THE UTILITY OF THE NHTS IN UNDERSTANDING BICYCLE AND PEDESTRIAN TRAVEL

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1. INTRODUCTION

The interest in understanding walking and cycling behaviors is increasing from a variety of disciplines. Politicians see levels of cycling and walking as an indicator of livability. Policy advocates rely on increased rates of non-motorized transport as evidence of relief of traffic congestion. The public health community, concerned over increasing rates of obesity and other related diseases, are looking to American's levels of physical activity as one explanatory factor. Travel behavior researchers aim to uncover motivating factors behind decisions to walk or bike. Even transportation economists are keen on discerning the degree to which walking or cycling has monetary benefits over other modes.

Despite such escalating interest from varied groups, however, walking and cycling remain one of the most understudied—and subsequently least understood—modes of transportation. The lack of research in this area contributes to and is hampered by a lack of a consistent effort to collect and distribute data on these behaviors and the environment in which they occur. This deficiency of secondary data sources focused non-motorized travel has been well documented [1]. Recognition of this deficit has lead to a number of efforts to improve the quality and amount of walking and cycling data. In particular, the 2001 National Household Transportation Survey (NHTS) has paid considerable attention to non-motorized transportation activity collected in their national survey. However, little work has been done to map out these resources and their potential application in practice and research.

Although the NHTS and others have made substantial improvements over previous collection efforts, it is important for researchers to fully understand how these improvements can be used to advance the emerging and persistent research questions around non-motorized transport. The purpose of this paper is briefly review the prominent questions in the non-motorized research agenda, describe the NHTS data, clarify how they enhance our understanding of walking or cycling, and suggest how other analysis strategies or data sources can contribute.

2. EMERGING AND PERSISTENT POLICY QUESTIONS FOR NON-MOTORIZED TRANSPORTATION

As with any data collection effort, it is necessary to specifically articulate the myriad reasons why such data is being collected. Such questions invariably affect the sampling strategy, instrument, pre-analysis, and other associated elements of the survey. At its core (and the focus of this conference), the NHTS aim to "understand the Nation's travel." In Table 1 and Table 2 below, we articulate several of the current policy issues that justify increased attention to walking and cycling and the corresponding data needs.

Transportation researchers have long been interested in understanding the links between land use, urban form and travel choices, particularly in the trip generation rates of non-motorized modes (Crane, 2000). Studies have attempted to understand what factors of the built environment lead to increased frequencies of walking and cycling. Travel surveys have increasing linked their information to specific locations using geographic information systems, facilitating the incorporation of local land use data into analysis.

Less studied are the linkages between the built environment and route choices. Travel data do not typically account for the paths chosen by travelers, except for perhaps noting the major freeways taken by motorists. As with most data on non-motorized modes, including information on route choices would require an enormous level of detail. As global positioning systems (GPS) become more commonly used in data collection, the ability to study detailed movements of pedestrians and cyclists with travel survey data may increase.

The research agenda around non-motorized transportation has received a boost from the health community. Motivated by interests in understanding the links between diseases such as obesity, diabetes, sedentary behavior and the built environment, this research inquiry is interested in understanding the ways that the physical environment promotes or inhibits physical activity. Although this has lead to multidisciplinary collaborations, the transportation community appears to have the most specific and complete data on walking and cycling. However, the data collected for transportation purposes are not always suitable for studies of physical activity. Data obtained from travel diaries may be inadequate to assess the full range of pedestrian and cycling activities and inappropriate to gauge levels of physical activity gained from participation in these activities.

Another public health concern is the number of injuries and fatalities due to collisions with motor vehicles. According to a report by Surface Transportation Policy Project (2002), pedestrian and cycling fatalities account for nearly 13% of all traffic-related deaths in the US, a disproportionate amount given the relatively lower percentage (around 5%) of non-motorized trips. While travel survey data cannot be used to analyze collisions, these data can be used to evaluate risk exposures by estimating levels of pedestrian and bicycling demand for given areas. Combined with crash data, non-motorized activity data can reveal locations that are particularly threatening for pedestrians.

Children's travel behavior has been the focus of efforts to encourage walking and cycling by youth in their trip to school. The reduction in the number of children that walk to school, increasing congestion around schools, fears about crime and traffic safety, concerns about the decline in physical activity among children, and the lack of infrastructure for walking and biking have lead many communities to initiate "Safe Routes to School" programs (Appleyard, 2003). The increasing numbers of children who are driven to school illustrates their dependence upon others for their mobility. The academic community is just starting to take notice of these programs and investigate their impacts on children's travel. In addition, children's travel has important implications for the planning and siting of schools (EPA, 2003).

Having described the nature of the NHTS pedestrian and bicycle data, it is important to discuss the relative strengths and weakness of this data set compared to other sources of travel data frequently used at the national level. These include the Journey to Work questions from the US Census, the American Housing Survey (AHS), and the predecessor to the NHTS, the NPTS. For example, such improvements in data collection and study design have generated an artificially large increase in these trips when compared to previous efforts (NPTS), which limits the ability to examine trends in non-motorized travel using this data series. Because the 2001 NHTS data includes a total accounting of trips, pedestrian and cycling activity can be placed in the context of other daily travel choices and for travel purposes in addition to work. However, the limited geographic data available from the NHTS does not allow the researcher to marry such rich data with detailed features of the built environment (e.g., density, land use mix, other neighborhood attributes). On the other hand, the decennial census of population provides a large sample and permits fairly detailed information about the home and workplace to be included. Because these data are collected every decade, they provide the ability to examine trends over time. The drawback is that the use of this data for comprehensive assessment of non-motorized activity is limited because the travel data is limited to the commute trip. Moreover, some levels of walking and biking to work are obscured since the question is concerned with the mode taken most often and for the lengthiest part of the commute. The American Housing survey suffers similar limitations with the journey to work question and has the additional weakness of smaller sample size. But the AHS has the advantage of being a longitudinal data set, although the unit of analysis in the AHS is the housing unit and not the people that reside there.

3. IMPROVEMENTS TO THE NHTS

Travel behavior researchers have for some time been aware that traditional travel surveys tend to under-represent walking and cycling trips. To partially remedy this issue, the 2001 NHTS placed particular emphasis on capturing non-motorized trips through several improvements.

Below, we describe some of the improvements and how they help address walking and bicycling trips. The issues itemized below are not intended to be exhaustive but merely representative of the types of matters that need to be addressed when collecting such data. Following this discussion, we describe several recognized problems with pedestrian and bicycle data collection and how well the NHTS efforts address these matters.

The first improvement was to prompt respondents about walking and bicycle trips during data collection. This was done via the follow-up telephone questionnaire which includes interviewer scripts that ask specifically about walking and bicycling trips. Such a question was, “Did {you} use any other type of transportation during {your} stay in {city here}, including bicycling and walking?” So far, I have recorded {N} trip(s). Before we continue, did {you/SUBJECT} take any other walks, bike rides, or drives on {TRIPDATE}? Please include any other trips where {you/SUBJECT} started and ended in the same place.

Calling the respondent the evening of their diary data collection day helped the respondent recall the trips in which they completed. Furthermore, the survey consultant made efforts to ensure that there were few missing links or otherwise unreported trips.

A noted improvement was to ask the user about the frequency of walking and bicycling trips during the week prior to the interview day. These questions were:

> “In the past week, how many times did {you/SUBJECT} take a walk outside, including walks for exercise?”
>
> “In the past week, how many times did {you/SUBJECT} ride a bicycle outside including bicycling for exercise?”

The number of walk and bike trips made in the week prior to the interview day were recorded. This effort resulted in greater numbers of pedestrian and cycling trips and overall, increased the amount and detail of non-motorized travel in the data set. For this reason alone, the 2001 NHTS represents one of the best sources of non-motorized travel data at the national-level. However, the number of trips is based on respondent recall and not based on information recorded in a travel diary. Therefore the validity of the data is suspect to the same issues as other recall data.

This week-long window permits the capture of a greater number of non-motorized trips since many people do not walk or bike on a daily basis. The data allow exploration of the non-motorized trip rates by personal characteristics and by the land use data provided by Claritas. However, this query only gathered information about the amount of bicycling and walking and not about purpose, length, or other trip attributes.

The NHTS also gather information on the manner in which specific modes, including walking and cycling, were used to access and egress transit modes. Doing so avoids the issue of double counting such trips. This additional effort captures very short trips – to and from bus stops – for example – that respondents may otherwise omit. However, since these access trips are not included as separate trip records, they may be missed when calculated trip generation rates by specific modes. The additional trip information for that segment such as trip distance is also omitted.

The trip purposes in the 2001 NHTS have more detailed categories, including some trip purposes specific to non-motorized modes. The "exercise" and "pet care" purposes represent trips that my have been omitted from other survey data because there is often no discrete destination or trip end for these trips. This improvement is helpful for those studying levels of physical activity gained from transportation activities.

Neighborhood level characteristics for each household supplemented the travel and personal data collected in the NHTS. These data were derived from the US Census data at the block group or tract level and estimated for 2001 by Claritas, Inc. At the block group level, these data include: persons per square mile, housing units per square mile, percent renter occupied, and urban/rural indicator. At the tract level, jobs per square mile and urban/rural indicator are available.

Data collection process also asked respondents a number of attitudinal questions. Travel analysis is becoming more concerned with how attitudes, lifestyles and other subjective factors influence travel patterns. As such, these attitudinal questions are useful to help to understand how pedestrians and cyclists motivations differ (or not) from users of other modes. In the NHTS respondents were asked their degree of worry about the following: traffic accidents, congestion, distracted or impaired drivers, costs of motor fuel, the lack of pedestrian infrastructure, condition of road pavement, aggressive and speeding drivers, and the numbers of trucks on the road. While far from a comprehensive assessment, these attitudinal data provide some indication of the respondents' opinions on these issues, which may shed insight on their travel choices.

Finally, the NHTS provided the user with the option of recording the length of their trip according to miles or blocks. The advantage of this improvement is that the latter unit is particularly useful for differentiating between very short pedestrian trips. Since pedestrians and cyclists often do not have the advantage of a pedometer/odometer to record trip length, the option of recording trips by block may provide more accurate estimate of distance traveled. The disadvantages of this approach are that different environments have different block lengths, making conversion difficult, and the distances are recorded in two different variables. Trip distance distributions need to consider the responses in both variables to have a more accurate gauge of overall trip length.

4. LIMITATIONS

Having discussed some of the data collection issues relating to bicycle and pedestrian travel, we now turn to commenting on how well the revised version of the NHTS captures salient issues. The aim is to identify the critical dimensions that have plagued previous data collection efforts and comment on how and in what manner the NHTS is an improvement.

One of the biggest drawbacks to using the national sample is the omission of detailed geographic identifiers. Although somewhat offset by the inclusion of the Claritas data at the tract and block group level, the national data suffer from the inability to merge relevant local data, such as information on pedestrian and bicycle infrastructure, land use and urban form, and transportation system performance. While the national sample does allow comparison across a variety of metropolitan areas, analysis is unable to discern whether the variation is attributable to conditions of the built and natural environment or characteristics of its population. Likewise, spatial variations in levels of non-motorized activity within a region can be masked. This problem can be address to a certain extent by using the regional add on data; however, access to specific and detailed geographic information occurs is not public and permission must be obtained by the proprietary agencies.

Another drawback is the validity of the recall information on the number of non-motorized trips made in the past week. Using the seven day data do not improve the statistical accuracy of the models compared to the travel day data from the diary. Thus, these data are less useful in analysis and perhaps serve a better purpose as indicators of walkability, bikability, and levels of physical activity.

Finally, walking and cycling trips made in conjunction with transit must be analyzed separately from single-mode trips. Analysis of the trip data by mode under represents the level of non-motorized travel. However, no data are included about the trip distances for the walk or bike portion of the transit trip. This omission limits the ability to say anything about distance thresholds for transit access and thus cannot inform the practices of transit-oriented development, transit route planning, or intermodal access.

The NHTS is a national sample that collects data for a relatively general purpose. Given limited resources, asking this dataset to be able to fully address any one of the above matters would likely come at the expense of other matters. In the conclusion part of the paper, we offer our recommendations for practices that should continue and practices that should be refined. Before doing so, we offer two additional analysis—one focusing on predicting pedestrian travel, a second on predicting bicycle travel—which demonstrate the versatility and potential of the NHTS in understanding each. Both efforts described below provide empirical evidence of the how the NHTS can be supplement with accompanying NHTS data sets or completely other national-level datasets for more versatile and robust analysis.

5. PEDESTRIAN TRAVEL

The NHTS data can be used to study pedestrian travel with some degree of detail. The national data set includes 248,517 trips. There are 19,310 walking trips (7.8% of the total) and 1901 bicycling trips (0.8% of the total). These data can be used to understand differing rates of walking trip generation as a function of person, household and locational attributes and the role of access in facilitating pedestrian trips. For example, trip level details can provide insight into trip length distributions. Planners frequently use a ¼ mile trip distance as the critical threshold of walking distance for American context. But this dimension of walking has not been adequately studied using empirical evidence. The trip distance distribution in miles for the national sample is shown in Figure 1 and reveals that the majority of pedestrian trips exceed this ¼ mile threshold. One may expect trip distance to vary by trip purpose (work versus recreation, for example), gender, age and urban context (urban city center versus suburban) and more investigation is needed to fully understand how walking behavior interacts with these other variables.

Table 3 shows the distribution of walking trip purposes for the national sample. Not surprisingly, social and recreational trips comprise the largest percentage (26.4%) of walking trips, followed by family and personal business (9.8%), and shopping (8.3%) trips. Again, this distribution may vary quite a bit by land use patterns. Using the Claritas data at the neighborhood level, one could investigate the variations in these trip purposes by urban context. To assist policy makers in their struggle to increase walking activity, either for transportation or health purposes, a clearer understanding of the role of context and purpose is needed.

Some of the pedestrian research questions outlined in Table 1 may be investigated more thoroughly at the regional level using Add-on data, in part because of the ability to incorporate local information into the analysis and provide a greater degree of detail. For example, the Baltimore Add-on survey included 3,519 households for a total of 7,825 people, who made 27,366 trips on their travel day. Of these, there were 3,399 walking trips in the data set, representing 12.4% of the total trips (compared to only 128 bicycle trips, accounting for less than 0.5% of the total trips). At an individual level, 970 households (27.6%) and 1,360 (17.4%) persons recorded making at least one pedestrian trip. Additionally, walking was the access mode to transit for in an additional 1,067 transit trips and the egress mode for 1,010 of the transit trips. These data provide a significant number of pedestrian trips for robust statistical analysis. Combined with local level land use and transportation data, the Baltimore Add-on provide a rich data source for studies of pedestrian trips and trip makers.

Figure 2 shows the spatial distribution of walking trip destinations for a portion of the Baltimore region. This map illustrates the level of specificity available with the Add-on data and how integration of other data sources can bolster analysis. Figure 2 overlays these walking trip ends with local transit access, defined by a ¼ mile network distance from transit stops. Although not shown in this map, there is significant variation in the built and social environments for these pedestrian trips. Yet another walking variable in the trip data set is the access mode to transit, which is incorporated into the transit trip record, rather than listed as a separate record in the data file. From Table 4, nearly 87% of transit trips are accessed by pedestrians, which punctuates the need to examine the relationship between these two modes. Additional data to incorporate in an analysis might be pedestrian crashes, local land use attributes, urban form characteristics, and pedestrian infrastructure.

6. LEVELS OF CYCLING

Our second application focuses on demonstrating the utility of merging the NHTS information with data from the U.S. census to better understand levels of cycling in different metropolitan areas. The task of estimating rates of cycling has always been difficult in travel surveys because of the relatively low levels of use. Typical diary instruments—no matter how comprehensive—do not provide adequate samples because the samples do not exist. It is therefore necessary to rely on next-best strategies.

This section outlines a simple "sketch planning" method for estimating the number of daily bicyclists in an area using easily available data from the NHTS and the U.S. Census Transportation Planning Package (CTPP). Planners in some cities may be able to supplement and refine this estimate using data they have collected themselves. This could be used for general political purposes, justifying expenditures by reference to the number of bicyclists and the benefits that they receive from cycling. It could be used to estimate demand on new facilities by assuming that it will be some fraction of the total amount of riding in the surrounding area. Finally, it could be used indirectly to estimate changes to the amount of cycling resulting from facility improvements; assuming that changes will be some (probably small) fraction of the existing total.

Levels of cycling can be best predicted by employing all available information. Even marginal changes due to policies or facility improvements are likely to be better approached by looking at existing conditions both in terms of riding and the cycling environment than by a generic parameter value derived from some other location. It is unlikely that a mile of bike lane will have the same impact regardless of where it is placed, that is, regardless of its characteristics, the destinations it accesses, or what other facilities are already in place. Yet this sort of assumption implicitly underlies most modeling efforts and subsequent understanding of cycling travel.

Most of the available information about the amount of bicycling addresses the number of people who ride bikes, as opposed to number of trips or miles of riding. Because of the amount of information that is available about riding frequency, we use this as our measure of bicycling demand. At the end of this section we address how this can be converted into trips or miles.

The surveys and other sources that address the frequency of bicycling give a wide variety of results. Upon examination, each source asks a slightly different question covering a different time frame; the number of people who ride a bike in a week will be larger than the number who ride in a day. It turned out that not only was it possible to reconcile all these different sources, but that the act of doing so led to important insights regarding a distribution of frequencies rather than the simple population averages that were reported in the original sources.

The NHTS also gives this information for a number of specific metropolitan statistical areas (MSAs) and states. Among the identified MSAs, the percentage of adults who biked on their survey day ranges from about 0.25% to about 2.35%. Among the 34 identified states, the rate ranges from 0.2% or less to 2.2%. It should be noted that samples for many of these areas were fairly small, so the number for a specific area could be well off the true value. However, this is probably a reasonable estimate of the range of values that might be observed over areas with large populations.

The NHTS also asks about whether the individual made bike trips during the last week, which is the next time frame we consider. Here 6.7% of U.S. adults and 13.0% of children claim to have made at least one bike trip. Over the 18 individual MSAs in the NHTS, the range for this variable was from 4.5% to 12.7%, with all but three between 5 and 10 percent. Among states, the range was from about 3.5% up to 12.4%; a range of 4 to 10 percent includes all but three.

The basic assumption that motivates the predictive exercise described here is the idea that a large fraction of total bicycling is done by a small fraction of cyclists who ride frequently, as discussed earlier, and that many of these frequent riders are bike commuters who will be observed as such in the census commute to work data. The assumption is that the basic riding frequency table described in the previous section will hold more or less across different areas, so that an area with a lot of commuter cyclists will also have relatively high levels of total cycling; an area with few commuters will have little total riding. In other words commuting by bicycle, while it is a small fraction of the total bicycling in a given area, can still be used as a "leading indicator" of what might be happening with other types of cycling.

Three different geographical divisions are examined to study this issue. First is a set of 15 MSAs for which CTPP commute to work shares could be matched with NHTS daily bicyclist counts. Next are states; there are 34 for which both census and NHTS data were available. Last is an analysis of 66 "zones" of the Minneapolis-St. Paul MSA, showing that the basic principle still works at this very different geographic scale.

Both the NHTS and the Census, like all levels of bicycle data, are limited by small sample sizes. Because of this and the low level of cycling, the expected number of cyclists in the sample for a given area could vary by a factor of 10 or 12 from the low to high end of the range. Ordinary measures of goodness of fit have little meaning in this sort of environment; we focus instead on more heuristic measures such as the number of observations that fit within the predicted confidence interval.

6.1 Metropolitan Statistical Areas

There were 15 MSAs for which we had both commute to work shares by bike and total percent of adults biking on their survey day from NHTS. The commute shares ranged from 0.1% (Cincinnati and Dallas) to 1.4% (Sacramento). The daily adult biking shares ranged from 0.18% (Houston, although this is likely a sampling problem since the commute share is higher than this), to 2.45% (Portland, with Sacramento close behind at 2.25%). The estimated equation had an intercept of 0.3% with a slope of 1.5 times the commute share. The R squared for this equation was about 0.7 (see Figure 3).

This equation can be used to generate a predicted total riding share for each city. Given this predicted share and the NHTS sample size, a 95% confidence interval of expected number of adult bicyclists in the sample can be calculated assuming a binomial function. For 14 of the 15 cities, the actual number of bicyclists fell within this confidence interval. The one exception was Chicago, which generated 19 actual cyclists compared to a predicted level of 9. Figure 1 shows how actual daily bicyclist percentages compared with the predicted values for these cities.

The performance of this model at predicting the observed number of cyclists for the cities with the biggest samples (and presumably the most reliable numbers) is quite good, again with the exception of Chicago: New York had 20 predicted and 23 actual, Los Angeles had 23 – 22, San Francisco 21 – 19, and Boston 9 – 7.

The equation is also exactly consistent with the U.S. as a whole (0.4% commute share, 0.9% total daily cyclists), and with a division into larger and smaller cities, in which the same figures are observed.

6.2 States

There were 34 states with data from both the census and the NHTS. Alabama had the lowest bicycle commute share at 0.07%, Oregon the highest at 1.07%. Arkansas has the lowest rate of total bicycling at 0% (again, a sampling problem), and Florida the highest at 2.21%. The estimated equation was 0.4 + 1.1C, slightly different from that observed at the MSA level. The R squared of this model was about 0.3. It is not clear why the fit is so poor when the sample sizes are generally larger at this level. One possibility is that the geographical distribution of sampling for the NHTS might not have been as even across entire states as the much larger census sampling, so that the measures of the two variables could be drawn from somewhat different populations.

Using either these parameter values or those derived from the MSA level, the same predictive results emerge. Of the 34 states, 30 have actual counts within a 95% confidence interval of their predicted values; the exceptions are all underpredicted. Of the states with good sample sizes (over 1000) about half were predicted with good accuracy (less than one standard deviation), the other half were farther off the mark, with predictions both too high and too low.

7. CONCLUSIONS AND RECOMMENDATIONS

The NHTS has made great strides to improve the amount and quality of non-motorized data available at the national level. The improvements in the 2001 NHTS have provide a rich data source for investigation of a number of pedestrian and cycling issues. Nonetheless, an ideal data set for this purpose would include a number of different dimensions than this one focused on general travel.

To start, special attention to the specific modal characteristics is needed. For example, the spatial range of walking trips tends to include shorter distances than other modes. Pedestrians tend to be more exposed to the environment and travel at slower speeds than those traveling by other modes, which enhance the importance of microscale features of the immediate environment. Pedestrians can alter routes more readily, making numerous short stops, quick turns, and are presented with more choices for selection of route. Both transportation and health fields could define pedestrian activity as a form of human-powered movement through space. But even by this definition, more clarification is needed before this concept can be operationalized in a data collection effort.

As with all analysis of spatial activity, the importance of the scale of analysis is crucial. This complexity in the path of travel but the concept of walking “trips” tends to be ill-defined. There are several reasons for this ambiguity. The disciplinary orientation of the study and the categories of walking activity of interest have consequences for the types of data collected and analyzed in the studies. The pedestrian behavior captured in empirical studies from both of these perspectives does not always represent the total amount of walking taking place in the urban environment. For example, walking outside of the urban environment, such as the use of hiking trails or on treadmills, is included in studies where walking is taken as a physical activity and walking for health and leisure is often discounted when walking is treated as a mode of transport.

These fundamental characteristics of walking activity have implications for how we think about, collect, and analyze data on pedestrians and their activities. Regardless, consideration of these issues is important and some clarification of what characteristics define a walking trip or activity for transportation purposes is needed.

Another specific area of interest is the intersection between the use of non-motorized modes for transportation versus recreational purposes. The current questions surrounding public health outcomes and the built environment will undoubtedly press for more attention to this distinction. As travel budgets and exercise budgets may have different temporal dimensions, a one-day diary may not capture sufficient recreational trips or episodes. The inclusion of seven-day recall data in the NHTS is a start but this cannot substitute for the validity of diary data.

Non-motorized infrastructure provision tends to be incomplete or absent altogether in many urban environments. Information on routes would permit better understanding of how resources may be best allocated to accommodate path needs. Route choice or path data would be used to understand how pedestrians and cyclists deal with discontinuities and inconsistencies in the non-motorized transport system. We need to sensitive to how bicycle-pedestrian issues can be facilitated through GPS technology. This should prove a major part of future discussions in this area.

Many cities and regions are increasing the amount of land use and urban form data collected, due in part to the dissemination of GIS as an analytic tool. However, these data collection efforts are not consistent or comprehensive across jurisdiction. This hinders expansion of many pedestrian studies to use a national sample such as the NHTS and does not readily permit direct comparison between different areas of the county. Again the NHTS has included some aggregate measures of land use the tract level buy these are a far cry from some of the more microscale measure that are emerging as important in many non-motorized transport studies (Pikora, et al. 2003). At a minimum, the national data sets should include geographic identifiers to permit incorporation of local data, when available. A loftier goal would be to advocate for collection of these data and develop standards for the types of data and methods collected.

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Table 1 Research areas in bicycling and walking

Category of initiative	*Brief description*	*Target population*
Trip Generation	Overall rates of walking and cycling	
Route Choice	Investigation of the paths or routes traveled	
Safe Routes to School	Ensuring safe and comfortable access to schools for nearby residents.	School-age children (primarily age 5 to 16)
Physical activity	Understanding motivating factors and connections to built environment	Populations of all ages
Livability	Overall rates of walking and bicycling	Populations of all ages
Congestion	Rates of bicycle/pedestrian substitution for auto travel	Driving age population
Traffic Safety	Reducing pedestrian and bicycling crashes	Populations of all ages
Land use/urban design	Creating environments that encourage and promote walking and cycling	Populations of all ages
Activity analysis	What activities are likely to be accessed by cycling and walking?	
Transit	How are non-motorized modes used in conjunction with transit	
System evaluation	Methods of evaluating pedestrian and cycling environments for performance and needs assessment	

Table 2 Pedestrian and cycling data issues

Problem	*Description*	*How the NHTS addresses it*	*How well issue is addressed in NHTS*
Definition of pedestrian and/or pedestrian trip	What constitutes a pedestrian trip (walking across the parking lot, across the street to a neighbor?	Asks user about going to a different address? (prompted by telephone operator).	Fair
Relationship to other chained trips	Related to the above matter, it is important to identify various trips within the same shopping (or strip) ma.	Asks user about going to a different address? (prompted by telephone operator).	Fair
Missing trips	Respondents failing to accurately recount all small trips especially using recall methods.	Recall question as prompted by follow-up telephone interview.	Good
Misestimated tips distance	Difficult to accurately assess shorter distance trips because they typically lack reliable unit of measurement.	Allowing respondent to provide distance in blocks or miles	Good
Capturing populations with varying propensity for walking or bicycling	It is important to fully capture different populations of pedestrian or bicycling travel. For walking this possibly means oversampling youth and elderly populations; for cycling, this includes women.	NHTS captures elderly and youth travel.	Good
Destination-based versus non-destination based trips	Many travel surveys fail to detect or differentiate between recreational and non-recreational trips.	Contains additional coding for recreational trips.	Excellent
Neighborhood-scale urban form data	Micro-scale urban form features are thought to influence, in particular, pedestrian travel.	No neighborhood-scale urban form measures, only rudimentary level census-tract measures [1]	Fair
Trips aggregated to TAZ or tract level	Aggregation bias, thereby making it difficult to discern relative contribution of different geographic features.		Fair

[1] The 2000 NHTS made valiant stride in marrying the travel data with urban form data. The efforts, however, still provide only limited information regarding micro-scale level information.. What is available come from the Claritas vendor (a marketing information resources company) who serves to link tract level information of each NHTS respondent to the following urban form variables: (1) jobs per square mile, (2) housing units per square mile, (3) percent renter-occupied housing, (4) census tract urban/rural code, (5) population density (persons per square mile).

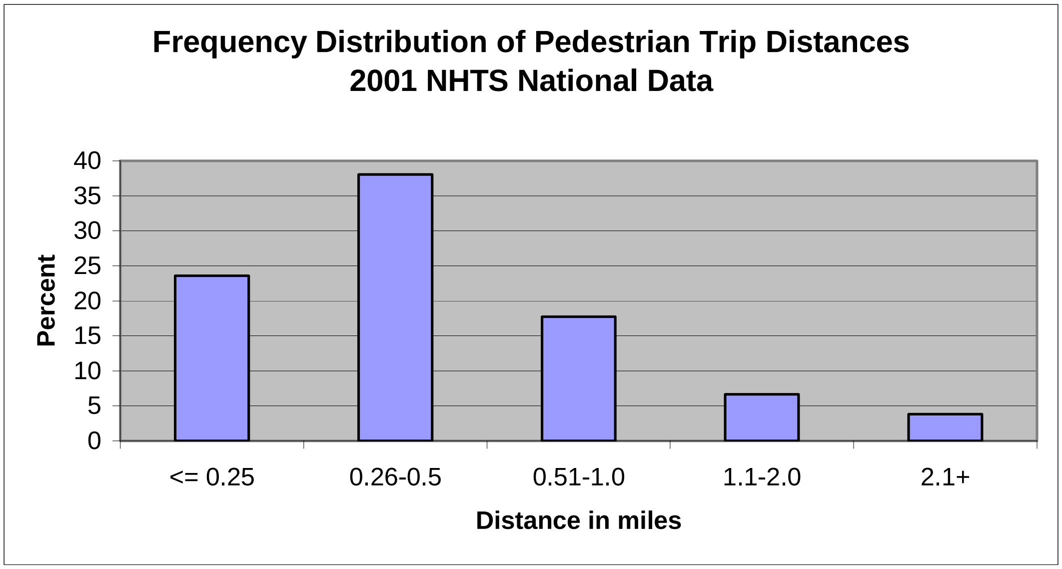


Figure 1 Distribution of Pedestrian Trip Distances (miles)

Table 3 Pedestrian Trip Purposes, 2001 NHTS National Sample

Trip Purpose	Percent
To work	2.4
Work-related	0.9
School	4.4
Religious	0.7
Medical/dental	0.5
Shopping	8.3
Other family & personal	9.8
Social/recreational	26.4
Eat meal	6.6
Serve passenger	2.5
Return to work	2.9
Return home	33.4
Other purpose	1.3
Total	100

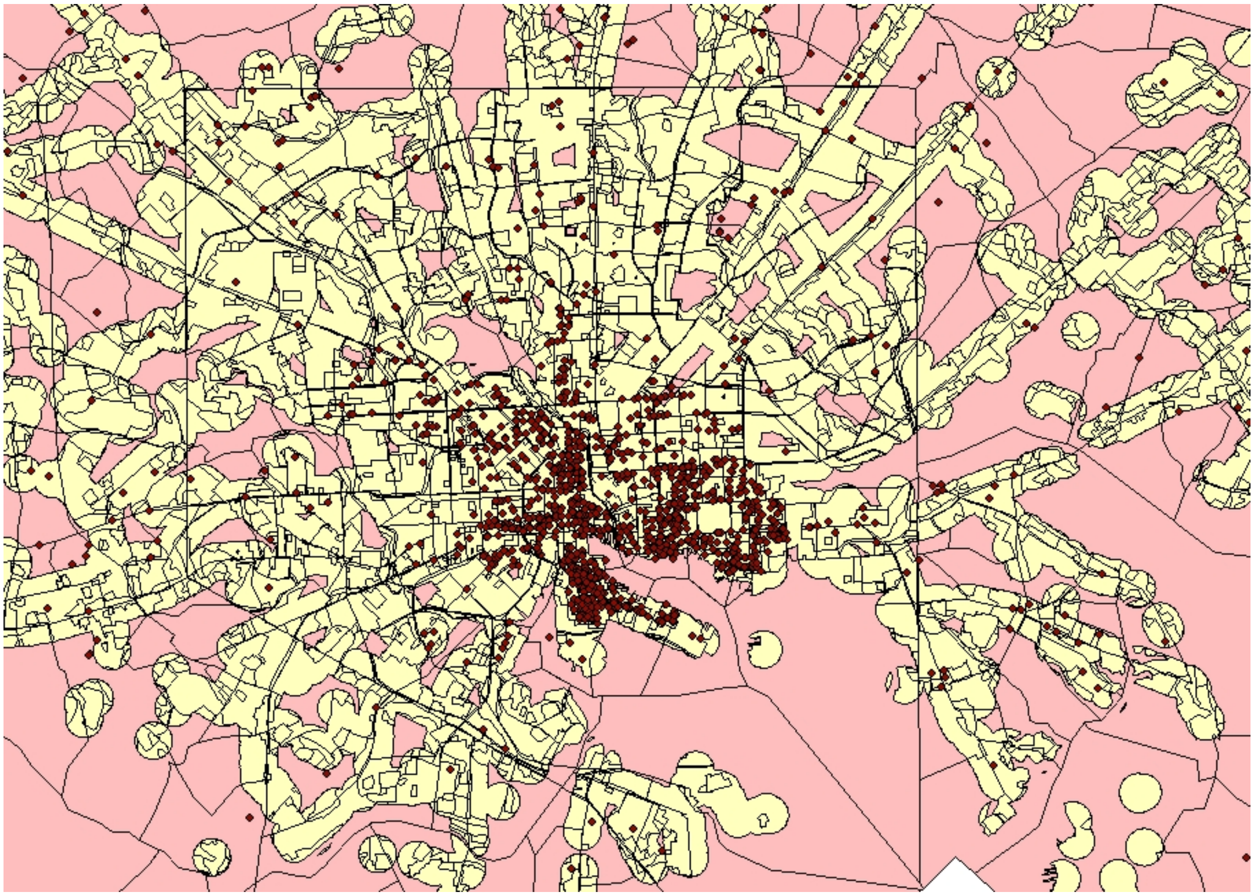


Figure 2 Spatial distribution of walking destinations and transit access (in yellow) in Baltimore area, 2001 NHTS, Baltimore Add-on

Table 4 Access mode to transit for Baltimore area

Mode	N	Percent
auto	82	6.7
transit	53	4.4
taxicab	7	0.6
bicycle	1	0.1
walk	1059	86.9
Total	1218	100.0

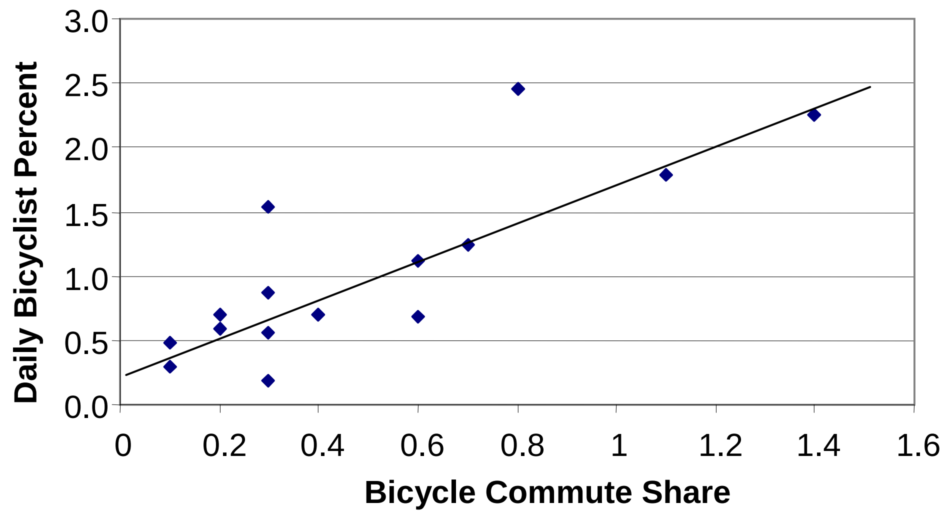
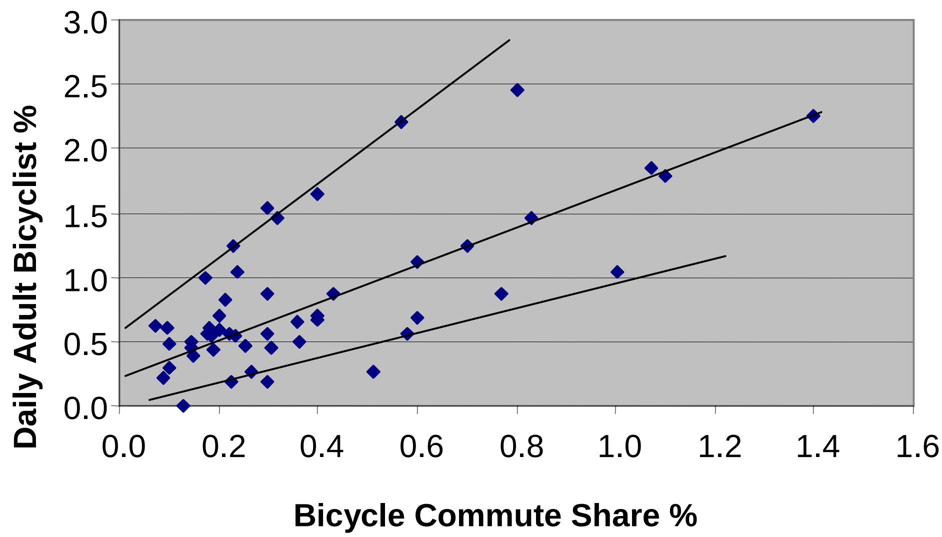
MSA level analysis	
State level analysis	

Figure 3 Correlations of cycling rates from CTPP and NHTS