Title
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Publication Date
2012-03-01

Peer reviewed

SafeTREC Safe Transportation Research & Education Center

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WP-2013-3

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2013
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How Common is Pedestrian Travel To, From, and Within Shopping Districts?

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For Presentation at Transportation Research Board Annual Meeting
Washington, DC
January 2012

Word Count: 5,986 text + 4 Tables and 2 Figures = 7,486 words
Key Words: Pedestrian, survey, mode share, measurement, shopping district

ABSTRACT
Growing interest in sustainable transportation systems and livable communities has created a need for more complete measures of pedestrian travel. Yet, many performance measures do not account for short pedestrian movements, such as walking between stores in a shopping district, walking from a street parking space to a building entrance, or walking from a bus stop to home. This study uses a 2009 intercept survey and the 2009 National Household Travel Survey to quantify pedestrian travel to, from, and within 20 San Francisco Bay Area shopping districts. Overall, walking was the primary travel mode for 21% of intercept survey and 10% of NHTS tours with stops in these shopping districts. However, detailed analysis of pedestrian movements showed that walking was common on respondent tours (52% of intercept survey tours included some walking) and that walking was used on the majority of trips within these shopping districts (65% of intercept survey trips and 71% of NHTS trips within the shopping districts were made by walking). In general, Urban Core and Suburban Main Street shopping districts had higher levels of pedestrian activity than Suburban Thoroughfare and Suburban Shopping Center shopping districts. The detailed analysis in this paper provides a more complete picture of pedestrian activity than is commonly shown by national and regional household survey summaries.

INTRODUCTION

According to the 2009 National Household Travel Survey (NHTS), approximately 10.5% of all trips in the United States are made by walking (*1*). Similarly, the 2000 San Francisco Bay Area Travel Survey reports a pedestrian trip mode share of 10.3% (*2*). However, reports suggest that existing analysis methods may not fully represent all short-distance pedestrian travel that is done by individuals (*3,4*). Transit trips often begin by walking a few blocks from home to a bus stop; automobile trips often end with a walk between an on-street parking spot and a store entrance. In addition, people often make short pedestrian trips between buildings in downtown areas and commercial zones.

The sidewalks of central business districts, neighborhood commercial corridors, and transit hub areas are often filled with pedestrians. Yet, this pedestrian activity may not be represented in standard travel analyses. Jurisdiction-wide mode share summaries often report the type of transportation residents use for the longest distance on trips between activity locations and may not include secondary pedestrian movements or pedestrian trips shorter than a minimum distance. This leaves out important information about pedestrian travel.

Pedestrian travel, whether it is done as a primary or secondary mode, uses public infrastructure, represents exposure to potential traffic injury, generates physical activity, and provides mobility that does not consume fossil fuel or produce tailpipe emissions. Accurate pedestrian data, including short-distance walking movements, are essential for making informed multimodal planning and policy decisions. Improved pedestrian data can:

- Provide a more complete representation of the amount of travel done by all modes in metropolitan areas.
- Represent the full extent of pedestrian activity in central business districts, shopping districts, and transit hub areas.
- Be used to evaluate how well local, regional, and national transportation systems are helping communities achieve sustainability and livability goals.
- Quantify the amount of exposure that pedestrians have to traffic crashes in order to improve estimates of community-level injury and fatality rates.
- Estimate physical activity obtained from routine travel to daily activities.
- Inform the design of public spaces and buildings.
- Provide local businesses with better measures of sidewalk activity and potential customers.

Purpose

This study is intended to quantify pedestrian travel that occurs on tours to, from, and within 20 San Francisco Bay Area shopping districts. It evaluates short-distance pedestrian trips and secondary pedestrian movements to and from parking spaces and transit stops. The analysis uses data from a 2009 intercept survey of retail pharmacy store customers as well as the 2009 NHTS. While it is unlikely that either survey captured every possible pedestrian movement, this research represents one of the first attempts to estimate the full amount of pedestrian travel done by individuals between a series of activities.

Definitions

Several terms are used throughout this paper to describe travel by individuals. A **trip** is a movement between a pair of activity locations, or stops (e.g., between home and work or between a store and a park). In general, a trip does not include travel on the same property.

Travel between two different stores in the same shopping complex is considered to be a trip, as long as it involves travel outside of a building. Each trip includes at least one stage. A **stage** represents movement using a single mode of transportation. If a person changes modes in the middle of a trip between two activity locations (e.g., changing from walking to riding the bus), he or she changes stages of the trip. Finally, a **tour** (i.e., trip chain) is the set of all trips that a person makes from the time he or she leaves home until he or she returns home. This tour definition is similar to the framework proposed for analyzing tours in the NHTS (*5*).

The study measures travel to, from, and within shopping districts. Each shopping district is defined as the area within a 0.5-mile (804-m) radius of the retail pharmacy store where the intercept survey was administered. Shopping districts contain commercial stores, but they also include a range of other land uses, including industrial, government, and residential properties.

LITERATURE REVIEW

Many metropolitan and national household travel surveys collect data on pedestrian travel, but they provide different levels of detail about walking movements. Some surveys exclude walking that is done to get to and from a private vehicle or trips that are less than a specified distance or duration (*6,7,8*). Others attempt to collect data on all modes used between activity locations, including walking from a transit stop or parking lot to a destination (*9,10,11*). Recently, several regional agencies have used global positioning systems (GPS) to gather travel data, which may be a promising method for capturing the full extent of respondent walking movements (*12,13,14*).

Even when short pedestrian stages are captured, it is not common for analysts to examine these data. According to a summary report for the Chicago Regional Household Travel Inventory, "If every single walking movement were gathered, the final mode to almost every location would be by foot" (*15*). Few studies have counted the number of pedestrian stages included in survey respondent tours or reported the amount of pedestrian travel within specific areas, such as shopping districts.

The review of household travel survey data and analysis shows that, in general:

- The private automobile is the primary (i.e., longest-distance) mode used for most tours in metropolitan regions throughout the United States, followed by walking (*1,8,9,10,15*).
- When walking is included in regional, state, or national analyses of person miles traveled (PMT), its mode share is often overshadowed by higher-speed modes that tend to be used for longer distances (*16*).
- Walking, bicycling, and public transit are common modes of access to activity sites in urban areas. This is shown by examples from California. Afternoon peak-hour surveys found that these modes account for 43% of trips to a bakery in Berkeley, 83% of trips to a coffee shop in San Diego, and 40% of trips to a restaurant in San Francisco (*17*). More than one-third of customers use walking, bicycling, or public transit as their primary mode of transportation to access six traditional urban shopping areas in Oakland and Berkeley (*18*). Fewer than 20% of all people traveling to shopping areas in Downtown San Francisco use a private automobile (*19*).
- The probability of a person choosing to walk decreases as tour length increases (*20*). People with poor accessibility to shopping destinations are more likely to drive to multiple store locations on a single tour, while people who live close to neighborhood commercial streets are more likely to walk to stores (*21*).

- Measuring pedestrian movement is one of the challenges to quantifying multimodal transportation. Pedestrian travel tends to be underreported because it usually covers short distances and is often done as the beginning or end stage of a longer automobile or public transit trip (*4*).

This analysis of existing studies suggests that there is a need to:

- Recognize differences in how pedestrian travel distance and mode share is represented by different surveys and research reports.
- Understand the implications of setting minimum distance or duration thresholds for trips in survey databases, particularly for underreporting pedestrian travel.
- Compare how well different survey methods represent the actual amount of pedestrian travel within metropolitan areas, neighborhoods, and shopping districts.

METHODOLOGY

Multimodal travel data were gathered from people who visited 20 San Francisco Bay Area shopping districts. This information was collected from two different surveys: 1) a 2009 intercept survey of retail pharmacy store customers in each shopping district and 2) the California supplement to the 2009 NHTS. The sections below describe characteristics of the shopping districts and the surveys.

Study Shopping District Characteristics

The 20 study shopping districts were located in the San Francisco Bay Area within Alameda, Contra Costa, San Francisco, and San Mateo counties (FIGURE 1). In order to compare pedestrian travel characteristics in different urban contexts, the 20 shopping districts were classified into four general types of local environments using cluster analysis. The cluster analysis was based on three variables describing the shopping district (number of residents, number of jobs, and sidewalk coverage along multilane roadways) and three variables related to the roadway corridor adjacent to the survey store (average number of through-lanes along the roadway, average number of major driveway crossings per mile along the roadway, and number of spaces in the store parking lot) (TABLE 1).

Four categories of shopping districts were identified and are described below:

- *Urban Core*: Surrounding neighborhood had high residential and employment density and extensive sidewalk coverage. Roadway corridor had short building setbacks, metered on-street parking, minimal off-street parking, two to four general-purpose through-lanes, and few non-residential driveways. Roadway had commercial retail properties along the length of the corridor.
- *Suburban Main Street*: Shopping district had moderate residential and employment density and extensive sidewalk coverage. Roadway corridor had mostly small commercial stores with short building setbacks, on-street parking (some metered), minimal off-street parking, and two to four through-lanes. Roadway had commercial retail properties along the length of the corridor.
- *Suburban Thoroughfare*: Shopping district had low residential and employment density and moderate sidewalk coverage. Roadway corridor was a high-speed, high-volume, multilane street with commercial properties that were generally set back from the sidewalk behind moderate-sized parking lots. Roadway corridor had minimal on-street parking. Roadway had commercial retail properties along the length of the corridor.

- *Suburban Shopping Center*: Shopping district had low residential and employment density and moderate sidewalk coverage. Center of district had a shopping complex with extensive off-street parking that tended to be separated from surrounding areas by high-speed, high-volume, multilane streets. Roadway corridor had minimal on-street parking. Beyond the shopping complex, the shopping district had few commercial retail properties.

FIGURE 1 20 San Francisco Bay Area Study Shopping Districts by Cluster Type

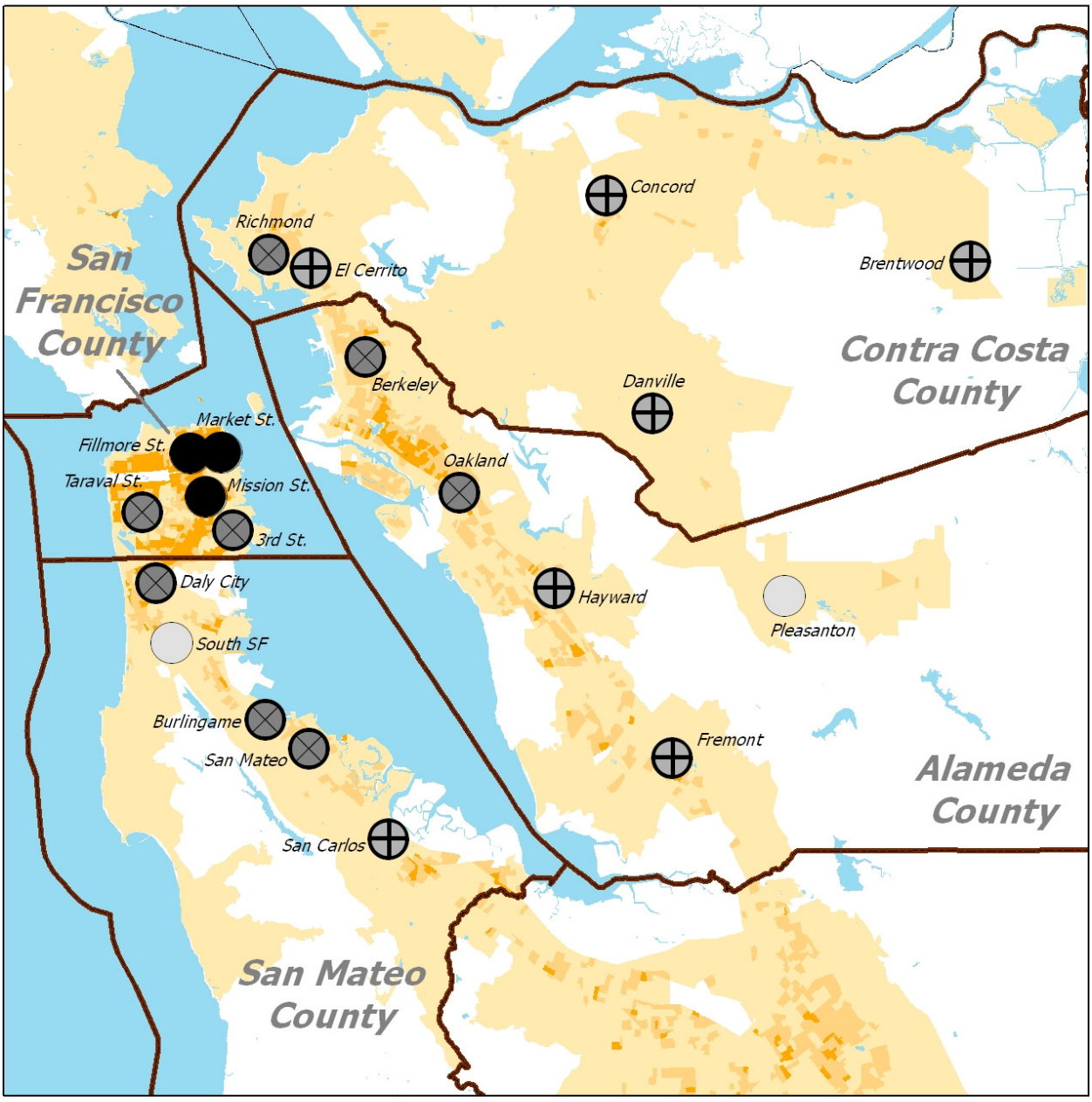

TABLE 1, Part 1 Shopping District Characteristics and Intercept Survey Respondent Tour Mode Share

1. Urban Core	Variables Used in Cluster Analysis						Respondent Primary Tour Mode Share[7]				
Shopping District	Residential population within shopping district[1]	Jobs within shopping district[2]	Sidewalk coverage on multilane roads within shop. district[3]	Average commercial street number of lanes[4]	Commercial street major driveway crossings per km[5]	Automobile parking spaces at the survey store[6]	N	Walk	Bicycle	Transit	Automobile
SF-Market St.	22100	145200	100%	4.00	0.00	0	49	46.9%	4.1%	40.8%	8.2%
SF-Fillmore St.	24000	14600	100%	2.00	0.00	10	52	59.6%	0.0%	15.4%	25.0%
SF-Mission St.	32200	7600	100%	4.00	0.00	0	53	45.3%	1.9%	39.6%	13.2%
Cluster Average	**26100**	**55800**	**100%**	**3.33**	**0.00**	**3**	**154**	**50.6%**	**1.9%**	**31.8%**	**15.6%**

2. Suburban Main Street	Variables Used in Cluster Analysis						Respondent Primary Tour Mode Share[7]				
Shopping District	Residential population within shopping district[1]	Jobs within shopping district[2]	Sidewalk coverage on multilane roads within shop. district[3]	Average commercial street number of lanes[4]	Commercial street major driveway crossings per km[5]	Automobile parking spaces at the survey store[6]	N	Walk	Bicycle	Transit	Automobile
Berkeley	12200	6300	100%	2.91	21.50	37	54	31.5%	13.0%	1.9%	53.7%
Oakland	12500	1600	89%	4.00	20.44	51	50	18.0%	2.0%	6.0%	74.0%
Richmond	10900	3200	95%	2.78	1.20	310	50	24.0%	2.0%	10.0%	64.0%
SF-Taraval St.	12700	2100	98%	4.00	1.25	0	47	25.5%	0.0%	19.1%	55.3%
SF-Third St.	12700	3400	96%	4.00	4.96	44	45	17.8%	0.0%	15.6%	66.7%
Daly City	12000	2400	81%	4.00	13.55	78	45	22.2%	0.0%	20.0%	57.8%
Burlingame	4400	4400	77%	2.77	16.19	20	52	25.0%	3.8%	1.9%	69.2%
San Mateo	9600	6300	100%	2.21	14.86	60	53	24.5%	1.9%	1.9%	71.7%
Cluster Average	**10900**	**3700**	**92%**	**3.33**	**11.75**	**75**	**396**	**23.7%**	**3.0%**	**9.1%**	**64.1%**

3. Suburban Thoroughfare	Variables Used in Cluster Analysis						Respondent Primary Tour Mode Share[7]				
Shopping District	Residential population within shopping district[1]	Jobs within shopping district[2]	Sidewalk coverage on multilane roads within shop. district[3]	Average commercial street number of lanes[4]	Commercial street major driveway crossings per km[5]	Automobile parking spaces at the survey store[6]	N	Walk	Bicycle	Transit	Automobile
Hayward	6200	1700	87%	5.72	44.82	44	51	11.8%	0.0%	3.9%	84.3%
Fremont	6500	4200	97%	6.00	14.70	197	47	14.9%	2.1%	2.1%	80.9%
Danville	1600	600	92%	4.00	28.63	290	42	2.4%	0.0%	0.0%	97.6%
Brentwood	1700	200	80%	4.00	8.86	193	43	2.3%	4.7%	2.3%	90.7%
Concord	4300	11600	97%	5.78	23.67	59	45	17.8%	0.0%	0.0%	82.2%
El Cerrito	6400	2200	100%	4.28	36.09	250	41	7.3%	0.0%	4.9%	87.8%
San Carlos	4900	4200	74%	5.00	19.98	85	47	2.1%	4.3%	6.4%	87.2%
Cluster Average	**4500**	**3500**	**90%**	**4.97**	**25.25**	**160**	**316**	**8.5%**	**1.6%**	**2.8%**	**87.0%**

4. Suburban Shopping Center	Variables Used in Cluster Analysis						Respondent Primary Tour Mode Share[7]				
Shopping District	Residential population within shopping district[1]	Jobs within shopping district[2]	Sidewalk coverage on multilane roads within shop. district[3]	Average commercial street number of lanes[4]	Commercial street major driveway crossings per km[5]	Automobile parking spaces at the survey store[6]	N	Walk	Bicycle	Transit	Automobile
Pleasanton	3800	1200	84%	4.87	11.49	442	47	4.3%	2.1%	2.1%	91.5%
S. San Francisco	8600	800	54%	4.53	9.51	420	46	6.5%	0.0%	0.0%	93.5%
Cluster Average	**6200**	**1000**	**69%**	**4.70**	**10.50**	**431**	**93**	**5.4%**	**1.1%**	**1.1%**	**92.5%**

Overall	Variables Used in Cluster Analysis						Respondent Primary Tour Mode Share[7]				
	Residential population within shopping district[1]	Jobs within shopping district[2]	Sidewalk coverage on multilane roads within shop. district[3]	Average commercial street number of lanes[4]	Commercial street major driveway crossings per km[5]	Automobile parking spaces at the survey store[6]	N	Walk	Bicycle	Transit	Automobile
Overall Average	**10500**	**11200**	**90%**	**4.04**	**14.59**	**130**	**959**	**21.3%**	**2.2%**	**9.9%**	**66.6%**

TABLE 1, Part 2 Footnotes

1) The calculation of population only included portions of census block groups that were within the 0.5-mile (804-m) radius of the store (i.e., the shopping district). Source: US Census (2000).
2) The calculation of jobs only included portions of traffic analysis zones that were within the 0.5-mile (804-m) radius of the store. Source: San Francisco Bay Area Metropolitan Transportation Commission traffic analysis zones (2005).
3) Sidewalk coverage was calculated for multilane roadways within the shopping district. The sidewalk coverage calculation assumed that complete coverage was continuous sidewalks on both sides of the street. Therefore, if a street had sidewalks on both sides, it had 100% sidewalk coverage. If a street had a complete sidewalk on one side, but no sidewalk on the other, it had 50% coverage. Source: Google Earth & Bing Maps aerial photographs (2007-2009).
4) The number of travel lanes was documented for the main (highest-volume) commercial roadway through the shopping district. Travel lanes included all general purpose through-lanes in both directions. The number of through-lanes did not include left- or right-turn lanes, two-way center turn lanes, bicycle lanes, shoulders, or other auxilary lanes. In addition, it did not include lanes that ended within the segment. Source: Google Earth & Bing Maps aerial photographs (2007-2009).
5) The number of driveway crossings was documented for the main (highest-volume) commercial roadway through the shopping district. Major driveway crossings inclued all active non-residential and more than 10-unit residential property driveways. Source: Google Earth & Bing Maps aerial photographs (2007-2009).
6) Number of parking spaces in the survey store parking lot (included shared parking with other stores in the same shopping complex). Source: Google Earth & Bing Maps aerial photographs (2007-2009).
7) Survey respondent transportation mode share was the mode that respondents used for the greatest distance on their whole tour. Cluster average was weighted average of individual store mode shares based on surveys per store (2009).

2009 Retail Pharmacy Store Intercept Survey

The sections below describe the intercept survey distribution, design, and data. Each of the intercept survey stores was part of the same national retail pharmacy chain, which helped control for store and brand preferences among participants in different shopping districts. More detail about the intercept survey methodology is provided in other sources (*22*).

Intercept Survey Distribution

Intercept surveys were used to gather detailed travel data from retail pharmacy store customers in the 20 shopping districts between August 29, 2009 and December 9, 2009. 4,585 customers were invited to participate in the survey, and 1,003 (22%) took the survey. Surveys were distributed relatively evenly between each of the 20 stores (between 45 and 56 customers were surveyed at each store). Overall, the survey respondents were similar to people who were invited to take the survey but declined to participate in terms of gender, age, and group size (*22*).

Approximately half of the surveys at each site were done on weekday afternoons between 4 p.m. and 6 p.m. Fridays were excluded because they were expected to have substantially different travel patterns than other weekdays. The other half of the surveys at each site were done on Saturdays between 11 a.m. and 5 p.m. All surveys were administered during daylight and fair weather conditions. Temperatures during survey periods ranged from 50°F (10°C) to 85°F (29°C). Surveys were not offered when it was raining or when the previous day's forecast predicted more than a 50% chance of rain.

Three people administered surveys throughout the study period, including the lead researcher and two Spanish-speaking assistants. The surveyors stood three to six meters (10 to 20 feet) outside of the store exit. Customers aged 18 and older were invited to participate as they exited the store. After each completed survey, the next customer who exited the store was asked to participate. Some customers shopped in a group. Only one member of each group (the first adult) was invited to participate.

Participants answered questions verbally, and the surveyors recorded responses on the survey form. The survey was designed to be completed in three minutes for someone who was making a simple tour. However, the average survey time was estimated to be five minutes (longer surveys were typically due to additional comments provided by participants).

Intercept Survey Design

The front side of the survey captured customer travel habits, socioeconomic characteristics, attitudes towards different travel modes, and perceptions of crime and transportation safety in the shopping district. The back side of the survey instrument included a map of all streets within a two-mile (3.2-km) radius of the store. Survey respondents were asked to identify the locations of their home and all stops that they had made and were planning to make on their tour before returning home. In addition, they were asked to report all modes of transportation that they used for each trip on their tour. When an automobile was used for a trip, respondents were asked if they walked for one-half block or more from a parking spot to an activity or home (walking from a parking lot space to a store entrance, from a driveway into a house, or from a street parking space directly in front of a destination to a store entrance were not recorded). If transit was used, respondents reported how far they walked to and from each transit stop (walking within a transit station or station parking lot was not recorded).

The survey instrument was pilot tested in spring 2009 and was approved by the UC Berkeley Committee on the Protection of Human Subjects in August 2009. English and Spanish versions of the survey were used.

Intercept Survey Data

Of the 1,003 survey respondents, 959 (96%) provided tour data suitable for geocoding. These 959 tours covered approximately 11,800 miles (19,000 km) and included 4,069 trips and 4,945 stages (604 trips had more than one stage). The median tour length was 5.21 miles (8.38 km) (average = 12.3 miles (19.8 km)), and the median number of trips per tour was four (average = 4.24 trips). 126 (13%) of the respondents made only two stops (e.g., traveled to the survey store and back home), and 186 (19%) made six or more stops.

The intercept survey provided a detailed database of pedestrian movements. For example, all walking stages were geocoded and used to create maps of pedestrian path density in different urban environments (FIGURE 2). Respondent pedestrian movements in higher-density Urban Core and Suburban Main Street shopping districts tended to be spread along the main commercial street and on streets accessing this roadway, while respondent walking in lower-density Suburban Thoroughfare and Suburban Shopping Center shopping districts was typically concentrated in the shopping complex that contained the survey store.

FIGURE 2 Respondent Pedestrian Path Density in Different Urban Environments

California Supplement to the 2009 NHTS

The 2009 NHTS gathered data from approximately 150,000 households throughout the United States between April 2008 and April 2009. Random-digit dialing was used to select survey participants, and data were collected from daily travel diaries and follow-up telephone interviews. The survey methodology is described in detail in other references (*23*).

The California Department of Transportation (Caltrans) purchased additional surveys to supplement the national sample. More than 21,000 California households and 47,000 California residents participated in the survey. They reported more than 171,000 individual trips. The California supplement also includes geocoded trip ends for all respondents, making it possible to identify travel to specific shopping districts.

This study analyzes 574 California NHTS respondent tours that included at least one stop (or home location) in one of the 20 study shopping districts. The tour analysis database was created by combining sets of individual trip records into tours. For comparison with the intercept survey, 139 NHTS tours done exclusively for the purpose of recreation were excluded from the analysis. More than 50 other tours were omitted because they were longer than 100 miles (i.e., most likely involved travel outside of the region) or were missing information about travel mode or distance.

The final database of 574 tours represented approximately 11,700 miles (18,800 km) of travel and included 2,043 trips. The median tour length was 11.4 miles (18.3 km) (average = 20.4 miles (32.8 km)), and the median number of trips per tour was three (average = 3.56 trips). 241 (42%) of the respondents made only two stops, and 88 (15%) made six or more stops.

Differences between the Intercept Survey and NHTS

Overall differences between the intercept survey and NHTS include:

- *Intercept survey respondents were more likely to be female and younger than NHTS respondents*. 59% of intercept survey respondents were female, and 53% of NHTS respondents were female. 31% of intercept survey respondents were younger than age 35, while 17% of NHTS respondents were younger than age 35.
- *The intercept survey gathered data under more specific conditions than the NHTS*. Since the intercept survey was conducted during times and weather conditions that were favorable for walking, it is likely that it represented above average pedestrian activity levels in each shopping district. In addition, the intercept survey collected data from retail pharmacy store customers. These respondents could have had different travel characteristics than people who stopped at other locations in the shopping district. This suggests that it is valuable to compare the intercept survey data with NHTS data, which were collected at all times, under all weather conditions, and were not limited to retail pharmacy store customers.
- *Median tour length is shorter for the intercept survey than the NHTS.* This is likely due to differences in sampling methods. The intercept survey captures similar numbers of tours across all 20 shopping districts, but the NHTS sample includes more tours to the San Francisco urban core shopping districts than to suburban shopping districts. As a result, the NHTS analysis represents more long-commute tours to downtown San Francisco than the intercept survey analysis. Long commutes tend to be less conducive to walking.
- *The intercept survey captures more trips per tour than the NHTS.* While both surveys define a trip as travel between addresses, it is possible that the face-to-face intercept

survey format made it easier for respondents to understand the trip definition and report individual trips. There may also be more trips in the intercept survey database because half of the intercept surveys were done on Saturdays. Trips within shopping districts on Saturdays may be shorter and more frequent than trips on other days. By comparison, the NHTS includes about the same number of trips from each day of the week. Since the intercept survey tours tend to be shorter and have more stops then than NHTS, the intercept survey is likely to favor pedestrian travel.

- *Trip stages are only analyzed for the intercept survey.* Nearly 15% of trips captured in the intercept survey used more than one mode. Since many secondary stages within these trips are pedestrian movements, the intercept survey provides more information about the regularity of walking and pedestrian travel distances than the NHTS. Note that the NHTS includes information about walking travel time to and from transit stops, but these data are not analyzed in this study because similar data are not available for travel to and from parking.
- *Travel time is only analyzed for the NHTS.* The NHTS provides self-reported travel time data, which makes it possible to quantify the amount of time respondents spent walking (excluding walking time to and from transit or parking spaces). Travel time was not included in the intercept survey in order to reduce respondent burden and keep the survey short.

ANALYSIS

The first part of the analysis explores the total amount of pedestrian travel done on tours to and from the 20 shopping districts. This is followed by a focused study of the amount of walking reported within each of the 20 shopping districts.

Pedestrian Travel on Tours To and From Shopping Districts

Several pedestrian mode share measures were used to quantify walking on respondent tours to the study shopping districts (TABLE 2). Overall, walking was the primary tour mode for 21% of intercept survey respondents and 10% of NHTS respondents. By comparison, pedestrian travel represented a greater share of all individual trips (29% of intercept survey trips and 19% of NHTS trips), but a smaller share of total distance traveled (less than 5% of intercept survey travel distance and 3% of NHTS travel distance). The data reveal several other insights into pedestrian travel on tours to and from shopping districts:

- *Pedestrian travel is common on shopping district tours.* According to the intercept survey, 52% of respondents walked for at least one tour stage (i.e., walked along a sidewalk or between buildings at some time between leaving and returning home). While walking was more common on urban shopping district tours, approximately 30% of Suburban Thoroughfare and Suburban Shopping Center shopping district intercept survey participants walked for at least one tour stage.
- *Pedestrian tour mode share varies by type of local environment.* Nearly all measures show that more people walk to and from Urban Core and Suburban Main Street shopping districts than Suburban Thoroughfare and Suburban Shopping Center shopping districts. Urban Core and Suburban Main Street districts tend to have higher concentrations of population, jobs, and a greater mix of land uses than the more dispersed suburban districts. In general, these two types of higher-density, mixed-use shopping districts are also surrounded by more connected street grids, narrower roadways, fewer parking lots,

more expensive parking, and more frequent transit service than the Suburban Thoroughfare and Suburban Shopping Center districts. These surrounding environment characteristics are associated with walking (*17,21,22*). Localized differences in pedestrian tour mode shares suggest that it is useful to analyze travel data in areas smaller than the region or jurisdiction level. Note that the Urban Core pedestrian mode shares from the intercept survey are much higher than from the NHTS. This is probably because the NHTS sample for these shopping districts includes more long-distance commute tours than the intercept survey.

- *Walking provides travelers with physical activity*. Approximately 28% of NHTS respondents reported walking during a tour to the study shopping districts. The median walking time for these respondents was 25 minutes. Tours made solely for recreational purposes were not considered in this analysis, so this result shows that walking to activities such as work and shopping on a regular basis can provide a majority of recommended weekly physical activity (*24*).

TABLE 2 Pedestrian Travel on Tours To and From Shopping Districts

	Primary Tour Mode[1]				Primary Trip Mode[2]				Total Distance Traveled by Mode			
	2009 Intercept Survey		2009 NHTS		2009 Intercept Survey		2009 NHTS		2009 Intercept Survey		2009 NHTS	
Shopping District Type (#)	# Tours (all modes)	**% Walk**	# Tours (all modes)	**% Walk**	# Trips (all modes)	**% Walk**	# Trips (all modes)	**% Walk**	# Miles (all modes)[3]	**% Walk**	# Miles (all modes)[3]	**% Walk**
Urban Core (3)	154	**50.6%**	199	**10.6%**	768	**70.4%**	741	**29.3%**	1359	**17.9%**	4126	**4.3%**
Suburban Main Street (8)	396	**23.7%**	175	**13.1%**	1624	**27.6%**	567	**16.9%**	4348	**4.5%**	3639	**1.6%**
Suburban Thoroughfare (7)	316	**8.5%**	145	**6.2%**	1299	**10.6%**	532	**9.6%**	4934	**1.5%**	3039	**2.7%**
Suburban Shopping Center (2)	93	**5.4%**	55	**5.5%**	378	**12.4%**	203	**7.4%**	1179	**1.9%**	880	**1.0%**
All Shopping Districts (20)[4]	*959*	***21.3%***	*574*	***9.8%***	*4069*	***28.9%***	*2043*	***18.6%***	*11819*	***4.5%***	*11684*	***2.8%***

1) Primary tour mode is the mode used for the greatest distance on the tour (e.g., between all activity stops from leaving home until returning home).

2) Primary trip mode is the mode used for the greatest distance on a trip (e.g., between each pair of activity stops).

3) 1.0 miles = 1.61 kilometers.

4) Percentages represent the proportion of travel that is done by walking versus other modes for each type of shopping district, so the column totals do not sum to 100%.

Pedestrian Travel Within Shopping Districts

Walking was the most common mode used for trips completely within shopping districts by intercept survey respondents (65%) and NHTS respondents (71%) (TABLE 3). Pedestrian travel also represented 22% of intercept survey respondent miles traveled and 48% of NHTS respondent miles traveled within shopping districts. NHTS pedestrian mode shares within the Suburban Thoroughfare and Suburban Shopping Center shopping districts are less reliable because of small sample sizes.

The two surveys highlight attributes of pedestrian travel within shopping districts:

- *Most individual trips within the study shopping districts are made by walking.* According to both surveys, the majority of trips within the study shopping districts were made by walking. Despite pedestrian barriers in the more dispersed, automobile-oriented Suburban Thoroughfare and Suburban Shopping Center shopping districts, the intercept survey showed that more than 30% of trips between stops within these districts were also made by walking.
- *Pedestrian mode shares are higher for trips within shopping districts than for traveling to and from shopping districts.* Walking was used for a much larger proportion of trips within shopping districts (65% intercept survey and 71% NHTS mode share) than for trips on tours to and from shopping districts (29% intercept survey and 19% NHTS mode share). This is generally due to shorter, more walkable, trip distances between activity locations in shopping districts but longer trip distances to reach the shopping districts. Walking rather than driving within a shopping district may also depend on parking availability and the difficulty of pedestrian travel along and across roadways.
- *Pedestrian activity within shopping districts varies by local environment characteristics.* Like overall tour mode shares, walking within shopping districts was more common for Urban Core and Suburban Main Street districts. Many of the local environment characteristics associated with these higher-density, mixed use shopping districts (mentioned above) make walking within these areas feasible and attractive.

TABLE 3 Pedestrian Travel Within Shopping Districts

	Primary Trip Mode[1]				Total Distance Traveled by Mode			
	2009 Intercept Survey		2009 NHTS		2009 Intercept Survey		2009 NHTS	
Shopping District Type (#)	# Trips	**% Walk**	# Trips	**% Walk**	# Miles (all modes)[2]	**% Walk**	# Miles (all modes)[2]	**% Walk**
Urban Core (3)	440	**95.9%**	111	**87.4%**	260	**60.6%**	47	**79.8%**
Suburban Main Street (8)	564	**63.3%**	55	**63.6%**	599	**20.9%**	47	**29.6%**
Suburban Thoroughfare (7)[3]	296	**30.1%**	23	**52.2%**	523	**7.5%**	13	**51.5%**
Suburban Shopping Center (2)[3]	82	**40.2%**	19	**15.8%**	163	**6.8%**	17	**10.8%**
All Shopping Districts (20)[4]	*1382*	***65.2%***	*208*	***70.7%***	*1545*	***21.6%***	*125*	***48.2%***

1) Primary trip mode is the mode used for the greatest distance on a trip (e.g., between each pair of activity stops within the shopping district).
2) 1.0 miles = 1.61 kilometers.
3) NHTS sample includes less than 30 trips and less than 30 miles traveled for all modes in Suburban Thoroughfare and Suburban Shopping Center shopping districts.
4) Percentages represent the proportion of travel that is done by walking versus other modes for each type of shopping district, so the column totals do not sum to 100%.

PRACTICAL APPLICATIONS

Detailed analysis of the intercept survey and NHTS reveal a more complete picture of pedestrian activity than is commonly shown by overall national and regional household survey summaries. First, the intercept survey analysis includes all pedestrian stages done by respondents when traveling to, from, and within the 20 study shopping districts. Therefore, intercept survey pedestrian mode shares include walking to and from transit stops as well as to and from on-street parking spaces. Second, by focusing on specific shopping districts where pedestrian travel is common, both surveys reveal much higher walking mode shares than reported for the metropolitan area as a whole. Higher walking mode shares are also likely to be found in other pedestrian-oriented areas, such as near transit hubs.

More complete pedestrian data can improve transportation planning and prioritization processes. Fully accounting for pedestrian travel in all parts of a jurisdiction is useful for prioritizing multimodal transportation projects as well as focusing pedestrian improvements in specific locations. More complete pedestrian data can also be used to:

- *Measure pedestrian mode share accurately*. Most jurisdiction-wide mode share metrics include all automobile, transit, and bicycle travel. However, it is common for these measures to omit short pedestrian trips and secondary pedestrian movements connecting to parking and transit stops. A full accounting of pedestrian mode share should include at least all walking in public spaces, including walking along sidewalks and across streets. This paper shows that this type of analysis is possible.
- *Calculate pedestrian crash rates*. The pedestrian crash rate for an area can be calculated as the ratio of reported pedestrian crashes to total pedestrian activity (e.g., exposure) within the area. All walking movements that may involve a risk of being struck by a vehicle, even crossing one street after driving to a parking spot, should be included to represent exposure and estimate pedestrian crash rates accurately.

- *Estimate levels of physical activity*. Quantifying the total distance or time traveled by pedestrians can provide estimates of the amount of physical activity done by people during their daily travel routines.
- *Quantify potential customer pedestrian traffic*. Retail stores and other businesses that depend on foot traffic for customers can use information about the total number and locations of pedestrian trips made in shopping districts to make store siting decisions.

CONSIDERATIONS

The intercept survey was conducted in specific geographic areas under a limited set of conditions. While the San Francisco Bay Area provided a range of urban and suburban environments for the survey, people in other regions may have different walking habits. Therefore, the intercept survey and NHTS data could also be explored in other communities. Intercept surveys could also be done at different types of stores in shopping districts to gather a more diverse set of data (e.g., people who purchase large items at a furniture store may be less likely to walk; people who travel to a restaurant or seek exercise may be more likely to walk). Responses could also be collected at different times (e.g., weekday morning or mid-day periods) and during different weather (e.g, rain, snow, cold, hot) to understand the extent of pedestrian activity under various conditions.

This study reports the overall amount of pedestrian activity on respondent tours, but additional research could also explore the relationship between walking and individual socioeconomic characteristics, attitudes towards walking, perceptions of traffic safety and crime, and local environment features within shopping districts. For example, after controlling for travel time, number of bags being carried, group size, and physical disabilities, the choice to walk rather than drive on trips within a shopping district may be associated with metered on-street parking, shared parking lots among stores, lower speed limits, and fewer commercial roadway driveway crossings (*22*).

The intercept survey instrument and distribution process were designed to avoid systematic exclusion of any type of customer from participating. However, it was not possible to offer the survey to all customers exiting the store. Common reasons for declining to participate in the intercept survey included lack of time, childcare responsibilities, language barriers, cell phones and other distractions, distaste for surveys or distrust of surveyors, and illness. It is likely that people do not participate in the NHTS and other household travel surveys for many similar reasons.

Several intercept survey respondents reported the locations of other stops they made before the store, but they did not know where they were going afterward. After prompting, these participants reported locations where they thought they might go. It was not possible to know how many people revised their travel plans after completing the survey. Responses describing when participants decided to go to the store provided some insight into unplanned stops: 24% didn't decide until after they left home, and 15% decided when they were passing by the store. Therefore, it was relatively common for people to make unplanned stops on a tour. This highlights a challenge of relying on self-reported travel behavior, especially for anticipated travel.

The intercept survey was designed to capture all walking greater than one-half block in distance. Many people remembered when they walked from on-street parking or from a transit stop to the store, but it is possible that some short walking stages were not reported because respondents had already forgotten them, had survey fatigue, or did not anticipate that they would

be walking from parking or bus stops later in their tour. Therefore, it is possible that the intercept survey still underreported pedestrian travel.

In the future, GPS technology may help address some of these challenges by capturing all pedestrian movements automatically. Applications of GPS for travel surveys over the last decade have identified several limitations, including representative sampling, respondent burden (e.g., activating, carrying, and charging the device), reliable contact with satellites, and accurate classification of travel modes (especially walking) (*13,25,26*). However, these issues are being addressed. As automated survey methods improve, a central challenge will be for analysts to use the detailed data to quantify individual pedestrian movements and overall pedestrian mode share more completely. This study shows that this can be done.

CONCLUSION

The detailed analysis in this paper provides a more complete picture of pedestrian activity than is commonly shown by national and regional household survey summaries. Analyses of only the primary mode used on trips omit pedestrian movements connecting to parking and transit stops. Analyses that only describe travel across a metropolitan area or jurisdiction mask the high levels of pedestrian activity that are found in areas such as downtowns, transit hubs, and shopping districts. Practitioners can use the detailed approaches presented in this paper to provide more accurate estimates of pedestrian mode shares, pedestrian crash risk, physical activity levels, and potential customer pedestrian traffic.

ACKNOWLEDGEMENTS
Special thanks to Carlos Velasquez and Melissa Chinchilla for assisting with Intercept Survey distribution and to Robert Cervero for advising on this study. California NHTS data were provided by Leonard Seitz of Caltrans. Fellowship support was provided the University of California Transportation Center and U.S. Environmental Protection Agency's Science to Achieve Results (STAR) program. Although the research described in the paper has been funded in part by the U.S. Environmental Protection Agency's STAR program through grant (FP-91695101-0), it has not been subjected to any EPA review and therefore does not necessarily reflect the views of the Agency, and no official endorsement should be inferred.

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