Transit and Active Transportation Use for Non-commute Travel among Portland TOD Residents

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ABSTRACT

Transit oriented development (TOD) seeks to promote non-single occupancy vehicle travel by placing dense residential and mixed-use buildings near high-capacity, high-frequency transit. Most research to date on the impact of TODs on travel behavior have focused on commute trips; however, many trips are for non-work purposes, and a sizable portion of the population does not commute to work. This study utilizes a set of surveys, conducted between 2005 and 2019, of residents of TODs in the Portland OR region to assess factors associated whether or not, and how often, people walk, bike or take transit for home-based non-work trips. Findings show that about 20% of TOD residents take transit for non-work trips at least once per week, while 65% walk or bike for such trips. Attitudes and housing preferences are important factors in predicting whether and how frequently TOD residents walk, bicycle or take transit for non-work trips. Within TODs, higher transit accessibility is associated with more non-work transit use, and street connectivity is associated with more non-work walking and bicycling. Lower access to a personal vehicle is also an important factor in non-work travel.

Keywords:
Transit oriented development; non-commute trips; trip purpose; shopping trips

INTRODUCTION

The term transit oriented development (TOD) has been part of urban planning research and practice for over 25 years, though the concept has existed for longer. While precise definitions vary, TOD generally refers to developments that are compact or dense, have a mix of land uses, are walkable, and are within a short distance (one-quarter to one-half mile) of a major transit station or hub (*1*, *2*). In concept, TODs seek to create a symbiotic relationship between two significant infrastructure investments, public transportation and residential and/or commercial buildings, which can help both to maximize their potential. Dense mixed-use buildings provide potential ridership for transit, while the increased density, mixed-uses, and pedestrian infrastructure provides building residents, employees and visitors the ability to walk or bike around a TOD. TOD has become a common policy lever for local, regional, and state governments aiming to reduce reliance on private vehicles and increase use of transit systems, particularly rail and bus rapid transit systems, representing major capital investments. More recently, practitioners and scholars have looked at TOD as a potential tool for more equitable development, partly in response to concerns that new rail transit could cause gentrification and displacement (*3*).

Much research to date on the impact of TODs on travel behavior have focused on work-related trips (*1*). This makes sense since one goal of TODs is to be a mechanism of combatting peak-hour congestion by reducing barriers associated with transit commuting. Less studied is the impact of TODs on non-work travel, including trips for dining, shopping, errands, visiting friends or family, and entertainment. This has been a critique of existing TOD research because non-work trips are a significant share of household travel (*4*).

This study utilizes a set of surveys, conducted between 2005 and 2019, of residents of TODs in the Portland OR region to assess factors associated whether or not, and how often, people walk, bike or take transit for home-based non-work trips. The sample includes over 1,300 residents of 44 TODs. The density, style, scale, and level of transit service of the TODs varies, providing an opportunity to examine how the features of TODs may influence non-work travel behavior, along with residents' attitudes and housing preferences, which can be indicators of self-selection. Most of the TODs are outside of the central core of the city and may resemble environments found in many metropolitan regions that have invested in modern light rail systems. As background, we first briefly review some of the research on the travel behavior of TOD residents, particularly for non-work trips, and TOD program in the Portland region. We then explain our methodology, including describing the TODs in the study, the survey method, and the analysis for this paper. This is followed by the findings, discussion, and conclusion.

BACKGROUND

Most studies focusing on travel behavior associated with TODs have examined the effect of TODs on taking transit to work or on reducing vehicle trips or miles traveled (VMT), but relatively few have examined their effect on non-work trips (*1*). A number of studies have found that motor-vehicle trip generation at TODs is significantly below rates suggested by the ITE Trip Generation Manual Guidelines (*7*–*10*), although it should be noted that, as of the 2017 10th Edition of the manual, additional residential categories have been added to better reflect some types of development, such as mid- or high-rise residential buildings with ground floor commercial. A study of California TODs in 2003 found that TOD residents were nearly five times as likely to take transit (and considerably less likely to drive) as residents living in the nearby community, with around a quarter of residents commuting by transit (*5*). These findings

are consistent with other research that has shown that access to transit increases transit use (*11, 12*). A study that distinguished denser (development and street networks) and more diverse TODs from other merely transit-adjacent development (TADs), found that people living in TODs were more likely to walk and take transit (*12*).

A few studies have looked specifically at non-work or non-commute travel. The 2003 California study found that transit was much less common for non-work trips. For both work and non-work trips, the numbers varied considerably by specific TOD and location, with other factors such as workplace parking, employer policies around flex-time and transit passes, along with land-use variables, seemingly accounting for many of the differences (*5*). Research on TODs in the Washington DC and Baltimore regions used travel survey data to show that the share of non-work trips by transit, walking and bicycling (combined) was higher among TOD residents than non-TOD residents. In the Washington DC TODs, those three non-auto modes were more common for works trips (45% vs. 33%), though in Baltimore the shares were similar (21% vs. 24%) (*13*). That analysis did not examine the factors behind non-work travel specifically. A study of seven TOD locations in North America found that new movers to TOD buildings tended to shift to non-single occupancy vehicle (SOV) trips for amenities and leisure trips, but less so for work and shopping trips (*14*).

In one of the few papers focused on factors associated with non-work travel and TODs, Laham and Noland (*15*) examined walking to restaurants-coffee shops and grocery-food stores among TOD residents in New Jersey. The respondents walked for over 30% of these trips. Factors increasing the likelihood of walking for one or both of these trip purposes included lower vehicle ownership, younger age, living in the home for a shorter time, smaller households, higher income, population density, employment density, and street density. However, once they controlled for self-selection (using attitudes), the length of residence and household size had a positive association with walking and income had a negative association; age, population density, and employment density were no longer significant. Street density and vehicle ownership were still significant. A study by Choi and Guhathatkurta (*16*) compared trips in traffic analysis zones (TAZs) in commuter rail transit catchment areas to TAZs without rail transit in the Atlanta region, and found that the presence of rail transit increased the frequency of non-commute walk trips, even after controlling for sociodemographic factors. That study also found that being female, having a driver's license, and having more vehicles per household member were associated with less walking, while Hispanic persons were more likely to walk; it did not explore other built environment or attitudinal factors.

Portland Metro, the region's directly-elected government, started a TOD program in 1998. In its first 21 years, the agency invested over $35 million in land or projects, with most of the funding coming from its Metropolitan Transportation Improvement Program (*17*). A 2011 strategic plan for the program explained that the program was "designed to provide incentives, primarily in the form of modest funding grants, to private developers to build higher-density, mixed-use projects located near transit. The program is structured to encourage projects that 'push the envelope' in terms of density or building type, acknowledging that these projects are often more expensive to build or carry additional risk" (*18*). Nearly all of the TOD projects supported are in locations outside of the core central city downtown, where the market already provides TOD-style development.

Since 2005, the author team has conducted surveys of TOD residents in the Portland region. Most, though not all, of the TODs in our research were supported financially by Metro's TOD Program. The results from these surveys were published in a series of reports (*7, 19–24*).

Findings from the 2005 surveys of commute mode share for transit (~26%) and driving (~58%) were very similar to the findings in the 2003 California Study (*25*). Subsequent surveys found similar commute rates, ranging from 25% to 36% by transit four to five days per week and 46% to 67% by driving (*19*, *21–23*). The data from these surveys differs from some other TOD studies in that we surveyed residents of new developments that were built as TODs, rather than using secondary data (e.g. regional travel surveys or Census data) from residents within a certain distance of transit. Most of our surveys were conducted within 1-3 years of the development being completed, though in 2019 we also surveyed residents from some of the TODs we had surveyed 8-13 years earlier.

METHODS

TODs in the Study

The TODs in our research are located throughout the region, outside of the core of downtown Portland (Figure 1). Most are near a MAX light rail station, though some are served instead by the Portland Streetcar, Westside Express Service (WES) commuter rail, and/or high-frequency TriMet bus service. Some basic land use and transit accessibility metrics are shown in Table 1, grouped by geography. Most of these developments received funding from Metro's TOD program and were built to take advantage of light rail or other high-frequency transit; however, they may fall short of some definitions of TOD. For example, Renne and Ewing (*6*) suggest that TODs should have block densities of at least 6.5 blocks per acre (which translates to roughly 400 intersections per square mile) and 30 people plus jobs per acre (about 19,200 per square mile). As can be seen in Table 1, only the Portland Center sites average over 400 intersections per square mile, while none of the groups average over 19,200 people plus jobs per square mile. However, for this study, we refer to all these locations at TODs, and incorporate population density, intersection density and job access into our analysis. The scale and housing types ranged from denser detached single-family homes, duplexes and triplexes to 6-10 story apartments with ground floor-retail (Figure 2 through Figure 6). Of the 44 TODs included, 12 had affordable units and two were age-restricted senior housing. Additional details on the TODs are included in a summary report (*26*).

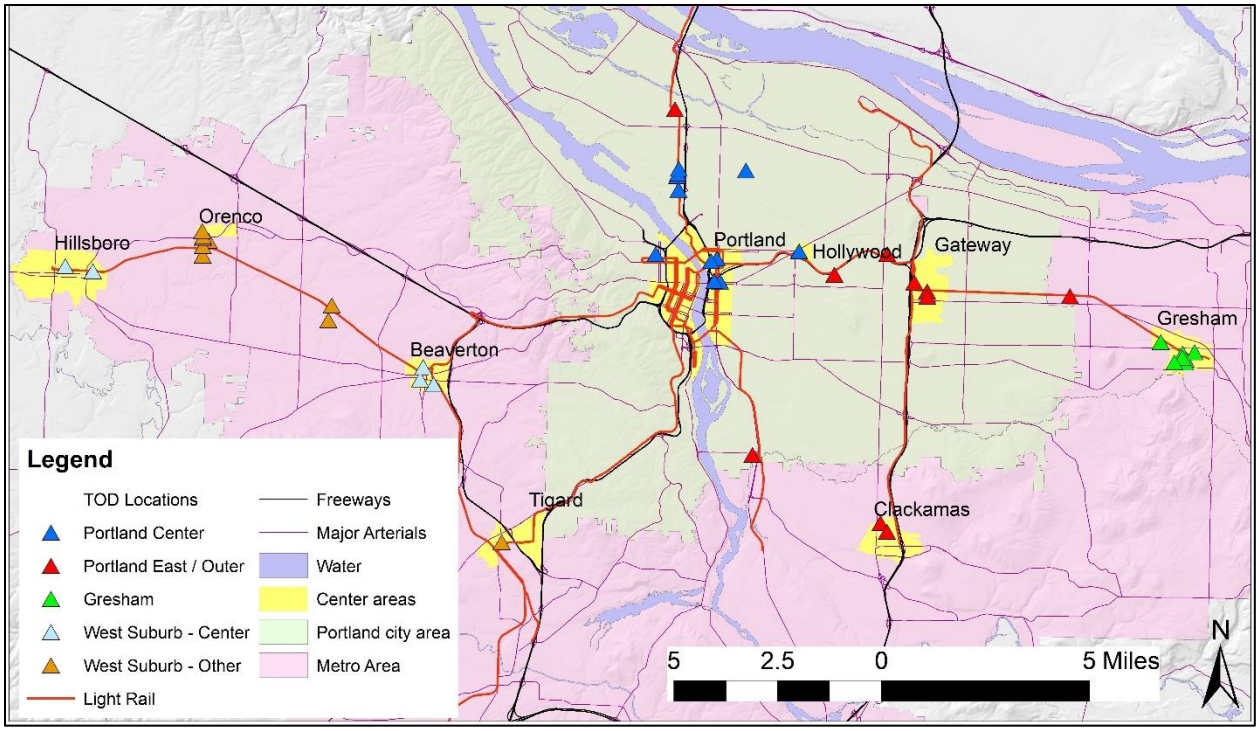


Figure 1 Map of all TOD locations

Figure 2: Portland Central TODs, apartments with ground-floor retail (left and right)

Figure 3: Portland East/Outer TODs, townhomes (left) and senior apartments (right)

Figure 4: Gresham TODs, apartments (left) and apartments with ground-floor retail (right)

Figure 5: Westside Suburb Center TODs, condominiums (left) and apartments (right), both with ground-floor retail

Figure 6: Westside Suburb Other TODs, Single-family detached, duplexes, and triplexes (left) and apartments (right)

Table 1: Land use characteristics around the TODs in this study

	TOD area				
	Portland Center	**Portland East / Outer**	**Gresham**	**West Suburb Centers (Beaverton, Hillsboro city centers)**	**West Suburb - other**
TOD count in study	11 TODs	11 TODs	8 TODs	5 TODs	9 TODs
Study respondents in area	292	265	204	75	577
Retail space in the building	10 of 11	4 of 11	4 of 8	4 of 5	3 of 9
¼-mile network buffer size (mean, sq. mi.)	0.120	0.096	0.107	0.105	0.099
	Min-Max (mean)				
Distance to Portland Center (miles)	0.3-2.3 (1.4)	3.2-9.4 (5.5)	11.7-12 (11.8)	7.2-15.4 (10.4)	8.5-12.2 (11)
Intersection Density (¼-mile buffer, per sq mi.)	304-569 (412)	78-371 (244)	133-382 (255)	145-419 (260)	100-346 (256)
Pop. Density (¼-mile buffer, per sq mi.)	2,023-9,493 (6,135)	5,540-10,482 (7,099)	3,976-5,720 (4,399)	3,826-9,791 (6,197)	1,039-6,808 (3,167)
Jobs Density (¼-mile buffer, per sq mi.)	1,350-25,281 (11,758)	1,119-9,009 (4,838)	4,990-8,373 (6,849)	696-9,518 (6,663)	633-11,964 (2,608)
Walkscore (Walkscore.com)	82-94 (86.6)	67-84 (75.2)	83-91 (89.3)	24-96 (77.2)	48-75 (64.9)
Weekly Transit Trips within half mile (AllTransit)	2,058-13,710 (7,008)	1,952-5,836 (4,344)	4,996-5,053 (5,009)	2,972-6,962 (4,636)	2,121-3,215 (2,491)

Survey Implementation and Respondents

Our surveys occurred in 2005, 2007, 2010/2011, 2014, and 2018/2019, generally within a few years of each TOD's construction. The development of our survey is described in detail in a summary report (*26*). The instrument changed some with each round of surveys, though the core questions used in this analysis did not. In most cases, survey packets were mailed to each unit in a TOD building, although in a few large TODs a random subset of all units were selected. For some buildings, with the permission of building management, surveys were placed at or under the doors of each unit. Packets contained an introductory letter, survey forms, and pre-paid pre-addressed return envelopes. Generally, two surveys were included in the packet, with instructions for all adults residing in the household to take the survey. Response rates ranged from 13% to 59% at the building level, with overall response rates by year of 30-36%. For this analysis, for households that returned more than one survey, we randomly selected one of the two or three responses. Note that we use the term "household" here to refer to everyone living in the same dwelling unit.

Information about the TOD residents included in this analysis are shown in Table 2. To understand how the TOD residents may differ from the general population, we make some comparisons to 2011 American Community Survey (ACS) 5-year data for the cities in which the TODs are located. We chose 2011 as roughly the midpoint of the different data collection efforts. Overall, 26% of the respondents owned their home, though these respondents were concentrated in the West Suburbs Other area, particularly around Orenco Station in Hillsboro OR. Nearly half of respondents (46%) lived in one-person households, with the average household size being 1.7, and just 10% having children under 16 years of age in the household. These household sizes are considerably smaller than average for the surrounding cities, which mostly range from 24% to 36% 1-person households. For our sample, 22% of respondents were over 65 years of age, above the 10-15% average for the surrounding cities. This difference is connected to the fact that 58% of the older adults in our sample lived in an age-restricted TOD. Between 8% and 10% indicated that they had a physical or anxiety condition preventing them from driving, walking, or using public transit. Nearly half (46%) had lived in the TOD for one year or less.

The incomes of the TOD residents appear to be similar to that found citywide; 17% had household incomes below $25,000 (compared to 16-25% for the cities), and the median income group was $50,000 to $74,999 (generally in line with surrounding cities). The TOD residents did have higher levels of education; nearly two-thirds (63%) had a four-year college degree, compared to 18-46% of the surrounding cities. Finally, 14% lived in zero-car households, and 39% had fewer cars than adults in the household. For the TODs outside the city of Portland, the car ownership rates of the TOD residents (specifically the percentage of 0 and 1 car households for 1-2 person households) were lower than overall rates for the cities.

Table 2: Independent variables

Variable label	Definition	Mean (std. dev.) or % yes	n*
Demographics			
Age	years	46.7 (20.7) 22% over 64 40% age 20-34	1,343
Physical or anxiety condition: Walking outside the home	yes=1, no=0	10%	1,357
Household size	Average # people per household 1-person households 2-person household	1.7 46% 43%	1,410
Child under 16 in household	yes=1, no=0	10%	1,373
Vehicle ownership	% living in zero vehicle household Lives in household with fewer cars than adults (yes=1, no=0)	14% 39%	1,366
Female	yes=1, no=0	62%	1,356
Person of color	yes=1, no=0	22%	1,331
College degree	yes=1, no=0	63%	1,359
Works or goes to school outside of home	yes=1, no=0	67%	1,342
Rents current home	yes=1, no=0	74%	1,366
Length of time living in residence:	Up to 6 months >6 months to 1 year >1 to 2 years >2 to 4 years Over 4 years	29% 17% 23% 17% 14%	1,329
Income	Continuous variable in $000, derived from categories: <$15,000, $15,000 - $24,999; $25,000 - $34,999; $35,000 - $49,999; $50,000 - $74,999; $75,000 - $99,999; $100,000-$149,999; $150,000 and over Median income category % of respondents with income under $25,000	65.7 (43.3) $50,000-$74,999 17%	1,281
Has a pet that needs regular walks	yes=1, no=0	20%	1,295
Built environment and transit accessibility			
Building style	Apartment/condo Apartment/condo with mixed use Townhome Detached single family home, duplex or triplex	45.7% 36.9% 13.7% 3.7%	1,413
Population density (000)	People (000) per square mile (1/4-mile network buffer)	4.6 (2.5)	1,413
Intersection density	Intersections per square mile (1/4-mile network buffer)	316.7 (100.0)	1,413
Jobs accessible on transit in 30 minutes (000)		202.1 (97.3)	1,413

Variable label	Definition	Mean (std. dev.) or % yes	n*
Bike infrastructure	Miles of bike lanes or trails within a ¼ mile network buffer	1.1 (0.6)	1,413
Distance to downtown Portland	Straight-line distance in miles to Portland city hall	7.6 (4.4)	1,413
Attitudes			
Transit attitude score	Mean of responses to three statements: I like transit/walking/riding a bike Transit/walking/biking can sometimes be easier for me than driving I prefer to take transit/walk/bike rather than drive whenever possible (1-5 scale, strongly disagree to strongly agree)	3.2 (1.1)	1,302
Walk attitude score		3.5 (1.0)	1,304
Bike attitude score		2.5 (1.1)	1,270
I need a car to do many of the things I like to do	1-5 scale, strongly disagree to strongly agree	3.8 (1.2)	1,294
I often use the telephone or the Internet to avoid having to travel somewhere		3.6 (1.1)	1,292
Housing preferences			
Access to transit	1-4 scale, Not at all important to Extremely important	3.0 (1.1)	1,334
Easy access to the freeway		2.5 (1.0)	1,324
Easy access to downtown		2.8 (1.1)	1,313
Shopping areas within walking distance		2.9 (1.0)	1,332
Lots of interaction between neighbors		2.1 (1.0)	1,313
Lots of people out and about within the neighborhood		2.4 (1.0)	1,314
Parks and open spaces nearby		2.9 (1.0)	1,321
Amenities in the building		2.5 (1.1)	1,320
High quality K-12 schools		1.4 (1.0)	1,310
Relatively new living unit		3.0 (0.9)	1,327

*number of respondents with non-missing data, of 1,413 total

Data Analysis: Variables and Models

The survey included a series of questions that asked how often, in a typical month in good weather, the respondent took transit from home to each of nine destinations: church or civic building; service provider; restaurant, bar or coffee place; store or place to shop; gym or indoor recreation; park or natural open space; visit friends or family at their home; entertainment; and taking someone else to school or daycare. The same set of questions was asked about walking or biking (combined). For this analysis, the response options were recoded to approximate monthly amounts: never (0); less than once per month (0.5); once or twice a month (1.5); about once every 2 weeks (2); about once per week (4); and two or more times per week (8). We then summed up the approximate monthly frequencies for the nine destinations to create two variables: Monthly Non-commute Transit Frequency (MNTF) and Monthly Non-commute Walk/Bike Frequency (MNWBF). The range of this composite variable is zero to 72, or a little over twice a day.

The intent of this analysis is not to accurately estimate the number of trips by mode, but rather to gauge relationships between factors and the general levels of using transit or walking/bicycling for non-commute travel. Therefore, some level of imprecision in the measure is acceptable. Given the design of the survey instrument, there is the possibility that some inattentive respondents would "straight-line" the block of questions, providing the same response for each of the nine destinations. For the MNTF, 28% (397 of 1,413) did so. However, all but one of these answered "none" for every destination, which is likely a valid response. Similarly, for MNWBF, the 30 respondents who provided the same response for all nine destinations indicated "none." In addition, it is important to note that the questions focused on trips *from home*. This measure does not capture linked transit or walk/bike trips made after, for example, commuting to work by transit. Therefore, it likely underestimates total non-commute travel by these modes. Data from the 2017-18 National Household Travel Survey (NHTS) for all trips made by adults reveals that 22% of all transit trips and 31% of walking and bicycling trips are non-home based, meaning that they neither start nor end at home.

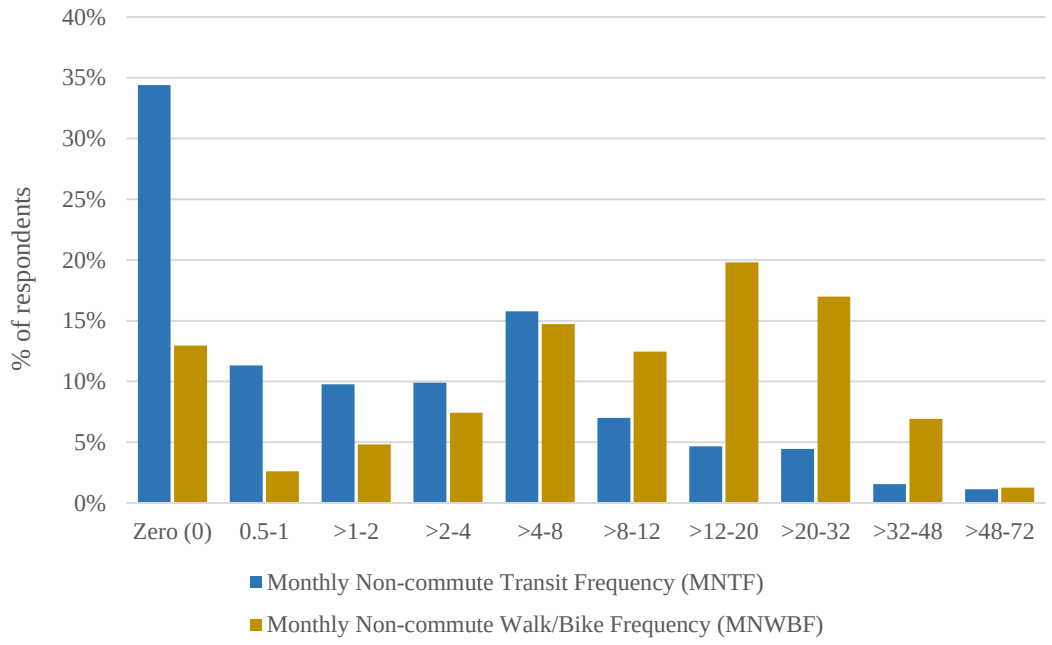
A large number of potential independent variables were considered in the modeling analysis, falling into three broad categories: demographics, the built environment and transit accessibility, and attitudes and housing preferences. The variables that were included in the final models are included in Table 2. The built environment variables are derived from U.S Census (population data from American Community Survey), the Portland Metro Regional Land Information System (RLIS, intersection density, bike facilities, distance to downtown Portland), and the Center for Neighborhood Technology (CNT) AllTransit tool (jobs accessible by transit). Area-based calculations, such as population density, intersection density, and bike facility miles, utilized a quarter-mile network buffer around the location address. RLIS and Census data were selected to correspond to the survey year for each building, to best reflect the built environment the respondent would have experienced. Job accessibility by transit data is from the AllTransit tool, which calculates a 30-minute transit shed from an input address using GTFS data and calculates jobs accessible within that access shed, pulling from Longitudinal Employer-Household Dynamics (LEHD) 2015 data. We use this measure as a proxy for transit access to non-work destinations.

To understand what factors may influence the likelihood and frequency of using transit and active transportation for non-commute trips, we estimated several regression models. Because of the large number of zero values (particularly for transit), we estimated models for propensity (whether the respondents used transit or active transportation for any trips in a month) and frequency (if they did, how many) separately. Propensity is modeled using binary logit models and frequency is modeled using ordinary least squares regression. The models were built in three steps, first with demographic variables, then adding variables representing the built environment and transit accessibility, followed by the respondents' attitudes and housing preferences. Before these steps, we separately tested different variables within each of the three categories, choosing the ones that were most significant ($p<0.10$), did not have multi-collinearity issues, and made theoretical sense. We then started with the significant demographic variables and added the set of built environment and transit variables that were significant without the demographic variables. Once in a single model, we eliminated the variables in the second set that were not significant, but left in all of the demographic variables, even if they became insignificant. The same was done in the third step with the attitude and preference variables. We also tested including the year of the survey in the models. It was not significant and included it did not change the other coefficients in any meaningful way.

FINDINGS

Non-work trips – frequency of using transit or active transportation

Respondents typically used transit from home to non-work destinations an average of 5.4 times a month and walking/bicycling an average of 12.9 times a month. However, the distribution is skewed, as shown in Figure 7. Over one-third of the respondents never took transit from home to a non-work destination.



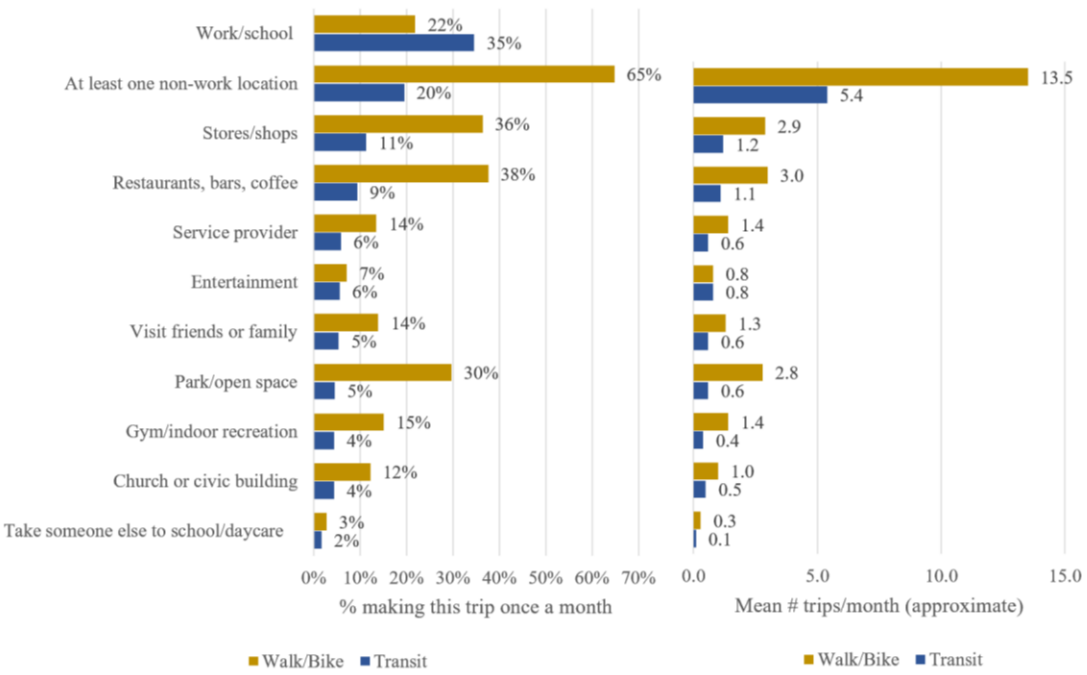
Note: Monthly Non-commute Transit Frequency (MNTF) and Monthly Non-commute Walk/Bike Frequency (MNWBF) are approximations. See Data Analysis: Variables for explanation.

Figure 7 Approximate monthly frequency of using transit and walk/bike to non-work destinations

While the TOD residents were using transit to commute to work or school, they were not using transit to get to other destinations very frequently (Figure 8). Over one-third (35%) of the respondents who worked or went to school outside of home (n=891) commuted by transit at least once a week. This was about 3-8 times more than the share of all respondents (n=1,219-1,320) who took transit to a non-commute destination weekly. The difference in walking and bicycling was not as great or was non-existent. Over one-fifth (22%) commuted by walking or bicycling at least once a week. A higher share than that used active transportation to dine out, shop, or access parks and open space at least once a week. The most common non-commute transit destinations were stores/shopping, where 11% used transit once a week or more to reach that destination type from home, and restaurants/bars/coffee, where 9% did so. Those were also the most common non-commute walk/bike destinations (36% and 38%, respectively). These destinations were followed closely by parks and open space (30%), which was not a common transit destination.

As might be expected, there is a relationship between commute and non-commute transit use. Of the people who commuted mainly by private vehicle, 61% used transit at least monthly for non-commute purposes, compared to 89% of those who primarily commuted by transit and

86% of active transportation commuters. There was no such difference for walking or bicycling from home to non-commute destinations.



Note: Monthly Non-commute Transit Frequency (MNTF) and Monthly Non-commute Walk/Bike Frequency (MNWBF) are approximations. See Data Analysis: Variables for explanation.

Figure 8: Use of transit and walk/bike for commute vs. non-commute purposes

Factors influencing propensity and frequency

The models of the propensity and frequency of using transit for non-commute trips are shown in Table 4, and for walking and bicycling in Table 5. To make the comparison between the models easier, Table 3 lists all the variables and indicates their significance in each of the four models (if $p<0.10$). The models have a low to moderate ability to predict the outcome variables. The adjusted R-square for the final frequency models is 0.204 for transit and 0.276 for walking and bicycling. The Nagelkerke pseudo R-square for the transit propensity model is 0.387 and is 0.402 for the walk/bike propensity model. The adjusted or pseudo R-square for models with demographic variables only (Model 1 in each table) ranges from about one-fifth to one-half that of the full model (Model 3 in each table). Adding the built environment and transit accessibility variables to the significant demographic variables (Model 2 in each table) only increases the explanatory power of the models by a small amount.

Several demographic characteristics are associated with propensity and frequency. As age increases, the propensity and frequency of using transit decreases, as does the propensity for walking/bicycling. This demographic variable remains significant even after adding attitudinal factors. Age is not a significant factor in the frequency of non-work walking/bicycling. Having a physical or anxiety condition that limits walking outside the home has a negative effect in all four models, though it is not significant after adding attitudes and preferences. This indicates that such conditions are highly correlated with attitudes, which would be expected. The survey included similar questions regarding using transit, bicycling, and driving, though conditions limiting walking were most significant when estimating the models. Gender is only significant in

predicting the frequency of walking/bicycling for non-work trips, with women doing so less frequently.

Having a college degree is positively correlated with the propensity of using transit or active transportation, though not the frequency. Furthermore, this variable is not significant in the final models with the attitude variables, indicating a strong relationship between having a college degree and attitudes and preferences. Income is only a significant predictor of transit frequency and is negative, indicating that as income rises, the number of non-work transit trips declines. The significance of this relationship is not affected by the addition of the attitude variables; both the coefficient and its significance level remain somewhat constant in all three models. Other demographic variables that are not significant after adding attitudes include working or going to school outside the home and being a renter (vs. owner of home).

Two significant demographic variables are more directly related to travel behavior. Respondents who live in households with fewer vehicles than adults are more likely to use transit and active transportation and do so more frequently for non-work trips. This relationship is still significant after attitudes are added to the models, except for transit propensity. Having a pet that needs regular walks is a significant predictor of the frequency of walking/bicycling to non-work destinations, though not the propensity for doing so.

As for the influence of the built environment and transit accessibility, transit service (measured by the number of jobs accessible on transit in 30 minutes) has a significant positive relationship with both the propensity and frequency of using transit for non-work trips. Street connectivity (measured by intersection density) is positively associated with both the propensity and frequency of active transportation. Bike infrastructure is only significant in predicting the propensity for walk/bike in the models without attitudes included. Higher population density is negatively associated with transit propensity, though not in the full model with attitudes. Respondents living in a mixed-use building (apartments or condominiums with ground-floor retail) are more likely to walk/bike at least once a month. Respondents living in single-family detached homes, duplexes and triplexes are the base in the models, so the coefficients are relative to those TOD residents. Those living in a building without mixed-use or in a townhome walked less frequently. Distance to downtown Portland is positively associated with walk/bike propensity, indicating that TOD residents living further away from downtown are more likely to walk/bike at least once a month.

Several expected attitudes and housing preferences related to transit and active transportation are significant in the models, including having positive attitudes about transit (positive for transit propensity and frequency), having positive about walking (positive for walk/bike propensity and frequency), and having positive attitudes about bicycling (positive for walk/bike frequency). Having a stronger preference for being near transit when choosing where to live is positively associated with transit propensity, though not frequency. Similarly, wanting to live in place with shopping areas within walking distance and with parks and open space nearby is positively correlated with both the propensity and frequency of walking and bicycling. A preference for having easy access to a freeway and needing a car to do things is negatively associated with the outcome variables.

A few attitudinal and housing preference variables that are less directly related to travel modes are significant in some models. People who wanted to live in place with lots of interactions with neighbors are less likely to walk/bike, though those that valued living in a place with lots of people out and about within the neighborhood walked and biked more frequently.

Those that valued high quality schools used transit and walked/biked more frequently, while those that valued a newer living unit used transit more but were less likely to walk/bike.

Table 3: Comparison of models

	Transit		Walk/Bike	
Variable label	**Propensity**	**Frequency (if >0)**	**Propensity**	**Frequency (if >0)**
Demographics				
Age	-	-	-	
Physical or anxiety condition: Walking outside the home	- (*w.a.)	- (* w.a.)	-	- (* w.a.)
Lives in household with fewer cars than adults	+ (* w.a.)	+	+	+
Female				-
Works or goes to school outside of home				- (* w.a.)
Has a pet that needs regular walks				+
Rents current home	- (* w.a.)			
Has a college degree	+ (* w.a.)		+ (* w.a.)	
Income		-		
Built environment and transit accessibility				
Building style: Mixed use			+	
Building style: Apt/Condo without mixed use				-
Building style: Townhome				-
Population density (000)	- (* w.a.)			
Intersection density			+	+
Jobs accessible on transit in 30 minutes (000)	+	+		
Bike infrastructure			+ (* w.a.)	
Distance to downtown Portland			+	
Attitudes				
Transit attitude score	+	+		
Walk attitude score			+	+
Bike attitude score				+
I need a car to do many of the things I like to do		-		
I often use the telephone or the Internet to avoid having to travel somewhere	+			
Housing preferences				
Access to transit	+			
Easy access to the freeway	-		-	-
Shopping areas within walking distance			+	+
Lots of interaction among neighbors			-	
Lots of people out and about within the neighborhood				+
Parks and open spaces nearby			+	+
High quality K-12 schools		+		+
Relatively new living unit		+	-	

* w.a.: only significant in models 1 and 2, without attitudes and housing preferences. "+" indicates a positive association with propensity or frequency, while "-" indicates a negative association.

Table 4: Propensity for and frequency of taking transit to non-commute destinations

Independent variables	Propensity (binary logit model)						Frequency (linear model)					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.
Demographics												
Age (years)	-0.014	<0.001	-0.014	<0.001	-0.022	<0.001	-0.051	0.021	-0.042	0.057	-0.079	<0.001
Physical or anxiety condition: Walking outside the home	-0.794	<0.001	-0.787	0.001	-0.362	0.177	-4.382	0.011	-4.747	0.006	-2.419	0.137
Lives in household with fewer cars than adults	0.691	<0.001	0.693	<0.001	-0.014	0.934	4.617	<0.001	4.591	<0.001	2.189	0.006
Has a college degree	0.458	0.001	0.425	0.002	0.141	0.380						
Rents current home	-0.276	0.066	-0.485	0.003	-0.223	0.232						
Approx. household income (000)							-0.036	<0.001	-0.033	<0.001	-0.029	<0.001
Built environment and transit accessibility												
Population density (000)			-0.066	0.021	-0.017	0.613						
Jobs accessible on transit in 30 minutes (000)			0.003	<0.001	0.003	0.004			0.012	0.001	0.014	<0.001
Attitudes and housing preferences												
Transit attitude score					0.815	<0.001					2.533	<0.001
I often use the telephone or the Internet to avoid having to travel somewhere					0.122	0.080						
I need a car to do many of the things I like to do											-1.349	<0.001
Housing pref.: access to transit					0.479	<0.001						
Housing pref.: Easy access to the freeway					-0.243	0.002						
Housing pref.: High quality K-12 school											1.710	<0.001
Housing pref.: Relatively new living unit											1.731	<0.001
Constant	1.181	<0.001	1.026	<0.001	-2.141	<0.001	11.067	<0.001	7.973	<0.001	-1.839	0.520
Nagelkerke R Square	0.088		0.108		0.387							
Adjusted R-square							0.081		0.093		0.204	
n	1,205						781					

Independent variables	Propensity (binary logit model)						Frequency (linear model)					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.
Dependent variable:	Uses transit at least once in a typical month (good weather) for non-commute trip purpose (0=no, 1=yes)						Approximate monthly frequency of using transit in a typical month (good weather) to reach non-commute destinations for those respondents who do so at least once.					

Table 5: Propensity for and frequency of walk/bike to non-commute destinations

Independent variables	Propensity (binary logit model)						Frequency (linear model)					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.
Demographics												
Age (years)	-0.028	<0.001	-0.026	<0.001	-0.024	<0.001						
Physical or anxiety condition: Walking outside the home	-1.736	<0.001	-1.701	<0.001	-0.954	0.004	-4.537	0.017	-4.834	0.009	-1.439	0.396
Lives in household with fewer cars than adults	0.935	<0.001	1.072	<0.001	0.622	0.035	4.158	<0.001	4.333	0.000	1.711	0.028
Has a college degree	0.557	0.010	0.463	0.040	0.164	0.502						
Rents current home	-0.534	0.037	0.138	0.683	0.046	0.898						
Female							-2.094	0.011	-1.596	0.048	-1.611	0.031
Works or goes to school outside of home							-2.070	0.030	-1.928	0.040	-0.951	0.265
Has a pet that needs regular walks							3.667	<0.001	3.250	0.001	2.681	0.002
Built environment and transit accessibility												
Intersection density			0.005	<0.001	0.004	0.010			0.013	0.001	0.007	0.048
Bike infrastructure			0.459	0.032	0.364	0.120						
Building style: Apt/Condo w/mixed use			0.955	<0.001	0.670	0.022						
Building style: Townhome									-3.983	<0.001	-4.442	<0.001
Building style: Apt/Condo without mixed use									-4.292	<0.001	-3.194	<0.001
Distance to downtown Portland			0.136	<0.001	0.091	0.029						
Attitudes and housing preferences												
Walk attitude score					0.753	<0.001					3.555	<0.001
Bike attitude score											0.707	0.040
Housing pref.: easy access to the freeway					-0.246	0.049					-0.788	0.038
Housing pref.: Shopping areas within walking distance					0.274	0.049					1.989	<0.001
Housing pref.: Parks and open spaces nearby					0.355	0.014					1.171	0.013
Housing pref.: Lots of interaction among neighbors					-0.246	0.060						

Independent variables	Propensity (binary logit model)						Frequency (linear model)					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.
Housing pref.: Lots of people out and about within the neighborhood											0.966	0.018
Housing pref.: Relatively new living unit					-0.412	0.008						
Housing pref.: High quality K-12 schools											1.409	0.001
Constant	3.663	<0.001	-0.221	0.745	-0.806	0.409	16.968	<0.001	14.832	<0.001	-10.614	<0.001
Nagelkerke R Square	0.203		0.289		0.402							
Adjusted R-square							0.056		0.104		0.276	
n	1,194						908					
Dependent variable:	Walks or bikes at least once in a typical month (good weather) for non-commute trip purpose (0=no, 1=yes)						Approximate monthly frequency of walking/bicycling in a typical month (good weather) to reach non-commute destinations for those respondents who do so at least once.					

Exploring the role of self-selection

While our models control somewhat for self-selection by including the attitude and preference variables, they do not show how factors might influence people who have a preference for non-auto modes differently than those who do not, e.g. TOD residents who chose to live in the TOD for reasons other than the travel-related features of the TOD. To explore this further, we estimated models separately for residents who expressed such preferences, using the question about how important "shopping areas within walking distance" was in choosing their current home. Responses to this question provide insight into whether residents self-selected a neighborhood that was good for walking for utilitarian trips. We divided the sample between respondents who answered either 1 or 2 on the scale ("not important") to those who answered 3 or 4 ("important"). Trips to parks were excluded from these metrics. Of those in the "not important" group, 75% took at least one walk/bike trip to a non-commute or non-park destination in a typical month, compared to 92% of those in the "important" group. The mean number of such trips for the groups was 8.4 and 14.2, respectively. Those who fell into the not important vs important groups were similar in many ways, including proportion of the subgroups that are female (64% to 60%), age (46.0 to 45.5 mean age), having drivers' licenses (93% to 91%), and income ($63.7k to $67.8k mean household incomes). We used the same independent variables from Table 5

These sub-group models do reveal differences based on the proxy for self-selection (Table 6). For those who said that having shops within walking distance was NOT important, significant variables for propensity to walk/bike include distance to downtown Portland, being in a mixed-use style building, and the positive walk attitudes. Those who indicated that they considered shops within walking distance to be important in their home selection appear to be more sensitive to a number of factors, include age, having a physical or anxiety condition preventing them from walking outside the home, having fewer cars than adults in the home, and intersection density, in addition to the factors that were significant for the "not important" group. For the models for walk and bike frequency, a similar pattern is observed, with the "important" group appearing to be more sensitive to more factors, including, gender, and having a pet that needs regular walks, and intersection density (significant at $p<0.10$), which were only significant for this group. Both groups were sensitive to having fewer cars than adults and living in a townhome or non-mixed use style condo/apartment. These results may indicate that, for people who have self-selected a TOD style location, their personal and built environment situation is important in determining their likelihood and frequency of walking.

Table 6 Propensity to walk/bike and walk/bike frequency by self-selection proxy

	Propensity to walk or bike (excluding to parks)				Walk or bike frequency (excluding to parks)			
	"Shopping areas within walking distance" important in housing decision?							
	Not Important		Important		Not Important		Important	
Independent variables	B	Sig	B	Sig	B	Sig	B	Sig
Demographics								
Age (years)	-0.012	0.152	-0.031	0.000				
Physical or anxiety condition: Walking outside the home	-0.761	0.077	-1.360	0.003	1.925	0.322	-2.056	0.319
Lives in household with fewer cars than adults	0.575	0.149	0.724	0.043	2.246	0.044	2.363	0.006
Has a college degree	-0.238	0.461	0.480	0.124				
Rents current home	0.705	0.066	-0.456	0.249				
Female					-0.673	0.506	-1.846	0.026
Works or goes to school outside of home					-1.891	0.144	0.047	0.960
Has a pet that needs regular walks					-0.192	0.875	1.918	0.042
Built environment and transit accessibility								
Intersection density	0.002	0.190	0.006	0.002	0.000	0.950	0.008	0.060
Bike infrastructure	0.280	0.323	0.573	0.059				
Distance to downtown Portland	0.128	0.020	0.146	0.003				
Building style: Apt/Condo w/mixed use	0.964	0.022	0.822	0.027				
Building style: Townhome					-4.356	0.002	-4.064	0.000
Building style: Apt/Condo without mixed use					-2.651	0.021	-2.712	0.003
Attitudes and housing preferences								
Walk attitude score	0.874	0.000	0.592	0.000	1.696	0.006	3.599	0.000
Bike attitude score					0.486	0.276	0.462	0.235
Housing preference: easy access to the freeway	-0.225	0.162	-0.147	0.361	-1.341	0.012	-0.413	0.322
Housing preference: Lots of interaction among neighbors	-0.210	0.253	-0.116	0.455				
Housing preference: Parks and open spaces nearby	0.154	0.416	0.277	0.112	0.792	0.197	0.334	0.513
Housing preference: Relatively new living unit	-0.331	0.091	-0.417	0.037				
Housing preference: High quality K-12 schools					1.616	0.031	1.303	0.003
Housing preference: Lots of people out and about within the neighborhood					0.105	0.857	1.311	0.004
Constant	-1.643	0.207	-0.566	0.680	3.472	0.278	-6.386	0.033
Nagelkerke R Square	0.340		0.336					
Adjusted R-square					0.155		0.190	
n	257		749		256		748	

DISCUSSION

Overall, we found several factors that help predict the propensity and frequency of using transit and active transportation for TOD-based, non-work trips. Our analysis is consistent with many other studies in finding that attitudes and preferences play a large role in travel behavior and can influence the relationships between the built environment and travel behavior. We generally

found few demographic variables to be significant separate from attitudes. Those that were included age (propensity and frequency of transit and propensity of walk/bike) and gender (frequency of walk/bike). The relationship between age and decreased likelihood of walking for non-commute trips was consistent with Laham and Noland (*15*). Our finding of being female and decreased walk/bike frequency is consistent with Choi and Guhathatkurta (*16*). Our findings of the strong role of vehicle ownership are also consistent with most TOD research. The relationship does reveal a limitation of cross-sectional research; it is hard to disentangle the decision to live in a TOD, use transit, walk, and bike more, and reduce car ownership.

Models that incorporated attitude and housing preferences, reduced or eliminated the significance of a number of sociodemographic variables. For example, being in a household with fewer cars than adults, having a college degree, or being a home-owner were correlated with increased non-work transit trip propensity, but these effects went way after incorporating attitudes and housing preferences. A similar trend was observed for having a college degree and being a home-owner on the propensity to make non-commute walk or bike trips, although renting was only significant for model 1. These trends speak to a strong inter-relationship between some sociodemographic characteristics and attitudes, which combine to influence travel decision-making.

While the built environment and transit variables did not add a lot to the explanatory power of the models, the analysis did show that level of transit service can help increase transit use for non-commute travel, and that street connectivity can contribute to walking and bicycling from home to local destinations. The latter finding is consistent with research of TODs in New Jersey which found street network density to be the one built environment factor associated with more frequent walking for all purposes (*27*) and for certain non-work trips (*15*). Our finding of higher walk/bike propensity for residents of mixed-use buildings, including those who did not consider walking to shops important in their home choice, is consistent with the intent of TODs. The insignificance of bicycle infrastructure in the final models may indicate that self-selection plays a larger role for that mode, at least for our relatively new TOD residents.

Most of the attitudinal and housing preference variables had the predicted outcomes. However, there were some what are difficult to interpret, including increased distance to downtown (higher walk/bike propensity), preference of a home with good schools (more frequent transit and walk/bike), and a preference for a new living unit.

It is also useful to understand which variables were not included in our models due to lack of significance, including the WalkScore and job density for the area around the TOD building. These are both indicators of possible non-work destinations to access by walking or bicycling. In addition, population density was only significant in the transit propensity model, without the attitudinal variables. These findings are somewhat consistent with other research. The New Jersey TOD study found mild negative relationships between employment density and overall transit and walking frequency and no significant relationship with population density (*27*). Population and job density were not significant in the New Jersey non-work trip analysis that controlled for self-selection (*15*). In our analysis, the length of time the respondent had lived in their home was not significant in any models. This indicates that behavior may not change significantly as people live in the TOD longer, though the large majority of our sample lived in the TOD for less than two years.

Finally, we note that people who may self-select locations with more walkable destinations are more sensitive to the built environment factors such as intersection density, and personal factors such as age, gender, and being in a low-car household, while others are more

specifically influenced by attitudes. This suggests that self-selection is important in determining the propensity or frequency of walking or biking for non-work trips, but that the walkability of the area is still important.

There are several limitations to this study. Some of our data limitations were noted in the methods section. The analysis uses questions about home-based trips only, not linked trips, and is based on recall of a typical month in good weather, rather than a trip diary. Having trip diary or GPS data would also provide information about destinations, which would reveal more about the mode choice decisions. The transit accessibility measure we used is not ideal; it measured access to jobs, rather than the types of non-commute destinations we analyzed. Also, it was also for a year that did not match the survey year, introducing some additional error. Similarly, a measure of bicycle and walking accessibility to destinations (rather than infrastructure density) may more accurately represent the relationships. There may have been some modal bias in who responded to the survey; this is difficult to detect because the demographics of TOD residents differs from non-TOD areas. Some of the findings that were more difficult to interpret may indicate other underlying factors that the survey or our statistical analysis did not reveal. The TODs included in the study were based primarily on locations funded through the Portland Metro TOD Program, rather than a random sample, limiting our ability to select for a variety of building and land use types. Relatedly, many of these developments are not strong examples of TODs, based on job and population densities and other factors such as mixed-use and walkability. The sample is also limited to TOD residents only, so we are not able to compare their travel behavior to non-TOD residents. The research was done in one metropolitan area, which can limit the transferability of the findings. However, many of the TODs were located in the suburbs, which we believe resemble many U.S. metropolitan areas, particularly those that have invested in light rail and are pursuing TOD-supportive policies.

CONCLUSIONS

TODs have been an important part of public agencies' efforts to reduce reliance on SOV trips while expanding the transit market. To reach their full potential, TOD residents need to use transit, walking, and bicycling for more than just commute trips. This paper offers insight into non-work trips, which are important to study as they make up a considerable share of all travel, including, all travel for people who do not work outside the home. We find that TOD residents are walking and bicycling relatively often for non-work trips, but that non-work transit use is low. Transit times for many non-work destinations are likely much longer than driving, particularly since much of the transit system is designed to get people to and from work locations more so than shopping or other destinations. And, most non-work destinations are likely outside of downtown, where paid parking and congestion encourage transit use. This and our findings of the influential role of vehicle ownership point to the likely need for complementary policies such as pricing (parking, vehicle, road use, etc.) for the potential of TOD to be fully realized. Our finding regarding the significance of transit accessibility reveals that higher levels of transit service will likely be necessary for suburban TODs to generate high levels of transit use. It may also be useful for transit planners to focus on non-work destination accessibility when planning service expansion or changes.

Consistent with other research, we found that attitudes and housing preferences account for a significant portion of whether or not and how frequently participants walk, bike or take transit for non-work trips. Attitudes and preferences also usurp many sociodemographic variables in importance in our models, suggesting an inter-connectedness between these factors that jointly influence non-work travel. This points to the need for more research on the formation

of attitudes and factors that may hep shift attitudes. While we did find that self-selection likely plays a big role, this does not negate the value of TOD. First, it is important to provide opportunities for people to self-select into a neighborhood that allows them to exercise their modal preferences. Secondly, even those without such home preferences are using transit and active transportation, just not as frequently. Further research comparing such TOD residents to non-TOD residents would help reveal the role the TOD plays in that behavior.

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AUTHOR CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study conception and design: Dill, McNeil; data collection: McNeil, Dill; analysis and interpretation of results: Dill, McNeil; manuscript preparation: Dill, McNeil. All authors reviewed the results and approved the final version of the manuscript.

REFERENCES

1. Jamme, H.-T., J. Rodriguez, D. Bahl, and T. Banerjee. A Twenty-Five-Year Biography of the TOD Concept: From Design to Policy, Planning, and Implementation. *Journal of Planning Education and Research*, Vol. 39, No. 4, 2019, pp. 409–428. https://doi.org/10.1177/0739456X19882073.
2. Renne, J. L., and B. Appleyard. Twenty-Five Years in the Making: TOD as a New Name for an Enduring Concept. *Journal of Planning Education and Research*, Vol. 39, No. 4, 2019, pp. 402–408. https://doi.org/10.1177/0739456X19885351.
3. Lung-Amam, W., R. Pendall, and E. Knaap. Mi Casa No Es Su Casa: The Fight for Equitable Transit-Oriented Development in an Inner-Ring Suburb. *Journal of Planning Education and Research*, Vol. 39, No. 4, 2019, pp. 442–455. https://doi.org/10.1177/0739456X19878248.
4. Ibraeva, A., G. H. de A. Correia, C. Silva, and A. P. Antunes. Transit-Oriented Development: A Review of Research Achievements and Challenges. *Transportation Research Part A: Policy and Practice*, Vol. 132, 2020, pp. 110–130. https://doi.org/10.1016/j.tra.2019.10.018.
5. Lund, H. M., R. Cervero, and R. W. Willson. *Travel Characteristics of Transit-Oriented Development in California*.
6. Renne, J., and R. Ewing. *Transit-Oriented Development: An Examination of America's Transit Precincts in 2000 & 2010*. Publication 17. UNOTI Publications., 2013.
7. Dill, J., and N. McNeil. *Transit-Oriented Development in Portland: Multiyear Summary Report of Portland State University Surveys*. Portland State University, Portland, Oregon, 2020.
8. Ewing, R., G. Tian, T. Lyons, and K. Terzano. Trip and Parking Generation at Transit-Oriented Developments: Five US Case Studies. *Landscape and Urban Planning*, Vol. 160, 2017, pp. 69–78. https://doi.org/10.1016/j.landurbplan.2016.12.002.
9. Cervero, R., and G. Arrington. Vehicle Trip Reduction Impacts of Transit-Oriented Housing. *Journal of Public Transportation*, Vol. 11, No. 3, 2008. https://doi.org/10.5038/2375-0901.11.3.1.

10. Ewing, R., G. Tian, K. Park, S. Sabouri, P. Stinger, and D. Proffitt. Comparative Case Studies: Trip and Parking Generation at Orenco Station TOD, Portland Region and Station Park TAD, Salt Lake City Region. *Cities*, Vol. 87, 2019, pp. 48–59. https://doi.org/10.1016/j.cities.2018.12.020.
11. Ewing, R., and R. Cervero. Travel and the Built Environment. *Journal of the American Planning Association*, Vol. 76, No. 3, 2010, pp. 265–294. https://doi.org/10.1080/01944361003766766.
12. Park, K., R. Ewing, B. C. Scheer, and S. S. Ara Khan. Travel Behavior in TODs vs. Non-TODs: Using Cluster Analysis and Propensity Score Matching. *Transportation Research Record*, Vol. 2672, No. 6, 2018, pp. 31–39. https://doi.org/10.1177/0361198118774159.
13. Nasri, A., and L. Zhang. The Analysis of Transit-Oriented Development (TOD) in Washington, D.C. and Baltimore Metropolitan Areas. *Transport Policy*, Vol. 32, 2014, pp. 172–179. https://doi.org/10.1016/j.tranpol.2013.12.009.
14. Langlois, M., D. van Lierop, R. A. Wasfi, and A. M. El-Geneidy. Chasing Sustainability: Do New Transit-Oriented Development Residents Adopt More Sustainable Modes of Transportation? *Transportation Research Record*, Vol. 2531, No. 1, 2015, pp. 83–92. https://doi.org/10.3141/2531-10.
15. Laham, M. L., and R. B. Noland. Nonwork Trips Associated with Transit-Oriented Development. *Transportation Research Record: Journal of the Transportation Research Board*, No. 2606, 2017, p. pp 46-53.
16. Choi, Y., and S. Guhathakurta. Do People Walk More in Transit-Accessible Places? *Journal of Transport and Land Use*, Vol. 13, No. 1, 2020, pp. 343–365.
17. Portland Metro. *Transit-Oriented Development Program: 2019 ANNUAL REPORT | JULY 2018 - JUNE 2019*. Metro, Portland, OR, 2020.
18. Center for Transit-Oriented Development and Nelson\Nygaard Consulting Associates. *Transit-Oriented Development Strategic Plan / Metro TOD Program*. Metro TOD Program, Portland, OR, 2011.
19. Dill, J. *Travel and Transit Use at Portland Area Transit-Oriented Developments (TODs)*. Publication TransNow Budget No. 821528-4. Portland State University, 2006.
20. Dill, J. *Travel Choice at Transit-Oriented Developments: Survey Results from Portland's Eastside*. Publication CUS-CTS-07-01. Portland State University, 2007.
21. Dill, J. *2010 Transit Oriented Developments Survey*. Publication TREC-11-01. Portland State University, Center for Transportation Studies, 2011.
22. Dill, J., and N. McNeil. *2014 Transit Oriented Developments Survey*. Publication TREC-15-01. Portland State University, Transportation Research and Education Center (TREC), 2015.
23. Dill, J., and N. McNeil. *Findings from 2018 TOD Surveys*. Portland State University, 2019.
24. McNeil, N., and J. Dill. *Revisiting TODs: How Subsequent Development Affects the Travel Behavior of Residents in Existing Transit-Oriented Developments*. Publication NITC-RR-1240. Portland State University, Transportation Research and Education Center (TREC), 2020.
25. Dill, J. Transit Use at Transit-Oriented Developments in Portland, Oregon, Area. *Transportation Research Record*, Vol. 2063, No. 1, 2008, pp. 159–167. https://doi.org/10.3141/2063-19.
26. Dill, J., and N. McNeil. *Transit-Oriented Development in Portland: Multiyear Summary Report of Portland State University Surveys*. Portland State University, Portland, Oregon, 2020.

27. Noland, R. B., and S. DiPetrillo. Transit-Oriented Development and the Frequency of Modal Use. *Journal of Transport and Land Use*, Vol. 8, No. 2, 2015, p. pp 21-44.