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Income inequalities in Bike Score and bicycling to work in Canada

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A B S T R A C T

The purpose of this study was to examine income inequalities in Bike Score and bicycle to work mode share, a health enhancing form of physical activity, at the census tract level in Canada. This ecological study examined associations between income quintiles and availability of cycling infrastructure and cycling behaviour in 1282 census tracts in 8 cities in Canada. The outcomes were Bike Score, its components (Bike Lane Score, Hill Score, and Destinations and Connectivity Score), and bicycle to work mode share. Quintiles of median income were calculated from the 2011 National Household Survey Data. We used linear and negative binomial regression with city level fixed effects, and controlled for unemployment, home ownership, total population, and number of new immigrants in the last 5 years in the census tract to examine social inequalities in environmental supports for cycling and bicycling behaviour. The mean Bike Score and bicycle to work mode share across all census tracts were 72.4 (SD = 16.9) and 2.6 (SD = 4.0), respectively. Final regression models showed significant income quintile gradients for Bike Score and Bike Lane Score. For bicycle to work mode share, higher income areas had significantly greater cycling compared to the lowest income areas, although there was not a consistent trend across quintiles. Our results show some income inequalities are present in the availability and quality of cycling infrastructure in several Canadian cities.

1. Introduction

Increasing active transportation has the potential to increase population health via physical activity (Tainio et al., 2016; Woodcock et al., 2014). Creating environments that facilitate safe cycling, in the form of cycling infrastructure, is an important population level intervention to increase cycling. Population health research is also concerned with equity aspects of population level interventions (Frohlich and Potvin, 2008).

Public health researchers are also concerned that a focus on active transportation will not address larger social structural factors, such as poverty (Chaufan et al., 2014). While, this may be the case, limited research has quantified inequalities in access and use of cycling infrastructure in North America. A recent review of equity in active transportation suggests that high quality data in multiple cities are not available to assess equity in cycling (Lee and Sener, 2016). An important challenge with examining equity in cycling research is the quantification of cycling infrastructure. Previous work developed an index called Bike Score, which is associated with cycling at the census tract level in North America (Winters et al., 2016).

The purpose of this study was to examine income inequalities in cycling and factors that support cycling at the census tract level. We hypothesized that income inequalities would be present for all factors.

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2. Methods

This ecological study examined income inequalities in the associations between Bike Score and bicycle to work mode share (2011 National Household Survey Data) in 1282 census tracts in 8 Canadian Census Metropolitan Areas (Calgary, Halifax, Moncton, Montreal, Saskatoon, Toronto, Vancouver, and Victoria). Collectively the 8 cities have 2961 census tracts, however, Bike Score data were only available for 1306 census tracts. Census tracts (n = 24) from St. John's, NL were removed because there was no cycling to work reported.

The outcomes were Bike Score (and components) and bicycle to work mode share. Bike Score is a weighted sum of environmental components: Bike Lane Score (cycling infrastructure, weight = 50%), Hill Score (topography, weight = 25%), and Destinations and Connectivity Score (weight = 25%). Bike Score and components range between 0 and 100. The data for Bike Score (and components) is from 2012, and is described elsewhere (Winters et al., 2016). Bicycle to work mode share is the percentage of people who report using bicycles as their primary mode of transportation to work. We created quintiles of individual median income before tax of those 15 years and over at the census tract level across the 1282 census tracts, using 2011 National Household Survey Data (Statistics Canada. National Household Survey, 2017), where Quintile 1 is the lowest income, and Quintile 5 is the highest income.

Potential confounding variables included in the models were also from the 2011 National Household Survey, and included the unemployment rate (% unemployed), the total number of private household owners, the total population number of new immigrants in the last 5 years, and the total population of the census tract. Covariates were selected to represent area housing stability, immigration, and employment characteristics. Population density is included within the Destinations and Connectivity Score of Bike Score, and we do not adjust for it.

2.1. Analysis

We used linear and negative binomial regression to examine income inequalities in Bike Score and components (linear), and bicycle to work mode share (negative binomial). The modeling approach included 3 steps. First, bivariate associations between income quintile and each outcome were examined. Second, city level fixed effects were added. Third, potential confounders were added. We also used pairwise comparisons to examine whether a significant income gradient was present for each outcome. The analysis is available in the online supplement.

3. Results

Table 1 shows descriptive statistics for each outcome. Across the 1282 census tracts, mean Bike Score was 72.4 (SD = 16.9), and for the three components: Hill Score (mean = 93.6, SD = 11.7), Destination and Connectivity Score (mean = 75.5, SD = 27.6), Bike Lane Score (mean = 60.6, SD = 32.7). Bicycling mode share was low overall, with a mean of 2.6% (SD = 4.0). In the lowest income quintile (Q1), the median of median individual income was $19,784 CAD, compared with $43,660 CAD in the highest income quintile (Q5).

Inequalities by median income in Bike Score showed a gradient pattern (see Table 2 and Fig. 1A & B), with quintiles 3 through 5 having significantly greater scores than the lowest income quintile, meaning that lower income neighbourhoods overall had a fewer bike lanes but tended to be hillier. Amongst the components, the Bike Lane Score showed this same trend but with a greater magnitude of effect, where areas in the highest income quintile had a Bike Lane Score 17 points greater than those in the lowest income quintile, on average.

The other two components did not show the same patterns with income. For Hill Score, higher values reflect areas with less topography, and better for cycling. On the whole there was limited variability in mean Hill Score across quintiles of income (95.7 in lowest income quintile versus 88.7 in highest quintile). Regression results for Hill Score (Table 2) show in fact that areas in the lower income quintile have flatter environments, likely to be better for cycling. The Destinations and Connectivity Score did not show any significant trend with income in regression analysis.

The negative binomial regression results showed income inequalities in bicycle to work mode share, with 2 times more cycling in higher income areas as compared to lower income areas. While income quintiles 3 through 5 were significantly greater than the lowest income quintile, there was limited evidence of an income gradient as pairwise comparisons were not significant.

Table 1
Descriptive statistics for Bike Score, Bike Lane Score, Hill Score, Destinations and Connectivity Score, Cycling to work mode share, and income by income quintile and overall in 1282 census tracts in 8 Canadian Cities.

Income Quintile	Bike Score (mean (SD))	Bike Lane Score (mean (SD))	Hill Score (mean (SD))	Destinations and Connectivity Score, (mean (SD))	Cycling to Work Mode Share (mean (SD))	Income (median (IQR))
Low	71.7 (17.6)	52.3 (34.0)	95.7 (9.1)	87.1 (15.2)	1.9 (3.2)	$19,784 ($2608)
Q2	69.5 (17.9)	50.5 (33.1)	95.9 (8.5)	81.6 (21.9)	2.7 (4.2)	$23,787 ($1753)
Q3	72.7 (16.8)	59.7 (31.2)	95.3 (11.5)	76.7 (26.0)	3.4 (4.9)	$27,779 ($2561)
Q4	74.9 (16.6)	68.0 (31.1)	92.0 (13.2)	72.3 (28.8)	3.0 (4.1)	$34,775 ($3418)
High	73.1 (15.3)	72.3 (28.8)	88.7 (13.5)	60.1 (34.5)	2.0 (2.7)	$43,660 ($8462)
Overall	72.4 (16.9)	60.6 (32.7)	93.6 (11.7)	75.5 (27.6)	2.6 (4.0)	$27,778 ($13359)