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Light rail leads to more walking around station areas

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ABSTRACT

Areas around Light Rail Transit (LRT) stations offer ideal conditions for Transit-Oriented Development (TOD). Relatively dense, mixed-use neighborhoods can have positive impacts on mobility, health, and perceptions of neighborhood safety among nearby residents, primarily through walking activity for both transit and other purposes. To examine how station areas may attract new activity, this study analyzed changes in walking around station areas among people living close to an LRT station before and after the opening of a new transit system.

This study examined walking behavior among the subset of 214 participants living within one mile of one of 13 LRT stations from among a sample of residents living close or further away from a new LRT line in Seattle. They completed a survey and a travel log and wore an accelerometer and a GPS for 7 days both before (2008) and after the opening of the Seattle area LRT (2010). Walking bouts were derived using a previously developed algorithm. The main outcome was the individual-level change in the proportion of daily walking within one quarter Euclidean mile of an LRT station.

Overall walking decreased from before to after the LRT opening while station area walking did not change significantly, indicating a shift in walking activity to the station areas after the introduction of LRT. Increases in the proportion of station area walking were negatively related to participants' distance between home and the nearest LRT station, peaking at <0.25 mile and decaying beyond >0.75 mile. Male gender, college education, normal weight status, less access to cars, and frequent LRT use were also significantly associated with greater positive changes in the proportion of station area walking.

The shift in walking to station areas after the completion of light rail provides evidence that the local proximate population is attracted to station areas, which may potentially benefit both transit use and TOD area economic activity. The residential catchment area for the shift in LRT area walking was $<$ 0.75 mile of the LRT stations.

1. Introduction

Fixed LRT lines have the potential to create urban corridors where each station area becomes one in a series of activity nodes where walking and transit are the most convenient modes of travel. Planners have long proposed clustering residents

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and workplaces around these nodes in Transit-Oriented Developments (TODs), which are characterized by relatively dense, mixed-use, and pedestrian friendly neighborhoods served by transit (Calthorpe, 1993; Cervero, 2001). TODs along LRT corridors can have a considerable impact on ridership and mobility through enhanced pedestrian accessibility to stations. TOD stations are known to generate more transit and walk trips than stations in lower-density, automobile-oriented areas. A California study found that at TOD rail stations, the share of walking as the transit access mode from home was as high as 87.8%; from workplace to rail station, the share of walking was 74.2%. Furthermore, every additional 100 employees per acre working near a station increased rail ridership by 2.2% (Cervero, 1994).

With more transit trips and more of those transit trips beginning and ending with a walk trip rather than a car trip, TODs are characterized by a high level of pedestrian activity. TOD walking has several economic, health, and social benefits. A longitudinal study of residents in an existing neighborhood before and after a LRT station was installed found that the 26% of participants who started using transit after the station opened experienced a reduction in car trips (Brown and Werner, 2008). Cross-sectional studies found that transit-related walking alone is responsible for higher levels of walking among transit users compared to those who do not use transit (Saelens et al., 2014; Brown et al., 2015) and that LRT ridership is associated with greater bouts of moderate physical activity (Brown and Werner, 2007; MacDonald et al., 2010). Longitudinally, increased LRT ridership was related to increased bouts of moderate physical activity (Brown and Werner, 2011; Spears et al., 2016). Even station area residents who do not use transit can benefit from the mix of nearby land uses and walk to local stores and other daily destinations near the station. Station area residents had higher neighborhood satisfaction after a light rail station was opened; they experienced greater perception of safety while walking, and felt that their children were safer (Brown and Werner, 2011). Finally, studies showed that retail, office, and residential rents, as well as housing prices are higher in more walkable places (Cortright, 2009; Leinberger and Alfonzo, 2007; Pivo and Fisher, 2011; Huang et al., 2015), suggesting that light rail's contribution to making a place more walkable can result in increased economic activity and property tax revenue.

The present longitudinal study details the extent to which LRT catalyzes pedestrian activity in station areas. It examines the impact of the introduction of the first line within Seattle's Sound Transit Link light rail system on walking activity among residents living within one mile of a station. Based on objective measures of changes in walking activity around LRT station areas, the study is among the first to provide planners with evidence regarding the "gravitational pull" of LRT stations following the completion of LRT. It also probes the effect of residential distance to stations on changes in walking activity, yielding estimates of actual measures of the size of TOD pedestrian catchment areas. Past research has identified a distance decay in the use of walking as an access mode to transit (Cervero, 2001), but little is known about station area residents' walking activity relative to how far they live from a station, which represents the "push factor" away from station locations.

2. Methods

2.1. Participants

The Travel Assessment and Community (TRAC) project used a longitudinal cohort study design to examine the impact of new Sound Transit Link light rail on physical activity and active travel. The first 13 Link light rail stations opened in fall 2009. The stations comprise a 14-mile corridor that connects downtown Seattle to SeaTac International Airport (Fig. 1). In July 2008, households proximal (<1 mile) or distal (>1 mile) from planned link light rail stations were sampled and one adult from each household was recruited for the TRAC study if they were aged 18 or older, able to complete a travel diary and survey in English, and able to walk unassisted for ≥ 10 minutes. The spatial sampling frame covered 773 Census block groups with a similar range of household income, race, home values, net residential density, housing type, availability of proximate neighborhood services, and levels of bus ridership (Moudon et al., 2009). Eligible households in identified areas were contacted via address and telephone information from marketing companies. For the present analysis, only those who did not change home address from baseline to post 1 were included.

Under the assumption that the 1-mile distance was the longest distance that people would be willing to walk to LRT (Beimborn et al., 2003; Dill, 2008; Kim et al., 2007; Stringham, 1982; Weinstein Agrawal et al., 2008; Wibowo and Olszewski, 2005), the present analysis included all participants who could potentially walk from home to a LRT station. A total of 214 participants living <1 mile of one of the LRT stations were selected from the baseline (2008–2009) and post 1 (2010–2011) sample. Preliminary analyses compared the sample of 214 to 62 participants who lived within <1 mile of one of the 13 LRT stations at baseline, but were excluded from the analysis because they did not participate in post 1 ($n=46$) or moved their residential locations ($n=16$). The two groups did not significantly differ on gender or race/ethnicity, based on a 2-sample test for equality of proportions with continuity correction. However, compared at baseline to those excluded, the analytic sample contained a smaller proportion aged <40 (12% vs 35%, $p<0.001$), with income <50 K (35% vs 53%, $p=0.016$) and with overweight or obese weight status (50% vs. 70%, $p<0.001$).

2.2. Data collection

At each time point, participants were mailed an accelerometer (Actigraph GT1M), portable GPS device (GlobalSat DG-100), and a 7-day paper travel log. Participants were also provided a written or on-line (based on their preference) attitudinal and

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