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Environmental and demographic correlates of bicycling

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ABSTRACT

Objective. The present study examined correlates of bicycle ownership and bicycling frequency, and projected increases in cycling if perceived safety from cars was improved.

Methods. Participants were 1780 adults aged 20–65 recruited from the Seattle, Washington and Baltimore, Maryland regions (48% female; 25% ethnic/racial minority) and studied in 2002–2005. Bicycling outcomes were assessed by survey. Multivariable models were conducted to examine demographic and built environment correlates of bicycling outcomes.

Results. About 71% of the sample owned bicycles, but 60% of those did not report cycling. Among bicycle owners, frequency of riding was greater among young, male, White, educated, and lean subgroups. Neighborhood walkability measures within 1 km were not consistently related to bicycling. For the whole sample, bicycling at least once per week was projected to increase from 9% to 39% if bicycling was safe from cars. Ethnic-racial minority groups and those in the least safe neighborhoods for bicycling had greater projected increases in cycling if safety from traffic was improved.

Conclusion. Implementing measures to improve bicyclists' safety from cars would primarily benefit racial-ethnic groups who cycle less but have higher rates of chronic diseases, as well as those who currently feel least safe bicycling.

Introduction

Bicycling is the least-used mode of transportation in the United States, but more bicycling could yield health and environmental benefits (Pucher and Buehler, 2012; Pucher et al., 2010a). At 1% of all trips, bicycling rates in the US are among the lowest in the world (Pucher et al., 2010a; Reynolds et al., 2009). Improved understanding of factors related to bicycling could provide an empirical basis for effective interventions targeted at populations who could benefit most. Access to a bicycle is the top predictor of bicycling for transportation (Cao et al., 2009; Pucher et al., 2010b). Fear of injury from cars is a major determinant of cycling decisions (Dill, 2009; Handy et al., 2002; Pucher and Buehler, 2012; Shenassa et al., 2006; Wood et al., 2007). Living in a walkable neighborhood is correlated with cycling (Dill and Carr, 2003; Krizek et al., 2009; Nelson and Allen, 1997; Reynolds et al., 2009; Van Dyck et al., 2010).

The aims of the present cross-sectional study were to: (1) evaluate environmental and demographic correlates of bicycle ownership and current bicycling frequency, and (2) assess the correlates of self-projected increases in cycling if safety from cars was improved.

Methods

Study design

The present paper used data from the Neighborhood Quality of Life Study (NQLS), an observational study conducted from 2002 to 2005 in King County-Seattle, WA and Baltimore, MD-Washington DC regions. NQLS compared physical activity and health outcomes of residents of neighborhoods that differed on "walkability" and census-based median household income. Details of study design, neighborhood selection, and participant recruitment have been reported (Frank et al., 2010; Sallis et al., 2009) but are summarized here. The study was approved by institutional review boards at participating academic institutions, and participants gave written informed consent.

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Neighborhood selection

A "walkability index" was computed (Frank et al., 2010) as a weighted sum of four standardized measures in geographic information systems (GIS) at the census block group level: (a) net residential density; (b) retail floor area ratio (retail building square footage divided by retail land square footage, with higher values reflecting pedestrian-oriented design); (c) land use mix (diversity of 5 types of land uses); and (d) intersection density. The walkability index has been related to total physical activity and walking for transportation (Owen et al., 2007; Sallis et al., 2009).

Block groups were ranked by walkability index separately for each region, then divided into deciles. Deciles were used to define "high" versus "low" walkability areas. Block groups were ranked on census-defined median household income, deciled, and deciles were used to define "high" versus "low" income areas. The "walkability" and "income" characteristics of each block group were crossed (low/high walkability × low/high income) to identify block groups that met definitions of study "quadrants." Contiguous block groups were combined to approximate "neighborhoods", and 32 total neighborhoods (8 per quadrant) were selected.

Recruitment

Participants were recruited from the selected neighborhoods, with study eligibility established by age (20–65 years), not living in a group establishment, ability to walk, and capacity to complete surveys in English. Participants were contacted for recruitment by mail and telephone in random order within study neighborhoods (balanced by quadrant). All study materials were sent by mail, with an option to complete surveys online or return by mail (Sallis et al., 2009). A total of 2199 participants completed an initial survey, and n = 1745 (79%) of these returned a second survey six months later. Because the bicycling-related items were in the second survey, the sample for present analyses was 1745.

About half of the sample were men (51.7%), and the mean age was 46 years (SD = 10.6). The majority of participants identified themselves as Caucasian (75.1%, White non-Hispanic), with other groups including African Americans (12.1%), Asian Americans (5.6%), and Hispanic/Mexican/Latin American (3.3%). BMI ranged from 15.0 to 62.6 (M = 26.7, SD = 5.5). The sample was well educated with only 8% having a high school education or less, 24.7% with some college, 34.6% with a college degree, and 32.7% with a graduate degree.

Measures

Bicycling behavior and perception

Access to a bicycle in the home, yard, or apartment complex was assessed by one item in a yes/no format (Sallis et al., 1997). Bicycling frequency questions were based on a previous study and excluded stationary biking (Frank et al., 2001). Biking frequency was assessed through the question, "How often do you bicycle, either in your neighborhood or starting from your neighborhood?" (Frank et al., 2001). Five response options ranged from "never" to "every day". An additional question was developed by NQLS researchers: "How often would you bike if you thought it was safe from cars?" Response options were the same as for current bicycling frequency. Projected changes in bicycling frequency if participants thought riding was safe from cars were computed by "frequency if safer" minus "current frequency".

Objective environment — walkability

The GIS-based block group walkability procedures for neighborhood selection (described above) were modified to construct GIS walkability measures for each participant using a 1000-meter street network buffer around the residence (Frank et al., 2010; Saelens et al., 2012). The four components, along with the walkability index, were analyzed, all at the individual level.

Perceived environment survey

The Neighborhood Environment Walkability Scale (NEWS) assessed perceived environmental variables thought to be related to physical activity (Saelens et al., 2003). Test–retest reliability and validity of NEWS have been supported (Brownson et al., 2004; De Bourdeaudhuij et al., 2003; Saelens et al., 2003). Eight established subscales were analyzed: residential density, land use mix-diversity, land use mix-access, connectivity, pedestrian/bicycling facilities, aesthetics, safety from traffic, and safety from crime. All subscales were coded so higher scores were expected to be related to more physical activity.

Four items within the NEWS with particular relevance to bicycling were selected for exploratory analyses based on previous findings (Moritz, 1998; Vernez-Moudon et al., 2005; Wardman et al., 2007): "parking is difficult in local shopping areas," "neighborhood streets are hilly, making walking difficult," "bike/pedestrian trails are easy to get to," and "it is safe to bike in my neighborhood." Response options were strongly disagree (1) to strongly agree (4). For comparability to previous studies, these items were also retained in the original subscales.

Body mass index (BMI)

Self-reported weight in kilograms and height in meters were used to calculate BMI = weight/height^2.

Demographic variables

Region (Seattle/King County or Maryland/Washington, DC region), gender, age, education level, ethnicity, marital status, and number of vehicles per adult in the household were included as covariates.

Data analysis

SPSS version 17.0 was used for analyses. Because the study design involved recruitment of participants clustered within 32 neighborhoods pre-selected to fall within the quadrants representing high/low-walkability by high/low-income, intraclass correlations (ICCs) reflecting any covariation among participants clustered within the same neighborhoods were computed for the bicycling frequency measures. The ICCs were very near or equal to zero: current biking frequency, ICC = 0.011; biking frequency if safer from cars, ICC =0.000; and difference score (i.e., difference between current biking frequency and frequency if safer from cars), ICC = 0.009. Because the ICCs were zero or almost zero, negligible random clustering effects were expected, and traditional regression procedures were used.

All variables were treated as continuous/ordinal except bicycle ownership (yes/no) and five demographic variables: region, sex, ethnicity (White non-Hispanic, vs. others), education (at least a college degree, vs. less than a college degree), and marital status (married or cohabiting vs. other).

The first group of analyses examined all environmental and demographic variables by bike ownership. Binary logistic regression was used to identify significant associations with bike ownership in separate models for each potential correlate.

The second set of analyses used linear regression procedures to examine bivariate correlates of the bicycling frequency outcomes: (a) frequency of biking (bike owners only) and (b) self-projected change (difference score) in bicycling frequency if participants thought riding was safe from cars. Although these outcome variables were somewhat skewed (+2.0 and +1.0, respectively), these skewness values fall within ranges of commonly used rules of thumb, especially when using ANOVA/regression procedures that are considered robust to non-normality (van Belle, 2002, p. 10). Thus, it was judged preferable to retain the original units (e.g., 5-point ordinal categories) rather than transform the ordinal categories to log-units. Each environmental and demographic correlate was examined in separate analyses.

The third group of analyses investigated whether variables significant ($p < .10$) in bivariate analyses remained significant ($p \leq .05$) in multivariable regression models. Multivariable binary logistic regression was used to evaluate the correlates of bike ownership; and multivariable linear regression models evaluated riding frequency (bicycle owners only), and projected change in biking if it was safe from cars (entire sample). Backwards elimination procedures were used to remove the non-significant correlates.

Results

Table 1 presents bivariate correlates of the three bicycling variables. Table 2 presents three multivariable models with variables that remained independently significant ($p < .05$) across the bicycling variables.

Correlates of bicycle access/ownership

Approximately 71% of participants reported access to a bicycle (i.e., owners). In multivariable models (Table 2), the odds of bicycle