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Associations of Walkability, Regional and Transit Accessibility Around Home and Workplace with Active and Sedentary Travel

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ABSTRACT

Few studies have simultaneously examined whether the neighborhood built environment near work is independently associated with active versus sedentary travel. We investigate the associations of objectively assessed built environment and regional/transit accessibility around home and work locations with active (walking, biking) and sedentary (auto-use) transportation while controlling for attitudinal predispositions, perceptions, and demographic factors. Baseline data from 2012-2013 on a sample of 648 participants in the Rails & Health study based in Portland, Oregon were analyzed. Data about active and sedentary travel outcomes, attitudes, perceptions, and demographics were derived from a survey. Road network buffers (with a 1 km range) around each of the home and work locations were used to create detailed measures of walkability, natural environment, regional and transit accessibility. Log-linear and log-linear Tobit regression models tested associations of home and worksite neighborhood features with weekly amount of walking, biking, and auto use. Significant differences in walkability, regional accessibility, and natural environment between home and workplaces were observed. Independent of walkability around home, a one-unit increase in walkability index around work was correlated with a 2.8% [90% CI: 0.5% - 4.9%] and 2.7% [90% CI: 0.5% - 4.8%] higher weekly duration of biking and walking, respectively. Greater walkability around workplace was associated with lower time spent in automobiles. Greater regional and transit accessibility around work was correlated with higher walking/biking and lower automobile travel. The study highlights the important role of more walkable, connected, denser, and diverse workplace environments in enhancing public health.

Keywords: Transportation, built environment, home and workplace, walking, biking, sedentary travel.

1. INTRODUCTION & BACKGROUND

Physical inactivity and sedentary lifestyle are responsible for over 3.2 million annual deaths worldwide (WHO 2018). The connection between built environment, physical activity (PA) and active travel is the most studied pathway for linking transportation design with health impacts (Berrigan and McKinno 2008, Saelens and Handy 2008, Sandercock et al. 2010, Harris et al. 2013, Su et al. 2014, Cheng et al. 2019, Frank et al. 2019a, Guzman et al. 2020, Rothman et al. 2021, Wali et al. 2021, Yang et al. 2022b). Most of the evidence linking the built environment with active travel has been derived from studies of the built environment features around one's home. Since an average American spends over 7 hours per day at work (BLS 2019), neighborhood features around the workplace may also be important determinants of active travel. Built environments around work cannot only influence engagement in active travel and mode choice for utilitarian travel to/from work but can also enable individuals to engage in active travel around work (e.g., errands, meals) and leisure PA before, after, or during working hours. The built environment around work often differs from that surrounding one's home and could provide valuable information missing when only the home environment is studied (Hurvitz and Moudon 2012, Carlson et al. 2018).

Compared to the residential neighborhood impacts, the potential impact of workplace built environment features on active travel is relatively under-examined. Studies have examined associations of built environment around workplace with physical activity and walking (Schwartz et al. 2009, Forsyth and Oakes 2014, Gehrke and Welch 2017, Yang et al. 2022a). Correlational analysis revealed positive associations between transport walking and density, land-use, and street pattern characteristics (Forsyth and Oakes 2014, Yang et al. 2022a). Gehrke and Welch (2017) found greater urban diversity supportive of work-based sub-tours (including walking). A higher perception of a few cul-de-sacs and the presence of sidewalks at workplace locations was associated with a higher proportion of individuals taking at least one walk trip (Schwartz et al. 2009). Despite highlighting the potential benefits of more dense and diverse workplace environments, the above studies did not simultaneously analyze residential and workplace built environments with active or sedentary travel outcomes.

Other studies have examined associations of home and workplace built environment (or built environment at trip origins and destinations) with physical activity or active travel outcomes (Frank and Pivo 1994, Cervero 2002, Troped et al. 2010, Dalton et al. 2013, Adlakha et al. 2015, Carlson et al. 2018). Employment density and more mixed land use at trip origins and destinations were correlated with a lower propensity of driving alone (Frank and Pivo 1994, Cervero 2002). Compared to using built environment measures only at the trip origin or destination, Frank and Pivo (1994) noted that using average urban-form measures can better explain drive-alone and walk trips (Frank and Pivo 1994). Collectively, previous studies examining residential and workplace built environments have revealed positive associations between physical activity and increased mixed land use (Dalton et al. 2013, Carlson et al. 2018), residential density (Troped et al. 2010), street connectivity (Carlson et al. 2018), and improved pedestrian safety (Adlakha et al. 2015, Carlson et al. 2018).

1.1. Research Gaps

Key gaps exist in our understanding of residential and workplace built environment relationships with active and sedentary travel. First, existing studies more often use perceived rather than objective assessment of the built environment (Adlakha et al. 2015, Carlson et al. 2018) and used aggregate measures of physical activity or active transportation that do not discriminate between different travel forms (e.g., walking, bicycling) (Cervero 2002, Troped et al. 2010, Adlakha et al. 2015). For example, Cervero (2002) did not examine transport walking or biking outcomes, whereas other studies focused on physical activity and did not analyze sedentary and active travel outcomes (Troped et al. 2010, Adlakha et al. 2015). From a policy standpoint, analyzing objective measures of the built environment is important since engineers and planners work with actual on-ground infrastructure conditions. Also, objective and perceived measures of the built environment are often in poor agreement (McGinn et al. 2007). Second, some previous studies did not simultaneously analyzed objectively assessed built environment features around individuals' home and work locations when analyzing sedentary and active travel outcomes (Troped et al. 2010, Adlakha et al. 2015). Third, the role of regional and transit accessibility, objectively measured, around the home and work locations in relation to sedentary and active travel has not been well examined. Impacts of the nearby built environment can diminish when accessibility is simultaneously considered (Maria Kockelman 1997). Finally, previous studies synthesized above did not control for individuals' preferences, residential choices, and attitudinal predispositions (Frank and Pivo 1994, Cervero 2002, Troped et al. 2010, Dalton et al. 2013, Adlakha et al. 2015, Carlson et al. 2018), which are important surrogates of latent self-selection effects (Khattak and Rodriguez 2005), and if omitted can lead to an overestimation of the built environment impacts.

1.2. Research Objective

The present study focused on investigating the simultaneous relationships of objectively assessed walkability around the home and work locations with active (walking and biking – separately) and sedentary (auto) transportation, after controlling for objective measures of the natural environment and accessibility around home and work locations. We also control individuals' preferences, attitudinal predispositions, and perceptions to account for potential self-selection effects in a cross-sectional design (Kitamura et al. 1997, Khattak and Rodriguez 2005, Frank et al. 2007). Log-linear and log-linear Tobit regression models were developed to test the relationships outlined above. A sample of 648 participants in the Rails & Health study was analyzed with information on active and sedentary travel outcomes, objectively assessed environmental and accessibility features, attitudinal, demographic, and socioeconomic factors.

2. METHODS

2.1. Design & Sample

This research is based on the Rails & Health study – a natural experiment focused on the health and economic effects of a new light rail transit (LRT) line in Portland, Oregon on Kaiser Permanente Northwest (KPNW) members (Frank et al. 2019b, Wali et al. 2022a, Wali et al. 2022b). The cross-sectional data used in this study are from the baseline period, i.e., before the LRT line opening in September 2015. Details of sources, recruitment, and methods of participant selection have been previously reported (Frank et al. 2019b, Wali et al. 2022a). The required data for this analysis were collected on a total of 1151 participants. Those who did not report working outside the home were removed, leaving a sample of 648. Both full- and part-time workers were included, but not students. The study was approved by the KPNW Institutional Review Board and written informed consent was obtained from participants.

2.2. Data

The study uses data from three main streams: (1) a transportation and neighborhood perception survey, (2) a database on objectively assessed built and natural environment features, and (3) objectively assessed regional and transit accessibility measures.

2.2.1. Transportation and Neighborhood Perception Survey

Using a transportation and neighborhood perception survey, we collected detailed information on key demographic and socio-economic factors, residential choices, travel attitudes and preferences, and individual perceptions of the environment. The demographic and socio-economic data included information on race/ethnicity (Hispanic, White, Black, Asian, Pacific, Other), age, marital status, income, highest level of education, housing size and structure, and vehicle ownership. These variables were used as covariates in statistical analysis.

Potential self-selection effects in travel behavior are partly determined by individuals' travel attitudes and preferences (Bohte et al. 2009, Cao et al. 2009). We collected detailed revealed preference data on residential choices, perceptions, travel attitudes, and preferences to capture self-selection effects to the extent possible in a cross-sectional design. Data on residential choices included information on five "most important" reasons revealed by individuals for moving to their current neighborhoods. The five "most important" reasons (coded as 1 and 0) were selected by participants from a choice-set of 18 factors including closeness to public open space, friends, cultural community, job or school, bus stop, train or streetcar, restaurants, ease of walking or biking, quality of schools, highway/freeway access, etc. (Cao et al. 2006, Frank et al. 2007, Chatman 2009). Data on travel attitudes and preferences included stated preference information on pro bike-walk attitudes, pro-transit attitudes, and revealed preferences for walking, auto, biking, and public transit (Frank et al. 2007). Pro bike-walk and pro-transit attitudes were recorded on a scale from 1 (low) to 5 (high) using 1-item scales each for bike-walk and transit attitudes. Preferences for different travel modes were recorded on a five-point Likert scale ranging from strongly agree to strongly disagree. In the subsequent models, these preference variables were recoded as dichotomous (1 if strongly agree, 0 otherwise) – capturing the difference in active/sedentary travel for individuals with strong preferences for different travel modes compared to those without positive strong preferences. Finally, we obtained individuals' perceptions about their home neighborhoods, including the presence of sidewalks, separation of sidewalks from moving traffic by buffers, speed, and traffic, etc. (Cao et al. 2006, Brownson et al. 2009, Carlson et al. 2018).

The outcome variables were individuals' self-reported average weekly time spent using active (walking and biking) and sedentary (auto) travel modes for utilitarian travel. The outcomes do not include leisure purposes. In the survey, participants were asked about the frequency (days per week) and average duration (minutes per day) of walking, bicycling, and auto use within the past week, from which we calculated the average minutes per week spent walking, bicycling, or in automobiles. The automobile "drive-alone" mode included automobiles, vans, trucks, and motorcycles and did not include using a car as a passenger. The outcome variables were collected at the person level through the transportation and neighborhood perception survey, as opposed to tour-level (where individuals may use multiple travel modes) data obtained from GPS and travel diaries (Saelens et al. 2022, Wali et al. 2022a, Wali et al. 2022b).

2.2.2. Built and Natural Environment Features Around Home and Work

To collect data on objective built and natural environment features surrounding home and work locations, spatial polygon catchment areas were defined for all participants. Such catchment areas can be referred to in several ways including service areas, walk sheds, and buffers (Adams et al. 2009, Bejleri et al. 2011, Saelens et al. 2012, Frank et al. 2019b). We use the term "buffers" throughout. Instead of "crow-fly" or Euclidean straight-line distance-based buffers, we developed "sausage" based road network buffers around each home and work location with a range of one kilometer in all directions from home or work. Compared to straight-line distance-based buffers, the sausage-based network buffers provide a more accurate representation of urban form features accessible within the walk distance as pedestrians travel along transportation networks (Frank et al. 2019b). Evidence suggests that built environment exposures assessed with crow-fly buffers (as opposed to "network" or "sausage" buffers) lead to a significant underestimation of the impacts of built environment on travel and health outcomes (Oliver et al. 2007, Thornton et al. 2012, James et al. 2014, Li et al. 2022). Two types of spatial buffers were created for measuring different components of built environment variables. A "primary" line-based sausage buffer defined the catchment area with a range of one kilometer in all directions of the road network. Using a 25 m trim distance, all the pedestrian-accessible urban form features within proximity were captured without going too far to include urban features on other blocks outside the one-kilometer range (Forsyth et al. 2012, Frank et al. 2017). Figure 1 contrasts the primary line-based "sausage" buffers with crow-fly buffers for four types of environments. The line-based primary buffer was used to calculate counts of relevant built environment features described below (e.g., number of intersections). To calculate area measures, a secondary 25 m solid surface sausage buffer was developed that extracted the interior islands or polygons between all network links in the primary line-based sausage buffer. The primary line-based and secondary solid surface sausage buffers were merged resulting in a solid surface (area) that was used as a denominator in the relevant built environment (e.g., density) measures[1]. The polygon sausage buffers were sensitive to measurement

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[1] Regarding different types of network-based buffers, empirical evidence suggests that correlations of built environment measures derived from detailed (polygon-based) vs. sausage (line-based) buffers with activity outcomes

requirements unique to each built environment measure, e.g., in calculating net residential density measures around home locations, the customized buffer configuration ensures that non-residential areas are not considered in the land area denominator. The sausage-based 1-km buffers were calculated around home and work coordinates (latitude/longitude) derived from participants' home and work addresses respectively.

Once the sausage buffers were created, detailed objective data on transportation systems were calculated. These included measures of street connectivity (intersection counts/density, cul-de-sacs), residential compactness (net residential density), accessibility to different types of lands (land use mix), and the amount to which surrounding business activities were oriented toward pedestrian versus automobile access (commercial floor area ratio).

As a measure of urban compactness, greater concentrations of residential developments provide population mass for nearby activities and services that predict activity patterns (Saelens and Handy 2008). Net residential density was computed by calculating the total number of single family and multi-family residential dwelling units (within individuals' neighborhood catchment area) divided by the total parcel area of residential land (in acres). Compared to other density measures (population density or gross residential density), net residential density is a better metric since it only considers residential parcel areas (in the denominator) (Leslie et al. 2007, Frank et al. 2010a). On the other hand, gross density measures consider all land area regardless of type.

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are largely indifferent in terms of magnitude and statistical significance (Forsyth et al. 2012, Frank et al. 2017). However, line-based sausage buffers are conceptually better suited for transport applications. Proposed by Oliver et al. (2007), sausage or "line-based" buffers follow line (road) segments along the street network within 1 km of the home or work locations and select urban features that fall on the roads or within a distance (e.g., 25 m) directly accessible from the roads. On the other hand, "detailed" or polygon-based buffers define a neighborhood by an irregular polygon constructed from the endpoints of a journey (1 km in our case) in the network as its vertices (Forsyth et al. 2012). Thus, polygon-based buffers may pick urban features that are not pedestrian-accessible from the road network. Compared to "detailed" or polygon-based buffers, "sausage" or line-based buffers are conceptually superior for the assessment of land use-travel links because they explicitly consider the street network as the organizing geography (Forsyth et al. 2012, Duncan et al. 2014). The difference between the two buffers becomes substantial in networks with low to moderate connectivity (Oliver et al. 2007). A line-based sausage buffer was thus used in this study.

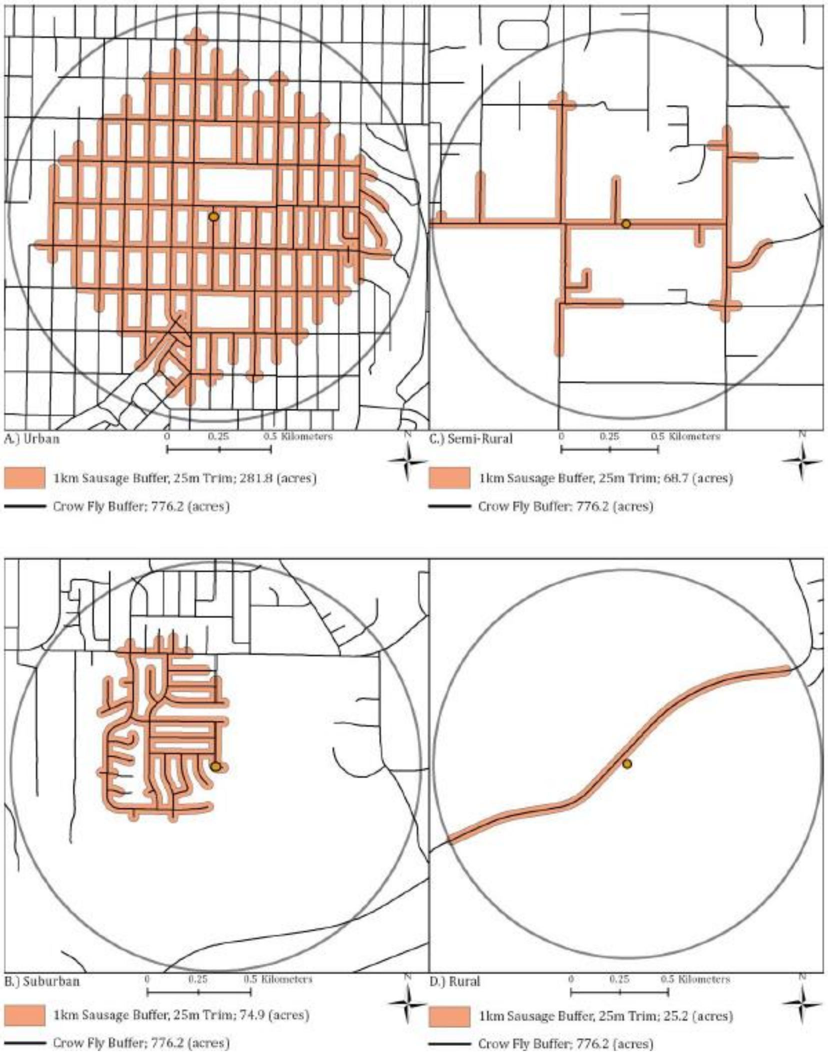

Figure 1: Examples of the 1 Kilometer "sausage" Road Network and Crow-Fly Buffers for Urban, Suburban, and Rural Areas. Modified from (Frank et al. 2017).

Street connectivity indicates the ease (directness) of routes with which a pedestrian can traverse the network, which predicts active travel and health outcomes (Frank et al. 2006, Ewing and Cervero 2010, Cerin et al. 2017, Wali 2023). Urban areas with a defined grid street pattern and shorter block lengths exhibit greater connectivity (Frank et al. 2006). Street connectivity was measured by calculating the count of intersections and cul-de-sacs in buffers and the resulting densities. In calculating the intersection density ratio, the intersection counts (number of network junctions with three or more legs) by participants' home and workplace buffers served as the numerator, whereas the total land area (km^2) served as the denominator.

Land use mix captures the spatial distribution of different land use types (such as homes, shops, and employment use) that predicts active and sedentary travel (Cervero 1988, Maria Kockelman 1997, Ewing and Cervero 2010). The land use mix variable used here is an entropy measure first used by Cervero (1989) and Frank and Pivo (1994) (Frank and Pivo 1994, Cervero and Kockelman 1997), which measures the evenness of distribution of square footage for different land use types, such as homes, shops and employment uses. A "live and work" land use mix measure was developed considering residential (single and multi-family), commercial, retail, medical and office parcels in home and work location buffers. Ranging on a scale from 0 to 1, a value of one indicates a perfectly even distribution of floor area across different land use types.

The commercial floor area ratio was calculated as a measure of non-residential density and as a metric for assessing whether commercial areas in residential and workplace buffers were more oriented toward pedestrians or automobiles. The ratio of the building square footage (floor area) to parcel square footage (land area) was calculated for all commercial parcels.

From these individual measures around home and workplaces, a composite measure of utilitarian walkability index was calculated summing the standardized/normalized scores (relative to the sample) for net-residential density, intersection density, land use mix, and commercial floor area ratio (Frank et al. 2010b). The walkability index has been developed and validated previously with travel surveys (Frank et al. 2010b). Distances from home to work along pedestrian-enhanced networks were calculated – excluding freeway road segments while integrating multi-use pathways. The number of developed parks (and distances to parks) and the total park area were calculated within the sausage buffers surrounding the participants' home and work locations. Additionally, the number of community gardens in a neighborhood and the distances to each community garden were calculated. Community gardens were also counted within the home and work sausage-based buffers. Gardens that were inside a buffer or intersected with the buffer were counted.

The environmental variables were aggregated into 1-km sausage buffers surrounding participants' home and work locations. Compared to census geographies (e.g., block groups, census tracts), parcel-level data is more advantageous to develop environmental measures given its very high spatial resolution with a wide variety of attribute information (Frank et al. 2008). The parcel tax lot database was obtained from Portland METRO (METRO 2015d). Additionally, two supplementary databases were also used, including, a multi-family parcel inventory database (METRO 2015b) and a building footprint database providing building polygons generated from LiDAR (METRO 2015a). These data sources were processed/analyzed extensively and formed the basis to develop the built environment variables (net residential density, commercial floor area ratio, and land use mix) by determining parcel counts, building floor area, and parcel land area by land use type, dwelling unit counts, and other features used in the development of variables. The intersection density measure was developed from junction points or nodes separating vertices along the walkable road network (Frank et al. 2019b). The walkable road network was derived from METRO Portland's road network shapefile considering road segments supporting walkability (METRO 2015c). Data on locations of community gardens were obtained from the City of Portland and Multnomah, Washington, and Clackamas County sources.

2.2.3. Regional and Transit Accessibility Around Home and Work

As an indicator of geographic central tendency across a metropolitan area, regional and transit accessibility measures were calculated. We measured network distances and estimated travel times between each participant's home and work locations and the full set of 14 regionally important destinations in Metro Portland (such as employment and shopping centers, key transportation hubs, educational institutions, and healthcare centers). Eight of the fourteen locations of regional significance were based on METRO-defined regional centers according to the METRO 2040 Growth Concept (METRO 2023). The six additional regionally important destinations added included, (1) Union Station (transport hub), (2) Portland International Airport (transport hub), (3) main campus of Portland State University, (4) main campus of Clackamas Community College, (5) Lloyd Center shopping complex, and (6) Oregon Health & Science University (OHSU) hospital. The average of distances (travel times) from each participant's home and work location to these fourteen regionally important locations was then calculated (Frank et al. 2019b). Regional accessibility measures (network distances and travel times) were derived from Portland's regional travel demand model. Auto and transit travel times reflected congested (AM-peak) traffic conditions. Transit travel times were developed using General Transit Feed Specification (GTFS) transit schedule information. The travel time and distance measures were calculated for the reported home and work locations (and not necessarily participants' actual routes) given the focus on regional accessibility patterns. For details, see Frank et al. (2019). Regarding transit accessibility, we measured the count of stops and stations for each participant (both home and work buffers) for each rail type (including light rail) and bus service (both frequent and infrequent). Nearest distance measures (meters) to rail and bus service classes were also calculated. Objective assessments of all built and natural environment and accessibility features were performed in ArcGIS Desktop (ESRI 2011).

2.3. Statistical Methods

A linear regression framework was first applied to model the three continuous variables - minutes per week spent walking, bicycling, and in automobiles. In these models, the outcome variables were regressed on walkability indices around home and work as key environmental exposure, while controlling for demographics, residential choices, attitudes, preferences, and other objectively measured regional accessibility and natural environment measures. A natural logarithm transformation was needed given the high skewness of the outcome variables. The distributions of the outcome variables indicated that many participants reported no activity (especially for biking and walking outcomes) within the week before the survey, leading to a spike at 'zero' in the distributions of outcome variables. Given these spikes, a (log-) linear regression on the complete sample as well as on the subsample with non-zero minutes of activity can lead to biased and inconsistent estimates (Wooldridge 2010). A latent-variable-based Tobit modeling framework was used to address this methodological issue (Wooldridge 2010). In our case, instead of the usual data censoring situation, the Tobit models were applied in a ‘corner-solution’ setting (Greene 2003). That is, an outcome of zero (0) minutes of active travel is not necessarily a data observability or censoring issue. Instead, it is a conceptually plausible and meaningful outcome. In this context, we refer to such models as ‘corner-solution models’ instead of censored regressions since using the latter terminology can be misleading. Such split distributions are typical in transportation where the realization of an outcome variable is derived from a utility maximization framework (Manski 1977), with two interlinked behavioral decisions: do something or not, and how much of something is done (if done). Also, the Tobit framework is empirically useful since it treats the rest of the (non-zero) log-transformed distribution differently than the spikes at zero. Response outcomes in linear and Tobit models were in log form. Thus, both frameworks are log-linear in terms of the response outcomes, with the Tobit framework additionally able to handle corner-solutions in respective outcome distributions. To handle zero minutes of activities in the log transformation, we added a value of one to all observations and subsequently calculated the logarithm as $\log(\text{duration} + 1)$. We omit the mathematical formulation of the Tobit model for brevity. For details, see (Wooldridge 2010).

Model selection between the log-linear and latent-variable Tobit models was performed using information-criteria based model evaluation metrics. Information criteria-based measures (including Akaike Information Criterion and Bayesian Information Criterion) are suited for comparative evaluation of non-nested models and evaluate competing models simultaneously considering goodness of fit and model complexity (Bozdogan 2000, Burnham and Anderson 2004). A difference of over 10 points in the Akaike Information Criterion (AIC) or Bayesian Information Criterion (BIC) indicates strong support in favor of the model with the lowest AIC/BIC. The (log) linear and Tobit models are estimated on the same samples with similar exogenous and dependent variables. Potential multicollinearity issues were examined using variance inflation factors (VIF) for all exogenous variables. The VIFs of all exogenous factors presented in Table 1 were less than 4 indicating an absence of problematic multicollinearity (Alauddin and Nghiem 2010). A 90% confidence level threshold was used to infer statistical significance of individual estimable parameters. We systematically tested all exogenous variables explained earlier and prioritized those that maximized the goodness of fit for each outcome being modeled. All models simultaneously included residential and workplace walkability measures as key exposures of interest. While the same and comparable measures were created for residential and workplace accessibility and natural environment constructs, only those individual variables (within each construct) were retained that emerged statistically significant, led to improved goodness of fit, and did not pose multicollinearity issues. A similar approach was followed for demographic and attitudinal factors.

To enable a more useful interpretation, we computed marginal effects for the variables in Tobit models since the Tobit coefficients cannot be readily interpreted. Depending on which expected value is of interest, three possible marginal effects can be calculated: change in expected values of the latent variable (Y_i^*), actual response outcome (Y_i), or expected value of actual response outcome for individuals that are not on the corner of the distribution ($Y_i|Y_i > 0$) (Amemiya 1984, Wooldridge 2010, Wali et al. 2019). Given the corner-solution setting, we base our interpretation of the findings based on average marginal effects (calculated at the individual level) pertaining to the actual response outcome (including both cases at the corner and non-corner of the distribution) (Greene 2003). Since a log transformation is used for the response outcomes, the marginal effects (MEs) from the models can be interpreted as elasticities. When both the dependent and independent variables are log-transformed, the MEs can be interpreted as a ME percent change in Y with a one percent change in X. If only the dependent variable is log-transformed, a one-unit change in X would imply a 100*ME percent change in Y. Data integration and statistical analysis was performed in Stata v14 (StataCorp 2015).

3. RESULTS

3.1. Descriptive Statistics

Table 1 shows the descriptive statistics of key variables. For brevity, only those variables are shown that remained in the final models derived from the model specification and model selection process detailed earlier. Participants spent on average 60, 87, and 264 minutes per week on biking, walking, and automobile driving, respectively (Table 1). Around 66.4%, 36.2%, and 4.2% of participants did not participate (zero days per week) in biking, walking, and auto use, respectively. The average participant age was approximately 51 years. Around 45% of the sample possessed a graduate degree, with about 4% of the participants earning less than USD 35,000 annually. Most participants were White and around 66% were female. The households possessed on-average around two vehicles. About 31% of participants strongly agreed with walking being easier than driving in their neighborhoods, whereas 20% preferred biking over driving. The participants were on the relatively high-end of pro bike/walk attitudinal spectrum with a mean of 3.4 ±1.04. More than half of the participants strongly agreed with the statement that most sidewalks in their neighborhoods are separated from traffic by a buffer. Around 9% and 5% of the sample considered the presence of ped-bike facilities and access to grocery stores as the most important reasons to move to their current neighborhoods[2].

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[2] We compared the characteristics of the study participants to the general population in Portland. Demographic and socioeconomic data for the general population in Portland was derived for 2015 from the U.S. Census (https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2015/). The average household size was similar for the study sample (2.6) and Portland (2.51). The percentage of White individuals was slightly higher in the

3.2. Walkability, Accessibility, and Natural Environment Around Home and Work

There were substantial differences in environmental walkability around home and work locations. Compared to home neighborhoods, work neighborhoods were substantially more walkable reflected by greater compactness (net residential density), connectivity (intersection density), pedestrian-oriented business activities (commercial floor area ratio), and proximity/diversity of uses (land-use) (see Table 1). Net residential density around work locations was greater since many work locations are in the most urban areas in the region, namely Downtown Portland, containing more high-density multi-family dwellings. Compared to home locations, the mean land-use mix around work locations was 0.71 (on a scale 0 to 1) – with values above 0.6 indicating decent mixing of land uses associated with greater propensity of active travel (Wali et al. 2021). The land use mix values in the study region were significantly greater compared to other US regions such as Atlanta, Washington DC, and Baltimore (Frank et al. 2004, Zhang et al. 2012) but similar to land use mix profiles in the Puget Sound Region (Zhang et al. 2012, Wali et al. 2022c). Neighborhoods around home and work also differed in regional accessibility and access to natural environment (Table 1). Represented as a composite score, higher values for walkability index in Table 1 indicate more walkable neighborhoods.

Figure 2 shows a Chord diagram to visualize the differences in neighborhood walkability around home and work locations. Of individuals who had ‘high’ neighborhood walkability around their home locations (green color), only about 29% also had high neighborhood walkability around work – the rest either had low (18%) or medium levels (53%) of workplace walkability. Likewise, of those having low walkability around homes (red), only 36% had low workplace walkability and 64% had medium or high level of workplace walkability.

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study sample (91% vs. 85.1% in Portland), whereas the percentage of individuals aged 65 or more was slightly lower in the study sample (11.1% vs. 15.4% in Portland). The average household income in the study sample and Portland was $75,000 - $100,000 and around $81,000, respectively. While the percentage of individuals with a high school or higher degree was somewhat similar between the study sample and Portland (94.9% vs. 89.8%), the proportion of bachelor’s degree holders was significantly greater in the study sample (31.6% vs. 19.3% in Portland). The percentages of females and married individuals were higher in the study sample (66% females in the study sample vs. 50.5% in Portland and 65% married individuals in the sample vs. 49.1% in Portland). The percentage of single-family households (85.4%) in the study sample was significantly greater than in Portland (68.1%). Related to regional accessibility, the mean travel time to work (in minutes) was similar between the study sample (22.6) and Portland (22.9). Overall, the study sample and the general population in Portland exhibited broader similarities in household size, old age, race (White), income, and regional accessibility, but key differences across education, gender, and marital status. The statistics shown above might enable readers to draw wider comparisons with other locations exhibiting similar distributions in these aspects.

TABLE 1: Descriptive Statistics of Key Variables

Variables	**Mean**	**SD**	**Min**	**Max**
Response Outcomes (average minutes per week)				
Biking	60.9	131.5	0	1500
Walking	87.4	184.9	0	3500
Auto-use	264	249	0	3360
Percentage of Users by Mode (No. of days per week)				
Biking: 0 days	66.4	47.3	---	---
Biking: ≥ 1 days	42.6	49.5	---	---
Walking: 0 days	36.2	48.1	---	---
Walking: ≥ 1 days	67.7	46.8	---	---
Auto: 0 days	4.2	20.0	---	---
Auto: ≥ 1 days	96.0	19.6	---	---
Demographics				
Age (years)	50.8	11.2	21	75
Female (%)	66.4	47.3	---	---
Race: White (%)	91.3	28.2	---	---
Married (%)	65.0	47.7	---	---
Partnered, not married (%)	6.33	24.4	---	---
Grade 9 to high school (%)	5.25	22.3	---	---
Grad degree (masters, doctorate) (%)	44.6	49.7	---	---
Income: Less than USD 35K (%)	4.01	19.6	---	---
Housing Structure: Townhouse (%)	2.47	15.5	---	---
No. of vehicles	1.92	0.89	0	4
Home Built Environment				
Net residential density (dwelling units / acre)	11.3	4.09	2.17	29.0
Intersection density (count / sq. km.)	104	17.4	56.9	158
Commercial Floor Area Ratio (FAR) (ratio)	0.43	0.18	0	0.83
Land-use Mix (scale 0 to 1)	0.54	0.24	0	1.00
Walkability Index [composite measure of standardized z-scores for residential density, intersection density, commercial FAR, & land-use mix]	-0.06	1.72	-4.79	5.39
Work Built Environment				
Net residential density (dwelling units / acre)	66.1	85.2	0.06	311.1
Intersection density (count / sq. km.)	105	37.9	18.1	179
Commercial Floor Area Ratio (FAR) (ratio)	1.27	1.43	0	4.56
Land-use Mix (scale 0 to 1)	0.71	0.27	0	1.00
Walkability Index	4.40	7.30	-6.36	21.0

Notes: N = 648 except for biking (553), walking (563), auto-use (616); number of vehicles (623); race (623). SD is standard deviation. For details on walkability index formulation, see (Frank et al. 2010b). See section 2 for the formulation of built environment measures. USD is United States Dollar; (---) is Not Applicable.

TABLE 1: Descriptive Statistics of Key Variables (Continued)

Variables	**Mean**	**SD**	**Min**	**Max**
Regional & Transit Accessibility				
Average network distance between origin and regionally important 14 location (in km) **[from home]**	14.6	1.86	12.25	23.35
Average network distance between origin and regionally important 14 location (in km) **[from work]**	15.3	4.46	11.68	40.29
Nearest distance in meters to bus stop (any type) (log-form) **[from home]**	5.30	0.78	0.69	7.47
Nearest distance in meters to bus stop (any type) (log-form) **[from work]**	4.65	1.35	0	9.53
Shortest distance from home to work along the pedestrian-enhanced network (in km)	8.12	6.82	0	45.18
Natural Environment				
Count of community gardens **[around home]**	0.47	0.78	0	4
Count of community gardens **[around work]**	0.19	0.51	0	4
Nearest distance to community gardens (in km) **[from home]**	1.54	1.24	0	9.58
Nearest distance to community gardens (in km) **[from work]**	2.27	1.52	0	17.12
Residential Choices, Preferences, Perceptions*				
Most important reason to move to current neighborhood: Presence of walk bike facilities	0.09	0.28	0	1
Most important reason to move to current neighborhood: Access to grocery stores	0.05	0.22	0	1
Pro bike/walk attitude [1 to 5]	3.43	1.04	1	5
Most sidewalks separated from traffic by buffer (strongly agree)	0.59	0.49	0	1
Walking easier than driving (strongly agree)	0.31	0.46	0	1
Prefer biking over driving (strongly agree)	0.20	0.40	0	1

Notes: SD is standard deviation; (*) mean values indicate sample proportions for residential choices, preferences, and perceptions related variables (except Pro bike/walk attitude). N = 648 except pro bike/walk attitude (645) and count of community gardens (around work) (647).

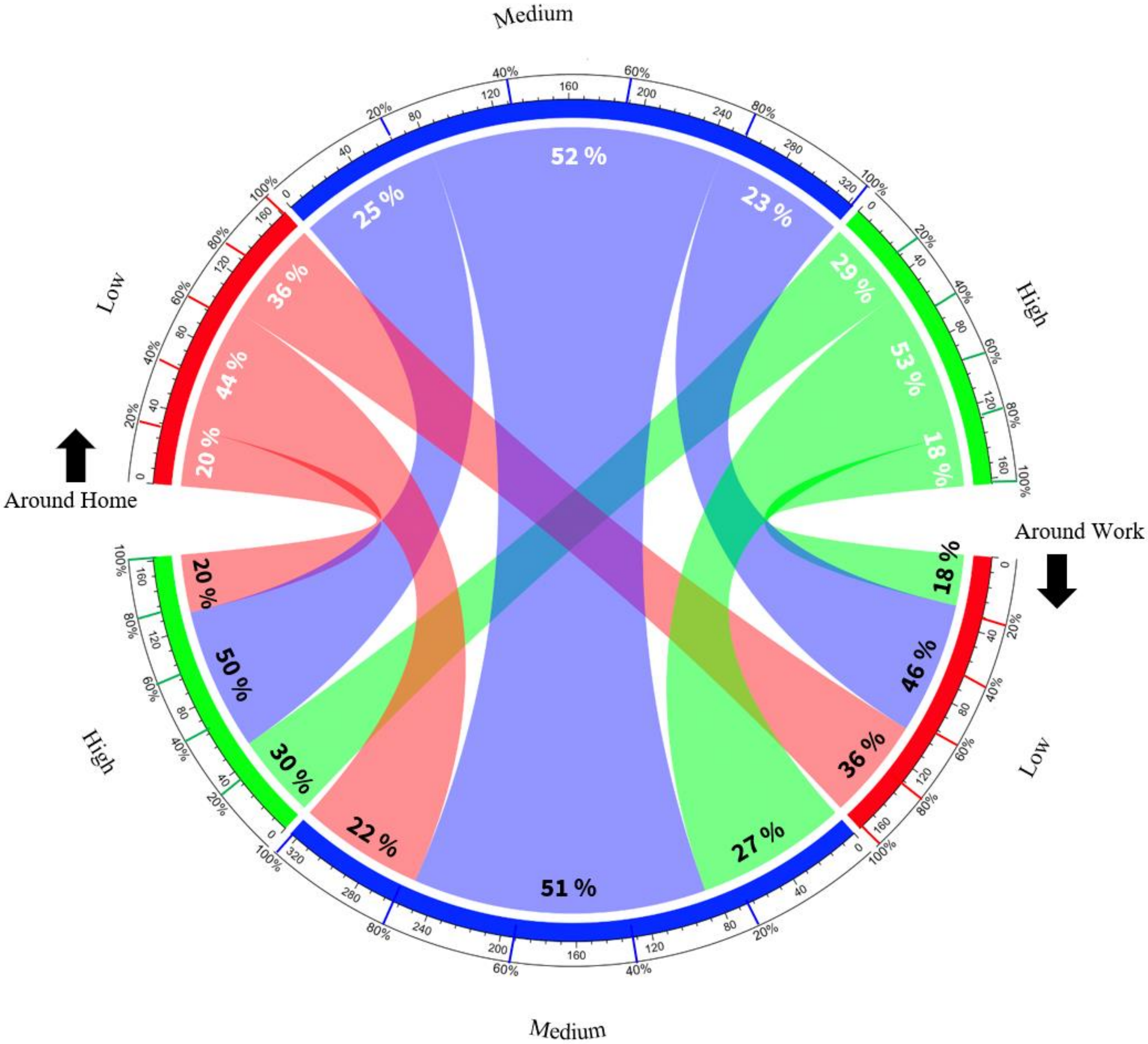

Figure 2: A Chord Diagram of Differences in Walkability Index Around Home and Work Locations

Notes: Low walkability – walkability around home/work less than 25th percentile value; Medium – between 25th and 75th percentile value; High – greater than 75th percentile value; Outer ring divided into sectors based on the actual number of individuals (and their proportions) in each of the walkability category around home (upper semi-circle) and work locations (lower semi-circle). The chords connecting different sectors of the outer ring show the proportion of individuals between a pair of walkability metrics around home and work. For each band, the percentages at source (home) and destination (work) were added. For example, of all the individuals who had medium walkability at home (blue ring in top semi-circle), 23%, 52%, and 25% had low, medium, and high workplace walkability, respectively. Likewise, of all individuals who had medium workplace walkability (blue ring in bottom semi-circle), 22%, 51%, and 27% had low, medium, and high walkability at home, respectively.

3.3. Modeling Results

For biking and walking outcomes, the log-linear Tobit models outperformed the log-linear models that did not consider the corner-solution spikes in the respective distributions. This is evident by a reduction of 932 and 928 units in the AIC and BIC of the log-linear Tobit model for the bike duration outcome, compared to the AIC and BIC of the log-linear model (Table 2). Likewise, the AIC and BIC of the log-linear Tobit model for walk duration outcome decreased by 265 and 261 units, respectively (Table 2). For time spent in automobile outcome (sedentary time), the log-linear model statistically outperformed the Tobit model, as evident by its lower AIC and BIC statistics in Table 2. This is expected given the lower prevalence of zero automobile time (short spike at zero) (only 4.2% reported spending 0 minutes in automobiles). Given these findings, we present the results of log-linear Tobit models for walk and bike duration outcomes (Table 3) and a log-linear model for the auto duration outcome (Table 4). Tables 3 and 4 show the final models with statistically insignificant variables removed.

TABLE 2: Goodness of Fit Comparison of Log-Linear and Log-Linear Tobit Models for Biking, Walking, and Auto Duration Outcomes

Goodness of Fit Measure	**Biking Duration**		**Walking Duration**		**Auto-use Duration**	
	Log-Linear Model	**Log-Linear Tobit Model**	**Log-Linear Model**	**Log-Linear Tobit Model**	**Log-Linear Model**	**Log-Linear Tobit Model**
N	546	546	556	556	616	616
N$_{\text{Left-censored}}$	---	367	---	205	---	26
N$_{\text{Uncensored}}$	---	179	---	351	---	590
Degrees of Freedom	16	17	11	12	10	11
Log-likelihood at convergence	-1174.9	-708	-1162.6	-1029	-994.8	-1023.3
F-test (F)	9.13	---	20.44	---	18.77	---
Prob > F	0.00	---	0.00	---	0.00	---
Likelihood-ratio Chi-square test	---	128.13	---	187.35	---	146.89
Prob > Chi-square	---	0.00	---	0.00	---	0.00
AIC	2382	1450	2347	2082	2010	2068
ΔAIC [AIC$_{\text{LOG-LINEAR TOBIT}}$ - AIC$_{\text{LOG-LINEAR}}$]	-932		-265		58	
BIC	2451	1523	2395	2134	2054	2117
ΔBIC [BIC$_{\text{LOG-LINEAR TOBIT}}$ - BIC$_{\text{LOG-LINEAR}}$]	-928		-261		63	

Notes: N is sample sizes for complete estimation samples; AIC is Akaike Information Criterion; BIC is Bayesian Information Criterion; (---) is Not Applicable.

Statistically significant and independent associations of walkability index around home and work with active and sedentary travel outcomes were observed. A one-unit higher walkability index around home was correlated with 16.3% and 11.4% higher weekly biking and walking durations, respectively (Table 3). Independent of walkability index around home, a one-unit higher walkability around work was associated with 2.8% and 2.7% higher weekly durations of biking and walking, respectively. Conversely, a one-unit higher walkability around home and work was associated with a 6.6% and 2% lower weekly time spent in automobile, respectively (Table 4).

Accessibility to transit showed somewhat inconsistent relationships to biking and walking. A greater nearest distance (meters) to bus stops (less accessibility) around *work* was associated with lower weekly biking duration but not more walking (Table 3). Conversely, a greater distance to bus stops around the *home* was negatively correlated with walking but no association was observed for biking. A negative correlation was observed between the nearest distance from home to work along a pedestrian-enhanced network and biking duration. The natural environment around home and work was correlated with weekly walking duration. Each additional community garden around home was associated with 22.1% more weekly walking. A one-kilometer increase in the nearest distance to community gardens around work correlated with 18.4% lower walking per week. Time spent in automobiles was negatively correlated with greater regional accessibility and better natural environment around home and work locations (Table 4). A one-kilometer increase in average network distance between work origin and all significant regional destinations was correlated with 3.9% [90% CI: 1.7% - 6.2%] more automobile travel. Auto and transit travel time measures exhibited high correlations (Pearson correlations ranging between 0.83 and 0.95) with the distance-based measures and thus were not included in the model to avoid multicollinearity issues. Less accessibility (greater distance) to bus stops around home was associated with greater time spent in automobile. We tested both bus and rail system accessibility measures independently in the walk, bike, and auto duration outcomes, but rail accessibility measures were statistically insignificant. Presence of green space around home, but not work, was correlated with lower sedentary travel (Table 4). We tested park variables (count and distances) and they were statistically insignificant.

Attitudinal predispositions and perceptions were strongly correlated with active and sedentary travel. Participants with high self-reported pro bike/walk attitude had a significantly greater amount of weekly walking. Individuals who perceived that most sidewalks in their neighborhoods are separated from traffic by a buffer had on-average 57.4% [90% CI: 24.1% - 90.7%] and 40.9% [90% CI: 6.6% - 75.1%] greater amounts of weekly walking and biking, respectively (Table 3). Potential self-selection effects were also observed. Individuals considering presence of facilities for walking and biking as the most important reason to move to their existing neighborhood had on average 56.3% higher biking duration (Table 3). Individuals who perceived walking to be easier than driving and preferred biking to driving had substantially lower time spent in automobiles (Table 4). Several demographic and socioeconomic variables are found statistically significantly correlated with active and sedentary travel. While a one-year increase in age was associated with a 1.7% lower time biking – we found a polynomial relationship between the two (Figure 3). Note that while the number of individuals in 'Income: Less than USD 35K' and 'Housing structure: Townhouse' categories are lower, we retained these statistically significant variables in the auto duration model as it improved model goodness of fit. This does not negatively impact our inferences on key exposure variables (walkability around home and work).

TABLE 3: Estimation Results of Log-Linear Tobit Models for Amount of Weekly Biking and Walking

Variables	**Walking**			**Biking**		
	β	**t-stat**	**ME [95% CI]**	**β**	**t-stat**	**ME [95% CI]**
Constant	1.119	0.99	---	-18.492***	-3.11	---
Built Environment						
Walkability Index **[around home]**	0.158*	1.76	0.114 [0.008,0.221]	0.454***	2.74	0.163 [0.065,0.260]
Walkability Index **[around work]**	0.037**	2.05	0.027 [0.005,0.048]	0.078**	2.09	0.028 [0.005,0.049]
Accessibility & Natural Environment						
Nearest distance in meters to bus stop (any type) (log-form) **[home]**	-0.729***	-4.22	-0.528 [-0.731,-0.325]	0.303	0.8	0.109 [-0.114,0.331]
Nearest distance in meters to bus stop (any type) (log-form) **[work]**	---	---	---	-0.389*	-1.82	-0.14 [-0.265,-0.013]
Nearest distance from home to work along the pedestrian-enhanced network (in km)	---	---	---	-0.153***	-3.17	-0.055 [-0.083,-0.026]
Count of community gardens **[home]**	0.306*	1.69	0.221 [0.007,0.436]	---	---	---
Nearest distance to community gardens (in km) **[work]**	-0.254***	-2.65	-0.184 [-0.298,-0.070]	---	---	---
Demographics, SES & Perception/Preferences (1/0)						
Most sidewalks separated from traffic by buffer (strongly agree)	0.792***	2.82	0.574 [0.241,0.907]	1.14**	1.96	0.409 [0.066,0.751]
Most important reason to move to current neighborhood: Presence of walk bike facilities	---	---	---	1.572*	1.84	0.563 [0.060,1.067]
Most important reason to move to current neighborhood: Access to grocery stores	---	---	---	-2.245**	-1.43	-0.804 [-1.731,0.122]
Pro bike/walk attitude [1 to 5]	1.091***	7.71	0.789 [0.627,0.951]	---	---	---
Education: Grad degree (masters, doctorate) [a]	---	---	---	1.989***	3.64	0.713 [0.391,1.034]
Education: Grade 9 to High School [b]	-1.409**	-1.98	-1.020 [-1.866,-0.174]	---	---	---
Female	---	---	---	-2.322***	-4.1	-0.832 [-1.165,-0.499]
Race: White	1.591***	3.02	1.151 [0.527,1.775]	4.007***	3.18	1.436 [0.693,2.179]
Married	---	---	---	1.185*	1.76	0.425 [0.028,0.822]
Partner	---	---	---	1.932*	1.69	0.692 [0.018,1.367]
Age	---	---	---	0.601***	2.81	-0.017 [-0.029,-0.005]
$[\text{Age}]^2$	---	---	---	-0.007***	-3.08	
No. of vehicles	-0.311**	-2.01	-0.225 [-0.409,-0.042]	---	---	---
Estimated variance	8.233***	11.98	---	24.426***	8.02	---

Notes: Dependent variables are the natural logarithm of minutes of biking and walking per week; ME is marginal effects; SES is socioeconomic status; Walkability index is a composite measure of net residential density, intersection density, commercial FAR, & land-use mix; (*), (**), and (***) indicate statistical significance at 90%, 95%, and 99% level of confidence, respectively; (---) indicates not applicable or statistically insignificant variables; Nearest distance to bus stop (from home) was retained in biking outcome as doing so led to improved fit (a) Individuals with education less than a graduate degree serve as the reference category in bike duration model; (b) Individuals with a higher education serve as the reference category in walk duration model.

TABLE 4: Estimation Results from Log-Linear Model for Amount of Weekly Auto Use

Variables	**β**	**t-stat**	**Marginal Effect [90% CI]**
Constant	3.668***	8.92	---
Built Environment			
Walkability Index **[home]**	-0.066**	-1.98	-0.066 [-0.12,-0.011]
Walkability Index **[work]**	-0.02**	-2.44	-0.02 [-0.033,-0.006]
Accessibility & Natural Environment			
Nearest distance in meters to bus stop (any type) (log-form) **[home]**	0.229***	3.54	0.229 [0.122,0.336]
Average network distance between origin and regional accessibility locations (in km) **[work]**	0.039***	2.94	0.039 [0.017,0.062]
Count of community gardens **[home]**	-0.117*	-1.65	-0.117 [-0.235,0]
Demographics, SES & Perception/Preferences (1/0)			
Walking easier than driving (strongly agree)	-0.324***	-2.85	-0.324 [-0.512,-0.137]
Prefer biking than driving (strongly agree)	-0.79***	-6.02	-0.79 [-1.006,-0.574]
Income: Less than USD 35K	-0.461*	-1.73	-0.461 [-0.899,-0.022]
Housing Structure: Townhouse	-0.503	-1.59	-0.503 [-1.025,0.018]

Notes: Dependent variable is the natural logarithm of minutes of automobile use per week; ME is marginal effects; SES is socioeconomic status; Walkability index is a composite measure of net residential density, intersection density, commercial FAR, & land-use mix; (*), (**), and (***) indicate statistical significance at 90%, 95%, and 99% level of confidence, respectively; (---) indicates not applicable.

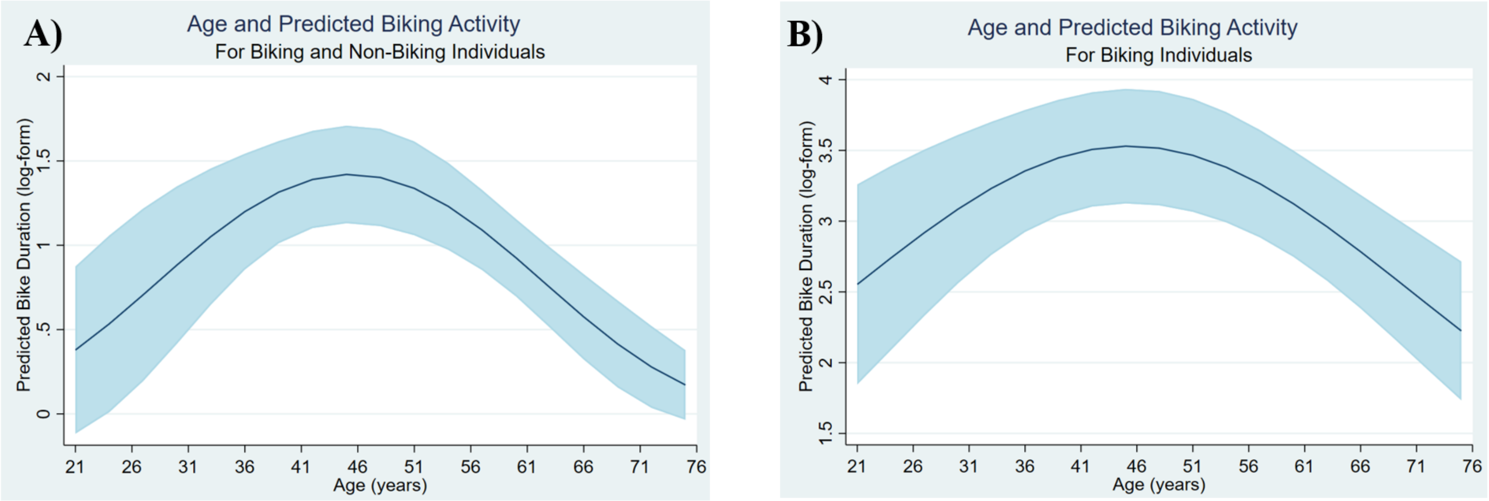

FIGURE 3: Relationship between Age and Weekly Biking Duration

Notes: Figure 3A shows the polynomial relationship for both individuals who did not bike and those who did. Figure 3B shows the relationship for only those individuals who had greater than zero minutes of biking (‘uncensored’ observations). The predicted values are obtained by marginalizing out the influence of other variables in the model by considering their average values in the sample.

4. DISCUSSION

This study found that walkability around home and work were independently associated with active and sedentary travel – even after controlling for attitudinal predispositions, preferences, perceptions, and demographics. These results are consistent with prior studies that reported a positive association between perceived built environment features at work and physical activity (Adlakha et al. 2015, Carlson et al. 2018). Results from the present study strengthen the findings from previous studies by harnessing objective built environment features, disaggregate measures of active transportation, and controlling for individuals' preferences and attitudinal predispositions. The results also exemplify the role of built walkability around work after controlling for home neighborhoods features. The marginal effects of objectively assessed walkability around home locations on travel behavior were significantly higher, especially for walking and cycling. This finding aligns with past studies reporting a greater impact of perceived residential walkability compared to perceived workplace walkability (Adlakha et al. 2015, Carlson et al. 2018). Nonetheless, the walkability index around work locations exhibited statistically significant and considerable associations with sedentary and active travel outcomes. Overall, the findings suggest that studies solely focusing on built environment features around the home could underestimate the associations of the built environment with health outcomes. We also found substantial differences in levels of walkability around home and work locations. As expected, workplace neighborhoods in the Portland, OR area were found to be more compact, diverse, and connected with greater provision of pedestrian-oriented infrastructure. Taken together with the statistically significant role of workplace walkability, this observation highlights the importance of retrofitting workplace neighborhoods to enhance active transportation and hinder automobile travel.

Furthermore, our results highlight the role of better regional and transit accessibility around home and work locations in enhancing active and reducing sedentary travel. Compared to the benefits of greater regional accessibility around home places (Maria Kockelman 1997, Lussier-Tomaszewski and Boisjoly 2021), the benefits of greater accessibility between workplaces and important destinations are not well understood in the literature. Our findings suggest that enhancing regional accessibility around workplaces may discourage automobile travel. Likewise, gains in active travel are possible by increasing accessibility to transit around home and workplaces.

Finally, individual factors related to attitudinal predispositions and preferences/perceptions continue to strongly influence active/sedentary travel behavior. Previous studies have failed to account for underlying neighborhood self-selection indicators (e.g., reasons for choosing a neighborhood) and neighborhood preferences – both of which influence travel behavior. Individual preferences and residential choices serve as key surrogates of self-selection and omitting such factors can lead to inflated estimates of built environment impacts (Khattak and Rodriguez 2005, Cao 2014). By controlling neighborhood selection and perceptions/preferences, the current study better isolates the potential health impacts of walkability around home and workplaces. However, this study did not consider potential workplace self-selection effects. Traditionally, individuals' work locations or their desire to access major job centers have been posited to influence their residential location choices in the travel behavior, urban economics, and labor market literature (Crane 1996, Van Ommeren et al. 1997, Bhat and Guo 2007, Pinjari et al. 2011, Pager and Pedulla 2015). Lifestyle and travel preferences have long been recognized as determinants of residential self-selection effects (Salomon and Ben-Akiva 1983, Mokhtarian and Cao 2008). Further, empirical evidence suggests that individuals are less likely to emphasize work location if their residential locations satisfy lifestyle aspirations (Kim et al. 2005). Yet, some households may also decide their work locations given their residential location choices (Waddell 1993, Tran et al. 2016). This is especially relevant in the post-COVID era where the emergence of teleworking has enabled individuals to choose home locations irrespective of their work locations. Thus, future studies could benefit by simultaneously considering residential and possible workplace self-selection effects in the context of home and work-built environment impacts on travel outcomes.

4.1. Strengths and Limitations

Self-reported measures of active and sedentary travel were used, which may deviate from the actual activity durations. The study analyzed utilitarian travel outcomes and thus the results may not be generalizable to other life domains (e.g., leisure or recreational physical activity). Even though residential and workplace environmental characteristics exhibited significant variations, care must be exercised in generalizing the study findings to other regions as Portland is among the most walkable urban areas in the U.S. Likewise, while the sampled participants exhibited considerable variations in travel behavior and socioeconomic factors, they may not be fully representative of the general population in Portland region. The outcome variables considered all utilitarian (no leisure) travel to different destinations and did not isolate utilitarian travel to work destinations due to the survey question limitation used to solicit data on outcome variables. Future studies could benefit by explicitly analyzing the amount of active and sedentary travel that takes place around the home and work locations (instead of summing all reported travel) and in places not within the home or work neighborhood buffer (Eisenberg-Guyot et al. 2019). To this end, the findings reported in this study perhaps underestimate the actual magnitude of associations between walkability and active/sedentary travel. For example, workplace walkability may predict work-related active travel better than predicting combined active travel taking place around home, workplace, and in between. The present study found that home and work environments were independently associated with travel behavior. Future studies can examine how the two environments potentially interact in predicting travel behavior across different domains. While higher than time spent in active travel nationwide (Pucher et al. 2011, Paul et al. 2015), the mean weekly biking and walking durations of 60.9 and 87.4 minutes are in line with previous studies and representative of active travel patterns in Portland. Previous studies found that 60% of cyclists had more than 150 minutes of weekly biking activity (Dill 2009) and the average weekly walking time was around 130 minutes in Portland (Nagel et al. 2008). Use of and time spent in transit was not analyzed since it is a mix of active (walking or biking to transit stop) and sedentary travel (when the user is on-board a bus). Future studies should examine home and work built environment impacts on time spent in transit as it is an important part of travel behavior. Future studies should also incorporate other natural environment measures (including forests, tree canopy, and a composite greenness index) around home and workplace locations. Car ownership variable was tested as a key control in active travel outcomes in line with previous studies (Frank and Pivo 1994, Bhat et al. 2005, Guo et al. 2007, Sehatzadeh et al. 2011, Carlson et al. 2015, Liu et al. 2021, Yang et al. 2021). Future studies should examine the potential mediating role of vehicle ownership in the links between home/work built environment and travel behavior as an avenue for future research. Finally, the study is cross-sectional which precludes the ability to determine causation.

Study strengths include an assessment of objective walkability measures at residential and work locations. We simultaneously analyze walkability around home and work locations to quantify the independent associations of each with active and sedentary travel – while controlling for objective measures of natural environment, regional, and transit accessibility around home and work locations. To the extent possible in a cross-sectional study design, we account for potential self-selection effects by controlling for individuals' preferences, attitudinal predispositions, and demographics that are largely ignored in the literature surrounding residential and workplace walkability impacts on active and sedentary travel.

5. CONCLUSIONS

Findings from the study revealed that home and work locations significantly differ in walkability, regional accessibility, and natural environment. After controlling attitudinal predispositions, preferences/perceptions, and demographics, walkability around home and work independently predicted walking, biking, and automobile travel. These findings highlight the important role of more walkable, connected, denser, and diverse workplace environments in enhancing sustainable and lowering sedentary travel. Built environment interventions improving workplace walkability and enhancing accessibility by active travel modes can support sustainable mobility goals. Results also suggest that mixed land uses that integrate residential developments within business areas can further promote active transportation and lower automobile travel by shortening walkable commute distances. Further gains in active travel or reductions in automobile use may be achieved by enhancing regional and transit accessibility around workplaces.

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7. AUTHOR STATEMENT

The authors confirm contribution to the paper as follows: Study Conception and Design: B. Wali, L.D. Frank, B.E. Saelens, D.R. Young, R.T. Meenan, J.F. Dickerson, E.M. Keast, S.P. Fortmann; Methodology & Analysis: B. Wali; Data Integration & Curation: B. Wali; Interpretation of Results: B. Wali, L.D. Frank, B.E. Saelens, D.R. Young, R.T. Meenan, J.F. Dickerson, E.M. Keast, S.P. Fortmann; Writing – Original Draft: B. Wali; Writing – Review & Editing: B. Wali, L.D. Frank, B.E. Saelens, D.R. Young, R.T. Meenan, J.F. Dickerson, E.M. Keast, S.P. Fortmann; Funding Acquisition: S.P. Fortmann. All authors reviewed the results and approved the final version of the manuscript.

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