentially lead to skewed data.

Conclusions

Overall, walkability at WSU is slightly higher compared to other college campuses. Campus planners have performed an adequate work to encourage walking on campus. Strong areas of walkability on WSU’s campus are those regarding safety, such as sufficient number of walking paths and less pedestrian/vehicular conflict on campus property. The quality of those walking paths is also conducive to encourage students to walk. Safety is a major concern for students when walking day or night on campus. Current features at WSU have shown to support safety and thus, make campus walkable for students both during the day and night. The general path quality on campus meets previously set standards to provide students with sufficient walking paths.

Although the walkability at WSU is slightly higher other college campuses, there are areas that need improvement, such as campus lighting at night for paths away from central campus towards the Nutter Center and the perimeter of campus property. For example, a sidewalk from south of campus towards the Nutter Center has lighting on the path but the lighting is dimmed. Similar to other college campuses, bikeability is another area that needs attention. WSU lacks a bicycle lane separate from its' sidewalks. Student bicyclists on WSU's campus share the same paths as student pedestrians. As previously mentioned, shade was low due to trees not fully matured. This is a feature that will improve over time. Improving those areas will increase in WSU's walkability.

WSU's Master Plan has listed "Pedestrian Movement" (Wright State University, 2011) as one of their goals for the development of the university's community. Future development of campus, such as addition of new buildings, will be constructed adjacent to the core of campus. These new building additions will also connect to the campus' already available tunnel system. Moreover, a construction of a pedestrian bridge that connects commuter parking lots and campus housing over the road that loops around campus to better accommodate those students. A bike path at WSU that connects all areas of campus for better accessibility of all facilities will improve walkability. With this development on WSU, students will be more encouraged to make walking their mode of transportation. The built environment of this type of campus design avoids any harmful effects of forcing physical activity to the college community. Adding key walking features to WSU would assist in increasing walkability on campus. Current features of path quality and safety at WSU are very conducive to walking. However, path quality and safety features may be used for future campus development to aid in increasing walking among students.

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Appendix A: Postsecondary Education Campus Walkability/Bikeability Semantic-Differential Assessment Instrument (Horacek et al., 2012)

A.1.: Data Collection Survey

Safety Criteria					
CRITERION	**1**	**2**	**3**	**4**	**5**
A. Pedestrian Facilities	No permanent facilities		Sidewalk on one side of road		Continuous sidewalk on both sides of road or completely away from road
B. Pedestrian/Biker Motor Vehicle Conflicts	High conflict potential: fast moving vehicles, high traffic volume, or poor visibility for foot or bike traffic				Low conflict potential: no vehicle traffic and good visibility for foot or bike traffic
C. Crosswalk Quality	No crosswalk at major intersection	No crosswalk at low volume intersection	Crosswalk, no traffic control (i.e., stop signs or lights)	Crosswalk with traffic control or walk signal	No intersection or crosswalks are clearly marked and traffic controlled
D. Nighttime Safety Features	No lights or no visible emergency call box	Dim light or no visible emergency call box	Partial light or no visible emergency call box	Partial light and visible emergency call box	Well-lit and visible emergency call box
Path Quality Criteria					
CRITERION	**1**	**2**	**3**	**4**	**5**
E. Path Maintenance	Major or frequent tripping/falling hazards such as cracked or buckled pavement, standing water				No tripping/falling hazards
F. Path Size	No permanent facilities	<3 feet wide or significant barriers to passage			>5 feet wide, barrier free
G. Buffer Zone	No buffer from roadway			>4 feet from roadway	Not adjacent to roadway
H. Accessible/ Passable for mobility impaired	Completely impassible for wheelchairs (lacks ramps, curb cuts)	Difficult for wheelchairs or other mobility impaired (lacks handrails on steps)		Inconvenient for wheelchairs or other mobility impaired	Easy access for wheelchairs or other mobility impaired
I. Bikeability	No designated bike lane	Designated bike lane shared with parking area	Narrow (<3 feet) designated bike lane on road	Wide (>3 feet) designated bike lane on road or walking path	Wide designated bike lane separated from cars on road and walking path
J. Terrain	Very hilly or steps that require extra effort		Moderate hill that requires some effort		Flat or level, easy to walk or ride
K. Aesthetics	Uninviting (presence of construction zones, noise, poor landscaping, no benches or water fountains)				Pleasant (visually inviting, quiet, benches and water fountains available)
Path Temperature Comfort Criterion					
CRITERION	**1**	**2**	**3**	**4**	**5**
L. Shade	No shade				Full shade

Appendix A.2.: Segment Identification List

SEGMENT IDENTIFICATION				
# on map	Name of street/area	Start point	End point	Evaluator

Appendix A.3.: Data Entry

DATA ENTRY																
Segment Identification																
#	Segment Name	Evaluator (Initial's)	Facility	Conflict	Crosswalk	Night	Mainten	size	Buffer	Accessible	Bikeable	Terrain	Aesthetic	Shade	High Import Sub-score	Med Import Sub-score	Total score
25% segments evaluated at night																	
														x	0	0	0.00
														x	0	0	0.00
														x	0	0	0.00
														x	0	0	0.00
														x	0	0	0.00
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														x	0	0	0.00
														x	0	0	0.00
														x	0	0	0.00
														x	0	0	0.00
														x	0	0	0.00
														x	0	0	0.00
														x	0	0	0.00
Average Nighttime Scores			#DIV/0!	###	###	###	###	###	###	###	###	###	###		0.00	0.00	0.00
#	Name	Evaluator	Facility	Conflict	Crosswalk	Night	Mainten	size	Buffer	Accessible	Bikeable	Terrain	Aesthetic	Shade	High Import Sub-score	Med Import Sub-score	Total score
75% segments evaluated during the day																	
						x									0	0	0.00
						x									0	0	0.00
						x									0	0	0.00
						x									0	0	0.00
						x									0	0	0.00
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						x									0	0	0.00
						x									0	0	0.00
						x									0	0	0.00
						x									0	0	0.00
Average Daytime Scores			#DIV/0!	###	###		###	###	###	###	###	###	###	####	0	0	0.00

Grade A = score ≥85 indicates excellent support for walking and biking
Grade B = score 70 to <85 indicates satisfactory support for walking and biking
Grade C = score 55 to <70 indicates fair support for walking and biking
Grade F = score <55 indicates poor support for walking and biking

Appendix A.4.: Calculating the Inter-Rater Reliability Score

INTER-RATER RELIABILITY														
Interrater Reliability for walkability segments (>0.8 desirable)														
Interrater Reliability		Evaluators scores												
#	Name of segment	Facility	Conflict	Crosswalk	Night	Maint	Size	Buffer	Access	Bike	Terrain	Aesthetic	Shade	Comments

Lower score for a Rater is divided by highest score for each Evaluator/Rater.

If you have more than one rater- divide all raters by the highest scoring evaluator/ rater (HSR)

Segment Evaluated for Interrater Reliability	Facility/ HSR	Conflict/ HSR	Crosswalk/ HSR	Night/ HSR	Maint/ HSR	Size/HSR	Buffer/ HSR	Access/ HSR	Bike/HSR	Terrain/ HSR	Aesthetic / HSR	Shade/ HSR	Average HSR	HSR Score (%)	Comments
VERAGE HSR															

Appendix B: List of On-Campus Path Segments for Assessment

SEGMENT IDENTIFICATION				
# on map	Name of street/area	Start point	End point	Evaluator
1	Col Glenn Hwy	Starbucks	University Blvd	AF/LN 6/30/12
2	Col Glenn Hwy	University Blvd	Center Rd	AF/LN 8/2/12
3	Col Glenn Hwy	Col Glenn Hwy	Loop Rd	AF/LN 6/30/12
4	Col Glenn Hwy	Center Rd	Raider Rd	AF/LN 8/2/12
5	Univ. Blvd	Col Glenn Hwy	Lot 1	AF/LN 6/30/12
6	Main Entre. Enter	University Blvd	Student Union	AF/LN 6/30/12
7	Main Entre. Exit	Student Union	University Blvd	AF/LN 6/30/12
8	Lot 4	University Blvd	Walking Path thru Lot 4	AF/LN 6/30/12
9	Univ. Blvd	Lot 1	Lot 7	AF/LN 8/2/12
10	Student Union	Lot 4	Student Union	AF/LN 6/30/12
11	Hamilton Hall	Lot 4	University Hall	AF/LN 6/30/12
12	E. Hamilton Hall	Student Union	N. Hamilton Hall	AF/LN 6/30/12
13	SW Univ. Hall	Comm Center	University Hall	AF/LN 6/30/12
14	Hamilton Hall	Hamilton Hall	Medical Science	AF/LN 6/30/12
15	Student Union	N. Student Union	SW Univ. Hall	AF/LN 8/2/12
16	Student Union	N. Student Union	W. Med. Sci.	AF/LN 6/30/12
17	Lot 7/8	SW Corner Lot 7	Lot 8	AF/LN 6/30/12
18	Lot 7	SW Corner Lot 7	NW Med Sci	AF/LN 6/30/12
19	Lot 7	Between Lot 7/8	Bridge	AF/LN 8/2/12
20	SW Univ. Hall	SW Univ. Hall	Allyn Hall	AF/LN 6/30/12
21	Bet. Univ Hall/Rike	Lot 7	Sidewalk #20	AF/LN 6/30/12
22	SW Univ. Hall	SW Univ. Hall	Allyn Hall	AF/LN 6/30/12
23	Bet. Rike/Allyn	Lot 9	Oelman Hall	AF/LN 8/2/12
24	Garden	Garden	Allyn Hall	AF/LN 8/2/12
25	Allyn Hall/ Lot 9/1(	Rike Hall	Lot 10	AF/LN 6/30/12
26	NE Brehm Hall	Allyn Hall	Fawcett Hall	AF/LN 6/30/12
27	E. Brehm Hall	Oelman Hall	Allyn Hall	AF/LN 6/30/12
28	N Fawcett Hall	Lot 11	Brehm Hall	AF/LN 6/30/12
29	Bio Sci 1/2	Brehm Hall	Bio Sci 1/2	AF/LN 6/30/12
30	Bio Sci 1	Bio Sci 1	Math/Micro	AF/LN 6/30/12
31	Math/Micro	Math/Micro	Medical Science	AF/LN 8/2/12
32	Around Medical Science			AF/LN 6/30/12
33	Top of Amphitheater			AF/LN 6/30/12
34	Medical Science	Medical Science	E. Student Union	AF/LN 6/30/12
35	Large Loop			AF/LN 6/30/12
36	Health Science	Health Science	Dunbar Library	AF/LN 6/30/12
37	Health Science	Health Science	Russ Engineering	AF/LN 6/30/12
38	Health Science	Health Science	Student Union	AF/LN 8/2/12
39	Health Science	Health Science	White Hall	AF/LN 6/30/12
40	White Hall	White Hall	Russ Engineering	AF/LN 6/30/12
41	Health Science	Medical Science	White Hall	AF/LN 8/2/12
42	Russ Engineering	Student Union	Lot 17	AF/LN 6/30/12
43	Russ Engineering	Lot 17	Russ Engineering	AF/LN 6/30/12
44	White Hall	White Hall	Lot 16	AF/LN 8/2/12
45	Fawcett Hall	Lot 15	Fawcett Hall	AF/LN 6/30/12
46	Dunbar Library	Dunbar Library	Bio Sci 1	AF/LN 8/2/12
47	Dunbar Library	Dunbar Library	Creative Arts	AF/LN 6/30/12
48	Comm Center	Comm Center	Forest Lane Apt	AF/LN 8/2/12
49	College Part Apt	College Part Apt	College Part Apt	AF/LN 8/2/12
50	Laurel/Jacob/Hickory Apt			AF/LN 6/30/12
51	LJH Appt	LJH Apt	Lot 9	AF/LN 6/30/12
52	Univ. Blvd	Lot 11	Physicians Bld	AF/LN 6/30/12
53	Lake	University Blvd	Nutter Center	AF/LN 6/30/12
54	Presidential	Col Glenn Hwy	Lot 4	AF/LN 6/30/12
55	Lot 4	Lot 4 Along Univ Blvd		AF/LN 6/30/12
56b	Around Forest Lane Apt			AF/LN 6/30/12
56	Forest Lane	Forest Lane	College Park Apt	AF/LN 6/30/12
57	Forest Lane	Forest Lane	College Park Apt	AF/LN 6/30/12
58	Lot 6	NW Lot 6		AF/LN 6/30/12
59	Col Glenn Hwy	Col Glenn Hwy	Nutter Center	AF/LN 6/30/12
60	Mills Morgan	Col Glenn Hwy	Mills Morgan	AF/LN 6/30/12
61	Mills Morgan	Nutter Center	Mills Morgan	AF/LN 6/30/12
62	NE Brehm Hall	Allyn Hall other side	Fawcett Hall	AF/LN 6/30/12
63	Bio Sci	Bio Sci	Medical Science	AF/LN 6/30/12
64	East Side of Union			AF/LN 6/30/12
99	Central Park Blvd	Loop Road	Lot 14	AF/LN 8/2/12
100	Col Glenn opposit(	Central Rd	Raider Rd	AF/LN 8/2/12

Indicates Night Assessment

Appendix C: List of Off-Campus Path Segments for Inter-Rater Reliability

SEGMENT IDENTIFICATION				
# on map	Name of street/area	Start point	End point	Evaluator
1	Duncan Drive	Beginning of Duncan Drive	End of Duncan Drive	AF/LN 7/28/12
2	Sanzon Drive	Beginning of Sanzon Drive	End of Sanzon Drive	AF/LN 7/28/12
3	Forest Lane	Beginning of Forest Lane	End of Forest Lane	AF/LN 7/28/12
9	Raider Rd	Coln Glenn	End of WSU Ervin J Nutter Center	AF/LN 7/28/12
10	Peppertree Blvd	Beginning of Peppertree Blvd	End of Peppertree Blvd	AF/LN 7/28/12
11	Raider Drive	Beginning of Raider Dr	End of Raider Dr at Reese Dr	AF/LN 7/28/12
12	Eagle Highlands Drive	Beginning of Eagle Highlands	End of Eagle Highlands Drive	AF/LN 7/28/12
17	Reese Drive	Beginning of Reese Dr	End of Reese Dr	AF/LN 7/28/12
18	Sidewalk along Coln Glenn on WSU perimeter			AF/LN 7/28/12
19	Zink Rd	Coln Glenn	Zink Rd	AF/LN 7/28/12
20	Zink Rd	Zink Rd	Eagle Highlands Drive	AF/LN 7/28/12
21	Zink Rd	Zink Rd	Springwood Ln	AF/LN 7/28/12
22A	Presidential Drive	Tire Discounter	Presidential Dr	AF/LN 7/28/12
22B	Presidential Drive	Coln Glenn	Tire Discounter	AF/LN 7/28/12
23	University Blvd	Presidential Dr	Coln Glenn	AF/LN 7/28/12
24A	Presidential Dr	University Blvd	Presidential Dr end of sidewalk	AF/LN 7/28/12
24B	Presidential Dr	University Blvd	Central Park Blvd	AF/LN 7/28/12
25	Executive Park Blvd	Presidential Dr	Coln Glenn	AF/LN 7/28/12
26A	Center Park Blvd	Center Park Blvd	Coln Glenn	AF/LN 7/28/12
26B	Center Park Blvd	Coln Glenn	WSU Campus	AF/LN 7/28/12
27	Presidential Dr	Center Park Blvd	Paramount Pl	AF/LN 7/28/12
28A	Paramount Pl	Paramount Pl	Coln Glenn	AF/LN 7/28/12
28B	Paramount Pl	Paramount Pl	Presidential Dr	AF/LN 7/28/12
29	Coln Glenn	Presidential Dr	Zink Rd	AF/LN 7/28/12
30	Coln Glenn	Zink Rd	National Rd	AF/LN 7/28/12
31	N Fairfield Rd	N Fairfield Rd	Coln Glenn Exit 675	AF/LN 7/28/12
32A	N Fairfield Rd	N Fairfield Rd	Exit 675 Crossing	AF/LN 7/28/12
32B	N Fairfield Rd	crossings of N Fairfield Rd	Pentagon Park Blvd	AF/LN 7/28/12
33	Pentagon Park Blvd	N Fairfield Rd	Fairfield Commons Mall	AF/LN 7/28/12
34	N Fairfield Rd	N Fairfield Rd	Buffalo Wild Wings	AF/LN 7/28/12
35	Crossing Blvd	Center Dr	McDonald's	AF/LN 7/28/12
36	Pentagon Park Blvd	Commons Blvd	Royal Gateway Dr	AF/LN 7/28/12
37	Pentagon Park Blvd	Crossings on Pentagon Park	Commons Blvd	AF/LN 7/28/12
38	Dirth path next to apartment complex on Duncan Drive			AF/LN 7/28/12

Appendix D: Scores for Off-Campus Segments

DATA ENTRY																	
Segment Identification																	
#	Segment Name	Evaluator (Initial's)	Facility	Conflict	Crosswalk	Night	Mainten	size	Buffer	Accessible	Bikeable	Terrain	Aesthetic	Shade	High Import Sub-score	Med Import Sub-score	Total score
25% segments evaluated at night																	
9	Raider Rd from Coln Glenn to End of Nutter Center	AF/LN 7/28/12	4	4	4	3	5	5	4	5	1	5	4	x	15	29	79.23
18	Sidewalk along Coln Glenn on WSU Perimeter	AF/LN 7/28/12	1	1	1	1	1	1	1	1	1	1	1	x	4	7	20.00
22A	Tire Discounter to Presidential Dr	AF/LN 7/28/12	3	4	4	2	5	5	4	5	1	5	2	x	13	27	71.54
26A	Center Park Blvd to Coln Glenn	AF/LN 7/28/12	5	1	3	3	5	5	4	5	1	5	3	x	12	28	70.77
32A	N Fairfield Rd to Exit 675 crossing	AF/LN 7/28/12	1	1	1	1	1	1	1	1	1	1	1	x	4	7	20.00
Average Nighttime Scores			2.80	2.20	2.60	2.00	3.40	3.40	2.80	3.40	1.00	3.40	2.20	x	9.60	19.60	52.31
#	Name	Evaluator	Facility	Conflict	Crosswalk	Night	Mainten	size	Buffer	Accessible	Bikeable	Terrain	Aesthetic	Shade	High Import Sub-score	Med Import Sub-score	Total score
75% segments evaluated during the day																	
1	Duncan Drive	AF/LN 7/28/12	5	4	5	x	5	4	4	5	1	3	3	2	14	25	78.33
2	Sanzon Drive	AF/LN 7/28/12	3	4	5	x	5	5	4	5	1	5	4	3	12	29	80.83
3	Forest Lane	AF/LN 7/28/12	3	4	5	x	3	4	4	4	1	2	2	2	12	20	65.00
10	Peppertree Blvd	AF/LN 7/28/12	5	4	4	x	5	5	4	5	1	3	4	1	13	27	78.33
11	Raider Drive	AF/LN 7/28/12	4	4	4	x	5	5	4	5	1	4	4	2	12	28	78.33
12	Eagle Highlands Drive	AF/LN 7/28/12	3	4	5	x	5	5	4	5	1	5	3	1	12	28	77.50
17	Reese Drive	AF/LN 7/28/12	4	4	4	x	5	5	4	4	1	3	4	1	12	26	74.17
19	Coln Glenn to Zink Rd	AF/LN 7/28/12	5	3	5	x	5	5	4	5	1	5	3	1	13	28	80.00
20	Zink Rd to Eagle Highlands Drive	AF/LN 7/28/12	5	3	5	x	5	4	4	5	1	5	3	2	13	27	79.17
21	Zink Rd to Springwood Ln	AF/LN 7/28/12	3	4	5	x	5	5	5	5	1	3	3	1	12	27	75.83
22B	Coln Glenn to Tire Discounter	AF/LN 7/28/12	5	1	3	x	5	5	3	5	1	4	2	1	9	25	65.00
23	University Blvd to Coln Glenn	AF/LN 7/28/12	5	4	3	x	5	5	4	5	1	4	3	1	12	27	75.83
24A	Presidential Dr to University Blvd.	AF/LN 7/28/12	5	4	4	x	4	5	4	5	1	5	3	1	13	27	78.33
24B	Presidential Dr from University Blvd to Central Park Blvd	AF/LN 7/28/12	3	4	5	x	5	5	4	5	1	5	3	2	12	28	78.33
25	Executive Park Blvd to Presidential	AF/LN 7/28/12	1	1	1	x	1	1	1	1	1	1	1	1	3	7	20.00
26B	Center Park Blvd to WSU Campus	AF/LN 7/28/12	3	4	5	x	5	5	1	5	1	4	4	2	12	25	73.33
27	Center Park Blvd to Paramount Pl	AF/LN 7/28/12	5	4	4	x	5	5	4	5	1	5	3	2	13	28	80.83
28A	Paramount Pl to Coln Glenn	AF/LN 7/28/12	3	4	4	x	5	5	4	5	1	5	3	2	11	28	75.83
28B	Paramount Pl to Presidential Dr	AF/LN 7/28/12	5	4	5	x	5	5	4	5	1	4	3	2	14	27	81.67
29	Coln Glenn to Zink Rd	AF/LN 7/28/12	3	1	4	x	4	5	5	5	1	5	2	1	8	27	65.83
30	Zink Rd to National Rd	AF/LN 7/28/12	5	1	4	x	4	5	5	4	1	5	2	1	10	26	69.17
31	Fairfield to Coln Glenn Exit 675 (no sidewalks)	AF/LN 7/28/12	1	1	1	x	1	1	1	1	1	2	1	1	3	8	21.67
32B	crossings of Fairfield to Pentagon Park Blvd	AF/LN 7/28/12	3	1	1	x	5	5	4	5	1	4	2	1	5	26	56.67
33	Pentagon Park Blvd from N Fairfield Rd to Fairfield Mall	AF/LN 7/28/12	5	2	4	x	5	5	4	5	1	5	2	1	11	27	73.33
34	N Fairfield Rd to Buffalo Wild Wings	AF/LN 7/28/12	3	1	5	x	5	5	4	5	1	5	2	1	9	27	68.33
35	Crossing Blvd from Center Dr to McDonald's	AF/LN 7/28/12	1	1	1	x	1	1	1	1	1	1	1	1	3	7	20.00
36	Commons Blvd to Royal Gateway Dr	AF/LN 7/28/12	5	5	5	x	5	5	5	5	1	3	3	2	15	27	84.17
37	Crossings on Pentagon Park Blvd to Commons Blvd	AF/LN 7/28/12	5	4	5	x	5	5	4	5	1	3	3	1	14	26	79.17
38	Dirth path next to apartment complex on Duncan Drive	AF/LN 7/28/12	1	5	5	x	1	1	5	1	1	5	1	1	11	15	53.33
Average Daytime Scores			3.6897	3.1	4	x	4.3	4.3	3.7	4.3	1	3.9	2.7	1.41	10.7931	24.24138	68.56

Grade A = score ≥85 indicates excellent support for walking and biking
Grade B = score 70 to <85 indicates satisfactory support for walking and biking
Grade C = score 55 to <70 indicates fair support for walking and biking
Grade F = score <55 indicates poor support for walking and biking

Appendix E: Calculated Inter-Rater Reliability Score

INTER-RATER RELIABILITY

Interrater Reliability for walkability segments (>0.8 desirable)

Segment Evaluated for Interrater Reliability		Evaluators scores												
#	Name of segment	Facility	Conflict	Crosswalk	Night	Maint	Size	Buffer	Access	Bike	Terrain	Aesthetic	Shade	Comments
1		3	3	5	x	5	4	4	5	1	4	3	3	
2		3	4	5	x	5	5	5	5	1	5	4	1	
3		3	4	5	x	3	4	4	5	1	3	3	3	
9 (evening)		4	4	4	3	5	5	4	5	1	4	4	x	
10		5	4	5	x	5	4	4	5	1	5	4	1	
11		5	4	4	x	5	5	4	5	1	4	4	1	
12		3	4	5	x	5	3	4	5	1	5	3	1	
17		5	4	3	x	5	5	5	5	1	3	3	1	
18 (evening)		1	1	1	1	1	1	1	1	1	1	1	x	
19		5	3	5	x	5	5	4	5	1	5	3	1	
20		5	4	5	x	5	4	5	5	1	4	3	1	
21		3	4	5	x	5	5	5	5	1	3	3	1	
22A (evening)		3	4	4	2	5	5	4	5	1	5	3	x	
22B		5	3	4	x	5	5	2	5	1	5	3	1	
23		5	4	3	x	5	5	5	4	1	4	3	1	
24A		5	4	4	x	4	5	5	5	1	5	3	1	
24B		5	4	5	x	5	5	4	5	1	5	3	1	
25		1	1	1	x	1	1	1	1	1	1	1	1	
26A (evening)		5	1	3	3	5	5	4	5	1	5	3	x	
26B		3	4	5	x	5	5	1	5	1	5	3	1	
27		5	4	4	x	5	5	4	5	1	5	3	2	
28A		3	4	4	x	5	5	4	5	1	5	3	2	
28B		5	4	4	x	5	5	4	5	1	5	3	2	
29		4	4	4	5	4	5	5	5	1	5	3	1	
30		5	1	4	x	4	5	5	4	1	5	2	1	
31		1	1	1	x	1	1	1	1	1	1	1	1	
32A (evening)		1	1	1	1	1	1	1	1	1	1	1	x	
32B		3	1	1	x	5	5	4	5	1	4	2	1	
33		5	2	4	x	5	5	4	5	1	5	2	1	
34		3	1	5	x	5	5	4	5	1	5	2	1	
35		1	1	1	x	1	1	1	1	1	1	1	1	
36		5	5	5	x	5	5	5	5	1	4	3	2	
37		5	4	5	x	5	5	5	5	1	3	3	1	
38		1	5	5	x	4	1	5	1	1	4	1	1	

Lower score for a Rater is divided by highest score for each Evaluator/Rater.

If you have more than one rater- divide all raters by the highest scoring evaluator/ rater (HSR)

Segment Evaluated for Interrater Reliability	Facility/ HSR	Conflict/ HSR	Crosswalk / HSR	Night/ HSR	Maint/ HSR	Size/HSR	Buffer/ HSR	Access/ HSR	Bike/HSR	Terrain/ HSR	Aesthetic / HSR	Shade/ HSR	Average HSR	HSR Score (%)	Comments
1	0.6	0.75	1	x	1	0.8	1	1	0.8	1	1	0.67	0.87	87.45	
2	1	1	1	x	1	1	0.8	1	1	0.8	1	0.33	0.90	90.27	
3	1	0.8	1	x	1	1	1	0.8	1	0.67	0.67	0.67	0.87	87.36	
9 (evening)	0.75	1	1	1	1	1	1	1	1	0.8	1	x	0.96	95.91	
10	1	1	0.8	x	1	0.8	1	1	0.25	0.8	1	1	0.88	87.73	
11	0.8	1	1	x	1	1	1	1	1	1	1	0.33	0.92	92.09	
12	1	1	0.8	x	1	0.8	1	1	1	1	0.75	1	0.94	94.09	
17	0.8	1	0.75	x	1	1	0.8	0.8	1	1	0.75	1	0.90	90.00	
18 (evening)	1	1	1	1	1	1	1	1	1	1	1	x	1.00	100.00	
19	1	1	1	x	1	1	1	0.8	1	1	0.75	1	0.96	95.91	
20	1	0.75	1	x	1	1	0.8	1	1	0.8	1	0.5	0.90	89.55	
21	1	1	1	x	1	1	1	1	1	1	1	1	1.00	100.00	
22A (evening)	1	1	1	0.67	1	1	1	1	1	1	0.67	x	0.94	94.00	
22B	1	0.33	0.75	x	1	1	0.67	1	1	0.8	0.67	1	0.84	83.82	
23	1	0.8	0.75	x	1	1	0.75	0.8	1	1	1	1	0.92	91.82	
24A	1	1	1	x	1	1	0.8	1	1	1	1	0.5	0.94	93.64	
24B	0.6	1	1	x	1	1	0.8	1	1	1	1	0.5	0.90	90.00	
25	1	1	1	x	1	1	1	1	1	1	1	1	1.00	100.00	
26A (evening)	1	1	0.75	1	1	1	1	1	1	1	1	x	0.98	97.73	
26B	1	0.8	1	x	1	1	1	1	1	0.6	0.75	0.5	0.88	87.73	
27	1	1	0.8	x	1	1	1	1	1	1	1	1	0.98	98.18	
28A	1	1	1	x	1	1	1	1	1	1	1	1	1.00	100.00	
28B	1	1	0.8	x	1	1	1	1	1	0.8	1	1	0.96	96.36	
29	0.75	0.25	1	x	0.8	1	1	1	1	1	0.67	1	0.86	86.09	
30	1	1	1	x	1	1	1	0.8	1	1	1	1	0.98	98.18	
31	1	1	1	x	1	1	1	1	1	0.5	1	1	0.95	95.45	
32A (evening)	1	1	1	1	1	1	1	1	1	1	1	x	1.00	100.00	
32B	1	1	1	x	1	1	0.8	1	1	1	1	x	0.98	98.00	
33	1	1	1	x	1	1	0.8	0.8	1	1	1	1	0.96	96.36	
34	1	1	1	x	1	1	0.8	1	1	1	1	1	0.98	98.18	
35	1	1	1	x	1	1	1	1	1	1	1	1	1.00	100.00	
36	1	1	1	x	1	1	1	1	1	0.75	1	1	0.98	97.73	
37	1	1	1	x	1	1	0.8	1	1	1	1	1	0.98	98.18	
38	1	1	1	x	0.25	1	1	1	1	0.8	1	1	0.91	91.36	
AVERAGE HSR	**0.95**	**0.93**	**0.95**	**0.93**	**0.97**	**0.98**	**0.93**	**0.96**	**0.97**	**0.92**	**0.93**	**0.86**	**0.94**	**94.21**	

Appendix F: List of Tunnel Path Segments

SEGMENT IDENTIFICATION				
# on map	Name of street/area	Start point	End point	Evaluator
a	Tunnel	Joshi Research Center	Student Union	AF/LN 7/28/12
b	Tunnel	Student Union	Medical Sciences	AF/LN 7/28/12
c	Tunnel	Medical Sciences	Biological Sciences	AF/LN 7/28/12
d	Tunnel	Biological Sciences I & II	Health Sciences	AF/LN 7/28/12
e	Tunnel	Biological Sciences I & II	Diggs Laboratory	AF/LN 7/28/12
f	Tunnel	Medical Sciences	Fawcett Hall	AF/LN 7/28/12
g	Tunnel	Fawcett Hall	Dunbar Library	AF/LN 7/28/12
h	Tunnel	Dunbar Library	Creative Arts Center	AF/LN 7/28/12
i	Tunnel	Dunbar Library	Television Center	AF/LN 7/28/12
j	Tunnel	Dunbar Library	Fawcett Hall	AF/LN 7/28/12
k	Tunnel	Fawcett Hall	Millett Hall	AF/LN 7/28/12
q	Tunnel	Brehm Laboratory	Fawcett Hall	AF/LN 7/28/12
l	Tunnel	Millett Hall	Oleman Hall	AF/LN 7/28/12
m	Tunnel	Oleman Hall	Allyn Hall	AF/LN 7/28/12
o	Tunnel	Allyn Hall	Rike Hall	AF/LN 7/28/12
n	Tunnel	Rike Hall	University Hall	AF/LN 7/28/12
p	Tunnel	University Hall	Medical Sciences	AF/LN 7/28/12

Appendix G: Scores for Day Segment Assessment

DATA ENTRY																	
Segment Identification																	
#	Segment Name	Evaluator	Facility	Conflict	Crosswalk	Night	Mainten	size	Buffer	Accessible	Bikeable	Terrain	Aesthetic	Shade	High Import Sub-score	Med Import Sub-score	Total score
75% segments evaluated during the day																	
6	Main Entre. Enter/ From Univ Blvd to Student Union	AF/LN 6/30/12	5	4	3	x	5	5	5	5	1	5	5	1	12	31	82.50
5	Univ. Blvd/ From Col Glenn Hwy to Lot 1	AF/LN 6/30/12	5	4	3	x	5	5	5	5	1	5	4	1	12	30	80.83
7	Main Entre. Exit/ From Student Union to Univ Blvd	AF/LN 6/30/12	5	4	3	x	5	5	5	5	1	5	5	1	12	31	82.50
8	Lot 4/ From Univ Blvd to Walking Path thru Lot 4	AF/LN 6/30/12	3	1	4	x	5	5	4	4	1	4	2	1	8	25	62.50
10	Student Union/ From Lot 4 to Student Union	AF/LN 6/30/12	5	4	4	x	5	5	5	5	1	4	5	5	13	30	86.67
12	E. Hamilton Hall/ From Student Union to N. Hamilton Hall	AF/LN 6/30/12	5	5	5	x	4	5	5	5	1	4	5	3	15	29	88.33
11	Hamilton Hall/ From Lot 4 to University Hall	AF/LN 6/30/12	5	4	4	x	5	5	5	5	1	4	5	5	13	30	86.67
14	Hamilton Hall/ From Hamilton Hall to Medical Science	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	4	1	15	30	88.33
18	Lot 7/ From SW Corner Lot 7 to NW Med Sci	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	4	5	3	15	30	90.00
13	SW Univ Hall/ From Comm Center to University Hall	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	4	1	15	30	88.33
32	Around Medical Science	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	3	4	15	29	89.17
33	Top of Amphitheater	AF/LN 6/30/12	5	5	5	x	2	5	5	5	1	5	5	1	15	28	85.00
29	Bio Sci 1,2/ From Brehm Hall to Bio Sci 1,2	AF/LN 6/30/12	5	5	5	x	1	5	5	1	1	1	4	5	15	18	71.67
30	Bio Sci 1/ From Bio Sci 1 to Math, Micro	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	4	3	4	15	28	87.50
28	N Fawcett Hall/ From Lot 11 to Brehm Hall	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	4	5	15	30	91.67
62	NE Brehm Hall/ From Allyn Hall other side to Fawcett Hall	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	5	4	15	31	92.50
27	E. Brehm Hall/ From Oelman Hall to Allyn Hall	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	5	1	15	31	90.00
22	SW Univ Hall/ From SW Univ Hall to Allyn Hall	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	4	3	1	15	28	85.00
20	SW Univ Hall/ From SW Univ Hall to Allyn Hall	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	4	3	2	15	28	85.83
25	Allyn Hall, Lot 9,10/ From Rike Hall to Lot 10	AF/LN 6/30/12	4	4	5	x	5	5	5	5	1	5	4	4	13	30	85.83
17	Lot 7,8/ From SW Corner Lot 7 to Lot 8	AF/LN 6/30/12	4	4	5	x	5	5	5	5	1	5	4	2	13	30	84.17
21	Bet. Univ Hall, Rike/ From Lot 7 to Sidewalk #20	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	5	3	15	31	91.67
63	Bio Sci/ From Bio Sci to Medical Science	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	4	5	15	30	91.67
45	Fawcett Hall/ From Lot 15 to Fawcett Hall	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	2	1	15	28	85.00
47	Dunbar Library/ From Dunbar Library to Creative Arts	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	3	3	15	29	88.33
36	Health Science/ From Health Science to Dunbar Library	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	4	4	1	15	29	86.67
35	Large Loop	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	4	4	1	15	29	86.67
39	Health Science/ From Health Science to White Hall	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	4	4	1	15	29	86.67
40	White Hall/ From White Hall to Russ Engineering	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	4	4	1	15	29	86.67
37	Health Science/ From Health Science to Russ Engineering	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	4	5	1	15	30	88.33
42	Russ Engineering/ From Student Union to Lot 17	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	4	3	2	15	28	85.83
43	Russ Engineering/ From Lot 17 to Russ Engineering	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	2	1	15	28	85.00
34	Medical Science/ From Medical Science to E. Student Unior	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	5	1	15	31	90.00
16	Student Union/ From N. Student Union to W. Med. Sci.	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	5	5	15	31	93.33
64	East Side of Student Union	AF/LN 6/30/12	5	5	5	x	3	5	5	1	1	1	4	2	15	20	72.50
55	Lot 4/ From Lot 4 along Univ Blvd	AF/LN 6/30/12	5	4	4	x	5	5	1	5	1	5	2	2	13	24	74.17
56	Forest Lane/ From Forest Lane to College Park Apt	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	2	2	1	15	25	80.00
57	Forest Lane/ From Forest Lane to College Park Apt	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	2	1	15	28	85.00
56**B**	Around Forest Lane Apt	AF/LN 6/30/12	5	5	5	x	5	2	5	5	1	3	2	3	15	23	78.33
58	Lot 6/ NW Lot 6	AF/LN 6/30/12	5	5	5	x	5	5	3	5	1	4	2	1	15	25	80.00
51	LJH Apt/ From LJH Apt to Lot 9	AF/LN 6/30/12	4	3	4	x	5	5	1	5	1	2	2	1	11	21	63.33
65	LJH Apt/Alongside complex	AF/LN 6/30/12	5	5	5	x	5	5	5	1	1	3	5	1	15	25	80.00
50	Laurel/Jacob/Hickory Apt	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	5	4	15	31	92.50
52	Univ Blvd/ From Lot 11 to Physicians Blvd	AF/LN 6/30/12	5	5	4	x	3	3	3	4	1	3	4	4	14	21	73.33
61	Mills Morgan/ From Nutter Center to Mills Morgan	AF/LN 6/30/12	5	4	4	x	5	5	4	1	1	3	1	1	13	20	66.67
60	Mills Morgan/ From Col Glenn Hwy to Mills Morgan	AF/LN 6/30/12	1	3	5	x	1	5	1	1	1	3	1	1	9	13	45.00
59	Col Glenn Hwy/ From Col Glenn Hwy to Nutter Center	AF/LN 6/30/12	5	5	5	x	5	5	5	5	1	5	4	1	15	30	88.33
3	Col Glenn Hwy/ From Col Glenn Hwy to Loop Rd	AF/LN 6/30/12	5	5	4	x	5	5	5	5	1	5	4	1	14	30	85.83
1	Col Glenn Hwy/ From Starbucks to University Blvd	AF/LN 6/30/12	5	5	5	x	5	5	3	4	1	5	1	1	15	24	78.33
54	Presidential/ From Col Glenn Hwy to Lot 4	AF/LN 6/30/12	5	5	5	x	5	5	4	4	1	5	1	1	15	25	80.00
	Average Daytime Scores		4.82	4.7	4.7	x	4.7	4.9	4.6	4.5	1	4.2	3.6	2.14	14.2	27.48	83.08

Grade A = score ≥85 indicates excellent support for walking and biking
Grade B = score 70 to <85 indicates satisfactory support for walking and biking
Grade C = score 55 to <70 indicates fair support for walking and biking
Grade F = score <55 indicates poor support for walking and biking

Appendix H: Scores for Night Segment Assessment

DATA ENTRY																
Segment Identification																
#	Segment Name	Evaluator (Initial's)	Facility	Conflict	Crosswalk	Night	Mainten	size	Buffer	Accessible	Bikeable	Terrain	Aesthetic	Shade	High Import Sub-score	Med Import Sub-score	Total score
25% segments evaluated at night																	
9	Univ. Blvd/ From Lot 1 to Lot 7	AF/LN 8/2/12	5	5	5	5	5	5	4	5	1	4	4	x	20	28	89.23
15	Student Union/ From N. Student Union to SW Univ. Hall	AF/LN 8/2/12	5	5	5	5	5	5	5	5	1	5	4	x	20	30	92.31
19	Lot 7/ From between Lot 7/8 to Bridge	AF/LN 8/2/12	5	4	4	4	5	5	5	5	1	4	4	x	17	29	83.85
23	Bet. Rike, Allyn/ From Lot 9 to Oelman Hall	AF/LN 8/2/12	5	5	5	5	5	5	5	5	1	5	5	x	20	31	93.85
24	Garden/ From Garden to Allyn Hall	AF/LN 8/2/12	5	5	3	5	5	5	5	5	1	4	5	x	18	30	87.69
26	NE Brehm Hall/ From Allyn Hall other side to Fawcett Hal	AF/LN 8/2/12	5	5	5	5	5	5	5	5	1	5	5	x	20	31	93.85
31	Math, Micro/ From Math, Mirco to Medical Science	AF/LN 8/2/12	5	5	5	5	4	5	5	5	1	5	5	x	20	30	92.31
46	Dunbar Library/ From Dunbar Library to Bio Sci 1	AF/LN 8/2/12	5	5	5	5	4	5	5	5	1	5	5	x	20	30	92.31
99	Central Park Blvd	AF/LN 8/2/12	3	4	4	4	5	5	1	5	1	5	3	x	15	25	73.08
44	White Hall/ From White Hall to Lot 16	AF/LN 8/2/12	4	4	3	5	4	5	1	5	1	5	4	x	16	25	75.38
38	Health Science/ From Health Science to Student Union	AF/LN 8/2/12	5	5	5	3	4	5	5	5	1	5	4	x	18	29	86.15
48	Comm Center/ From Comm Center to Forest Lane Apt	AF/LN 8/2/12	5	5	4	3	5	5	5	5	1	4	4	x	17	29	83.85
49	College Park Apt/ From Begin College Park Appt to End	AF/LN 8/2/12	5	5	5	3	5	5	5	5	1	3	4	x	18	28	84.62
2	Col Glenn/ From University Blvd to Center Rd	AF/LN 8/2/12	3	1	4	3	5	5	3	5	1	5	1	x	11	25	63.85
4	Col Glenn/ From Col Glenn to Raider Road	AF/LN 8/2/12	5	5	5	4	5	5	5	5	1	3	4	x	19	28	86.92
100	Col Glenn opposite side of road segment 4	AF/LN 8/2/12	1	1	1	1	1	1	1	1	1	1	1	x	4	7	20.00
	Average Nighttime Scores		4.44	4.31	4.25	4.06	4.50	4.75	4.06	4.75	1.00	4.25	3.88	x	17.06	27.19	81.20

Grade A = score ≥85 indicates excellent support for walking and biking
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Grade C = score 55 to <70 indicates fair support for walking and biking
Grade F = score <55 indicates poor support for walking and biking

Appendix I: Scores for Tunnel Segment Assessment

DATA ENTRY																	
#	Name	Evaluator	Facility	Conflict	Crosswalk	Night	Mainten	size	Buffer	Accessible	Bikeable	Terrain	Aesthetic	Shade	High Import Sub-score	Med Import Sub-score	Total score
a	Joshi Research to Student Union	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
b	Student Union to Med Sciences	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
c	Med Sciences to Bio Sciences	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
d	Bio Sciences to Health Sciences	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
e	Bio Sciences to Diggs Laboratory	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
f	Med Sciences to Fawcett Hall	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
g	Fawcett Hall to Dunbar Library	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
h	Dunbar Library to Creative Arts	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
i	Dunbar Library to Television Center	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
j	Dunbar Library to Fawcett Hall	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
k	Fawcett Hall to Millett Hall	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
l	Brehm Laboratory to Fawcett Hall	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
m	Millett Hall to Oleman Hall	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
n	Oleman Hall to Allyn Hall	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
o	Allyn Hall to Rike Hall	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
p	Rike Hall to University Hall	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
q	University Hall to Med Sciences	AF/LN 7/28/12	5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83
Average Scores			5	5	5	5	5	5	5	5	1	5	3	x	15	29	85.83

Grade A = score ≥85 indicates excellent support for walking and biking
Grade B = score 70 to <85 indicates satisfactory support for walking and biking
Grade C = score 55 to <70 indicates fair support for walking and biking
Grade F = score <55 indicates poor support for walking and biking

Appendix J: List of Tier 1 Core Public Health Competencies Met

Domain #1: Analytic/Assessment
Identify the health status of populations and their related determinants of health and illness (e.g., factors contributing to health promotion and disease prevention, the quality, availability and use of health services)
Describe the characteristics of a population-based health problem (e.g., equity, social determinants, environment)
Use variables that measure public health conditions
Use methods and instruments for collecting valid and reliable quantitative and qualitative data
Identify sources of public health data and information
Recognize the integrity and comparability of data
Identify gaps in data sources
Adhere to ethical principles in the collection, maintenance, use, and dissemination of data and information
Describe the public health applications of quantitative and qualitative data
Collect quantitative and qualitative community data (e.g., risks and benefits to the community, health and resource needs)
Use information technology to collect, store, and retrieve data
Describe how data are used to address scientific, political, ethical, and social public health issues
Domain #2: Policy Development and Program Planning
Gather information that will inform policy decisions (e.g., health, fiscal, administrative, legal, ethical, social, political)
Domain #3: Communication
Identify the health literacy of populations served
Communicate in writing and orally, in person, and through electronic means, with linguistic and cultural proficiency
Apply communication and group dynamic strategies (e.g., principled negotiation, conflict resolution, active listening, risk communication) in interactions with individuals and groups
Domain #4: Cultural Competency – N/A
Domain #5: Community Dimensions of Practice
Identify stakeholders
Identify community assets and resources
Domain #6:Public Health Sciences
Discuss the limitations of research findings (e.g., limitations of data sources, importance of observations and interrelationships)
Domain #7: Financial Planning and Management – N/A
Domain #8: Leadership and Systems Thinking
Describe how public health operates within a larger system