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Bicycle boulevards and changes in physical activity and active transportation: Findings from a natural experiment

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ABSTRACT

Objective. This study evaluates changes in physical activity and active transportation associated with installation of new bicycle boulevards.

Methods. This natural experiment study uses data from a longitudinal panel of adults with children ($n = 353$) in Portland, OR. Activity and active transportation outcomes were measured with GPS and accelerometers worn for up to 5 days in 2010–11 and 2012–13. The effect of the treatment was estimated using difference in differences estimation and multivariate regression models.

Results. In five of the seven models, the interaction term was not significant, indicating that after controlling for the main effects of time and exposure separately, there was no correlation between being in a treatment area and minutes of moderate and vigorous physical activity (MVPA) per day, bicycling >10 min, walking >20 min, minutes of walking (if >20), or making a bike trip. Significant covariates included rain, being female, living closer to downtown, and attitudes towards bicycling, walking, and car safety.

Conclusion. This study could not confirm an increase in physical activity or active transportation among adults with children living near newly installed bicycle boulevards. Additional pre/post studies are encouraged, as well as research on the length of time after installation that behavior change is likely to occur.

Introduction

Having safe places to bicycle is important in achieving higher levels of cycling among both adults (Handy and Xing, 2011; Heinen et al., 2010; Sallis et al., 2013) and children (Stewart, 2011). Most research has focused on two types of infrastructure, on-street bicycle lanes and separated paths, which are the most common in North America (Pucher et al., 2010). Both striped bike lanes and separated paths have been correlated with bicycle commuting (Buehler and Pucher, 2012). Few observational studies have examined a third type of bicycle infrastructure: bicycle boulevards. Bicycle boulevards are low-volume streets, often residential, that use traffic calming, diversion, signage, and intersection treatments to reduce the speed and volume of motor vehicles and create a better environment for people on bicycles (National Association of City Transportation Officials, 2014; Walker et al., 2009). A study using GPS found that regular bicyclists went out of their way to use bicycle boulevards, more so than for striped bike lanes (Broach et al., 2012). A stated preference survey found that both current and potential cyclists had stronger preferences for residential streets with traffic calming than for major city streets with striped bike lanes (Winters and Teschke, 2010). In addition to infrastructure, several studies have found that attitudes can play a significant role in predicting whether and how much people bicycle (or bicycle and walk) (Cao et al., 2009; Handy and Xing, 2011; Heesch et al., 2012; Miller and Handy, 2012; Titze et al., 2007, 2008; Vernez-Moudon et al., 2005).

Several reviews of research assessing the effects of new infrastructure on bicycling and walking activity have noted the lack of prospective or longitudinal research designs, particularly with control groups (Krizek et al., 2009; Ogilvie et al., 2007; Pucher et al., 2010; Yang et al., 2010). A review of 52 studies of trails published between 1980 and 2008 only found one that included pre/post data with a comparison group (Starnes et al., 2011). That study (Brownson et al., 2004) examined the promotion of trails, not new trail construction, and did not find a significant change in overall walking activity. Similarly, two other longitudinal studies without controls did not find a change in walking activity associated with trail promotion (Merom et al., 2003) or trail construction (Evenson et al., 2005). All three of these studies used surveys and self-reported measures of activity. The studies of trail promotion (Brownson et al., 2004; Merom et al., 2003) conducted surveys immediately following the intervention, while Evenson et al. (2005) collected data two months following trail construction. A review of 25 studies of bicycle interventions identified three that included changes in bicycle infrastructure, all at a community- or city-scale, and all found significant increases in bicycling (Yang et al., 2010).

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The lack of longitudinal studies of infrastructure changes with adequate controls likely reflects the difficulties in conducting such research. In their review, Yang et al. (2010) noted the challenge of identifying appropriate controls and lack of agreement on how to measure bicycling behavior. Only two of the six studies of interventions that focused on bicycling had comparable outcome measures, limiting findings regarding effect sizes. Construction delay has been noted as a limitation in two "natural experiment" studies (Evenson et al., 2005; Ogilvie et al., 2010). The reliance on self-reported data noted by Yang et al. (2010) reflects the costs and respondent burden associated with more objective measures.

The aim of this study is to evaluate changes in physical activity and active transportation associated with installation of new bicycle boulevards using a longitudinal, panel design with a control group. Based upon existing cross-sectional research, we hypothesized that levels of active transportation would increase in the neighborhoods with the bicycle boulevard treatment, while controlling for socio-demographics and attitudes.

Methods

Recruitment and data collection

This analysis uses data from the Family Activity Study (FAS), a longitudinal panel study in Portland, Oregon, designed as a natural experiment. The study areas include 8 street segments scheduled by the city for bicycle boulevard installation (0.9 to 4.2 miles long) and 11 control street segments (1.0 to 5.7 miles long). The control streets were selected to be similar in urban form and demographic characteristics, particularly with respect to access to bicycle infrastructure, and were often parallel streets several blocks away. Households within 1000 ft of the selected streets were recruited to participate through a flyer left at the front door of every accessible housing unit and mailed invitations for inaccessible units ($n = 54{,}381$). Potential participants were screened for eligibility. At least one child aged 5 to 17 and one adult parent or guardian had to agree to participate for the length of the study; both had to be physically able to ride a bicycle, have access to a working bicycle, and not be intending to move in the near future. Participants were not told that the study was related to installation of bicycle boulevards or any other infrastructure. A total of 335 families participated in the pre-data collection phase, representing 3.1% of the estimated eligible population (American Community Survey 2007–2011 5-year estimates, households with children aged 6–17).

For data collection purposes, the sample consisted of two groups based upon the anticipated date of boulevard installation. Data collection dates and weather information for each group appear in Table 1. Both groups include both treatment and control households, and the groups are combined in the data analysis. Data collection methods at both points in time included surveys, accelerometers (Actigraph GT3X), and person-based GPS (GlobalSat DG-100, 4-second intervals). Survey instruments and data collection protocols were approved by the Human Subjects Research Review Committee at Portland State University. Participants were asked to wear the GPS and accelerometer units for five consecutive days. Deployments were scheduled to include at least one weekend day, and post deployments were usually scheduled to start within one week (two years later) of the pre deployment. GPS and accelerometer data were processed by the research team and GeoStats (now Westat) to match the GPS and accelerometer data streams (fifteen-second epochs) based on date/time stamps.

This analysis presents data from the adults in the study. The number of adult study participants with valid data in each phase is shown in Table 2. Retention in the study was higher among the treatment group. This may reflect one limitation of a natural experiment. The city may have chosen to install bicycle boulevards in locations where residents were supportive of new bicycle infrastructure. This could correlate with stronger interest in the study, though study participants were not told that the study purpose was to evaluate the effect of the new facilities.

Table 2
Number of participants with valid data, by phase and group.

	Group	Pre[a]	Pre & post[b]	Retention
3 or more 10+ hour days of activity data	All	429	293	68%
	Treatment	215	154	72%
	Control	214	139	65%
3 or more days of GPS data	All	471	341	72%
	Treatment	231	177	77%
	Control	240	164	68%
Survey completed	All	490	353	72%
	Treatment	237	183	77%
	Control	253	170	67%

Location: Portland, Oregon, USA.
[a] 2010-11.
[b] 2012-13.

Measures and sample characteristics

Demographics. Demographics were collected by survey and are shown in Table 3. Comparing the demographics of the participants with only pre data to those with both pre and post data, there were no differences with respect to gender or employment status. Retention was higher among adults who were in excellent health (self-reported), had lower BMI (based upon self-reported data), were married, and were college graduates. For participants with both pre and post data, the adults in the treatment group were slightly more likely to be employed full-time, be married, and have a four-year college degree.

Objective environment. Data from the Regional Land Information System (RLIS) maintained by the Portland regional planning agency (Metro) and the City of Portland Bureau of Transportation was used to develop objective measures of the environment. The treatment and control households are in predominantly single-family neighborhoods with equal access to bike lanes (Table 4). The treatment households have better access to sidewalks and are somewhat closer to downtown.

Data from the NOAA Global Historical Climatology Network was used for the number of days of rain during the GPS data collection days. Data are from the Portland International Airport station, which is within 2–9 miles of each of the study areas.

Attitudes. Attitudes towards bicycling, walking, and driving were measured using a series of questions developed by Mokhtarian and Handy (Cao et al., 2006) and a 5-point scale (1 = strongly disagree to 5 = strongly agree). A variable measuring attitudes toward bicycling is the average response to the following statements: I like riding a bike, biking can sometimes be easier for me than driving, and I prefer to bike rather than drive whenever possible (Cronbach's alpha = 0.840). Similarly, the walking attitudes variable is the average response to the following statements: I like walking, walking can sometimes be easier for me than driving, and I prefer to walk rather than drive whenever possible (Cronbach's alpha = 0.658). Attitudes towards the relative safety of a car was measured by the following statements: traveling by car is safer

Table 1
Data collection timeframe.

	Group 1	Group 2
Pre-installation	$n = 307$ adults July 17, 2010 to November 8, 2010 High temperature (F): 51–98, avg. = 72 Low temperature (F): 38–63, avg. = 53	$n = 183$ adults April 27, 2011 to September 4, 2011 High temperature (F): 52–96, avg. = 72 Low temperature (F): 38–66, avg. = 53
Post-installation	$n = 240$ adults August 1, 2012 – November 4, 2012 High temperature range (F): 52–102, avg. = 75 Low temperature range (F): 40–65, avg. = 53	$n = 123$ adults April 27, 2013 – August 6, 2013 High temperature range (F): 50–97, avg. = 76 Low temperature range (F): 40–66, avg. = 54