

Health Promoting Community Design

Route Preferences Among Adults in the Near Market for Bicycling: Findings of the Cycling in Cities Study

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Abstract

Purpose. To provide evidence about the types of transportation infrastructure that support bicycling.

Design. Population-based survey with pictures to depict 16 route types.

Setting. Metro Vancouver, Canada.

Subjects. 1402 adult current and potential cyclists, i.e., the “near market” for cycling (representing 31% of the population).

Measures. Preference scores for each infrastructure type (scale from -1 , very unlikely to use, to $+1$, very likely to use); current frequency of use of each infrastructure type (mean number of times/y).

Analyses. Descriptive statistics across demographic segments; multiple linear regression.

Results. Most respondents were likely or very likely to choose to cycle on the following broad route categories: off-street paths (71%–85% of respondents); physically separated routes next to major roads (71%); and residential routes (48%–65%). Rural roads (21%–49%) and routes on major streets (16%–52%) were least likely to be chosen. Within the broad categories, routes with traffic calming, bike lanes, paved surfaces, and no on-street parking were preferred, resulting in increases in likelihood of choosing the route from 12% to 37%. Findings indicate a marked disparity between preferred cycling infrastructure and the route types that were currently available and commonly used.

Conclusion. This study provides evidence for urban planners about bicycling infrastructure designs that could lead to an increase in active transportation. (*Am J Health Promot* 2010;25[1]:40–47.)

Key Words: Bicycle, Survey, Infrastructure, Mode Share, Nonmotorized Transport, Stated Preference, Prevention Research. Manuscript format: research; Research purpose: descriptive; Study design: nonexperimental; Outcome measure: behavioral; Setting: local community; Health focus: fitness/physical activity; Strategy: built environment, policy; Target population: adults; Target population circumstances: geographic location

PURPOSE

The promotion of active transportation is a promising path to improve public health, addressing the widespread levels of inactivity in the population¹ and simultaneously reducing air and noise pollution through the replacement of car trips by walking or cycling.² Currently fewer than 10% of working Canadians commute by these active transportation modes.³ Cycling mode shares in Canadian cities (~2% of trips) are much lower than walking mode shares (~10% of trips), and are very low compared to those in European regions with similar climates and demographics (15%–30% of trips in Germany, Denmark, and the Netherlands).⁴ Therefore, increasing cycling for transportation offers one of the greatest opportunities for change, with potential corresponding benefits in physical activity levels and public health.

The goal of increasing population-wide physical activity levels calls for a shift from individual-focused programs to widespread environmental and policy interventions.⁵ Commuting by walking or cycling integrates physical activity into daily travel routines, providing a more sustainable means of meeting recommended levels of physical activity than tailored structured activity programs (e.g., going to the gym).^{6,7} Creating physical environments for activity that are safe, convenient, and attractive can have a positive influence that extends to the whole population.^{5,8}

Recent literature has established the linkage between urban form and travel behavior.^{9–11} However, to effectively

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modify the design of the transportation network to induce a mode shift onto bicycles and out of cars, there is a need for more detailed evidence on the specific types of infrastructure that are preferred by potential users. One planning approach would be to adopt infrastructure types similar to those that exist in regions with higher cycling mode share, such as the off-road or physically separated routes typical in European countries.¹² Alternatively, there are market research surveys that have elucidated preferences using very broad categories of infrastructure (e.g., “lanes” vs. “paths”), but often without visual aids to ensure a common understanding of terminology.^{13–16}

Studies on cycling infrastructure are heavily influenced by the population under study, because preferences for facilities may differ according to cycling experience or other personal traits.^{17–19} Some surveys have sampled from the full adult population, including both cyclists and noncyclists.^{13–15} Other studies have focused on frequent cyclists, recruiting from bicycle-related clubs and listserves, stopping cyclists on the road,^{19,20} or tagging parked bicycles.²¹ Others still have studied specific populations such as university staff or students.²² A strategic approach for increasing mode share is to survey the “near market” for cycling, that is, members of the population most likely to be willing and interested to make changes in their travel behavior. This group includes current cyclists who could cycle more frequently as well as noncyclists who are willing to start cycling (“contemplators”²³).

We conducted a population-based survey of adults in the near market for cycling in the Metro Vancouver region of Canada. We asked about their likelihood of choosing to cycle on 16 different route types, using a Web or mailed survey instrument that included multiple photos of each of the infrastructure types. We also asked how frequently they currently used the same route types, to determine whether the routes used differed from the routes preferred. The goal was to provide evidence for urban cycling infrastructure development to promote a substantial increase in cycling mode share and attract a new wave of cyclists.

METHODS

Location

Metro Vancouver is comprised of 22 municipalities with widely varying neighborhood characteristics and transportation infrastructure. The region is home to approximately 2.1 million people.²⁴ Bicycle mode share is estimated at 1.7% region-wide, and about 3.1% within the city of Vancouver.²⁵ The regional bicycle route network has over 1350 km of designated bicycle routes, ranging from paved off-road cycling paths, to residential streets with signage only to on-road bicycle lanes.²⁵ The climate is conducive to cycling year-round, with all monthly average low temperatures above freezing.

Design

The survey instruments were developed after an extensive review of the literature, which identified 70 studies and 40 surveys related to the choice of cycling as a mode of transport. The literature provided a broad range of data elements used as the basis for designing two questionnaires that comprised this survey: a telephone interview, and a follow-up Web or mail survey. The questionnaires were refined by a broad range of people interested in cycling and transportation (bicycle coordinators from the participating municipalities, members of cycling advocacy groups, and the regional transportation authority, TransLink) and in six focus groups (in two locations and of differing cycling segments).

The telephone interview filtered participants for eligibility, and collected demographics, travel patterns, and mode choices. The self-administered follow-up survey asked about current use of and preference for 16 distinct route types using three photographs each to clearly identify different infrastructures.

Measures

The 16 route types can be broadly classified as: (1) major streets, (2) residential streets, (3) rural roads and highways, (4) off-street paths, and (5) cycle paths next to major roads but physically separated from traffic; additional detail covers road markings, bicycle lanes, traffic calming, route surfaces, and car parking. The current use question was “How often do you

currently cycle on this type of route?” and had a five-point response scale: never, less than once a year, 1 to 10 times a year, 1 to 10 times a month, and 3 or more times a week. The preference question was “If this and other route options were available, how likely are you to choose to cycle on this type of route?” with a five-point response scale: very unlikely to choose, unlikely to choose, neutral, likely to choose, and very likely to choose. Preference responses were scaled from –1 (very unlikely) to 0 (neutral) to +1 (very likely) for calculating and comparing mean scores. The questionnaire is available from the authors.

Sample

The study was conducted in three waves distributed throughout 2006, with the focus on travel patterns in the preceding 4 months. In each wave a random sample of names was selected from the telephone book and each was sent an introductory letter. In the second and third waves this was complemented by random digit dialing to increase recruitment. All study methods were reviewed and approved by the University of British Columbia’s Behavioural Research Ethics Board.

In total, 31% of the individuals contacted were current or potential cyclists (those who had access to a bicycle and who had either cycled in the past year or were willing to consider cycling in the future), and were therefore eligible and invited to participate. 2149 individuals completed telephone interviews (37% of those eligible). Of these, 1402 completed the Web/mail follow-up survey whose results are presented here. This subset did not differ demographically from those who completed the telephone interview, with the exception of potential cyclists (who comprised 19.5% of the telephone survey respondents, but only 13.8% of the follow-up).

Analysis

Analyses included descriptive statistics and multiple linear regression using the SAS version 9.1 (Cary, North Carolina) statistical package. Responses were weighted to reflect the age, gender, and geographic distributions of the region. Because of the large sample size, very small differences between groups were statistically sig-

Table
Demographic Characteristics of Web/Mail Survey Respondents in Metro Vancouver (n = 1402) According to Cyclist Segment

	Cyclist Segment*				Overall
	Potential	Occasional	Frequent	Regular	
Weighted % of total (n)	13.8 (197)	43.5 (617)	34.6 (481)	8.1 (107)	100 (1402)
Gender, Male	45.1	49.0	57.5	58.3	52.1
Age, y					
19–24	6.3	10.4	5.1	12.3	8.2
25–34	19.1	20.1	21.0	21.7	20.4
35–44	31.0	26.7	30.8	22.8	28.4
45–54	22.8	23.1	23.1	21.0	22.9
55–64	12.0	14.6	13.9	14.8	14.0
65 & older	8.8	5.0	5.9	6.5	6.0
Residence					
Vancouver	26.3	28.5	38.1	50.5	33.3
Other municipality	73.7	71.5	61.9	49.5	66.7
Education					
Some high school or less	2.1	0.9	0.7	1.0	1.0
Graduated high school or less	13.2	11.5	9.6	12.7	11.2
Some postsecondary	82.9	86.4	88.5	85.5	86.6
Employment					
Full-time	51.9	54.9	56.2	52.1	54.7
Part-time	11.2	12.3	11.7	11.5	11.9
Self-employed	8.7	11.3	11.9	16.5	11.6
Student	2.1	5.8	6.1	4.5	5.3
Retired	14.4	7.6	9.5	7.3	9.2
Not employed	8.8	6.4	3.3	5.3	5.6
Household income, \$/yr†					
<30,000	10.6	7.1	8.5	14.1	8.6
30,000–59,000	17.9	20.1	16.6	23.4	18.9
60,000–89,000	21.6	19.5	23.8	12.3	20.7
>90,000	30.3	32.7	30.0	33.2	31.5
Mean no. of children/ household	0.9	0.9	0.7	0.5	0.8
Access to car (yes)	96.7	95.4	94.0	78.4	93.7
Mean no. of motor vehicles/household	1.8	1.9	1.8	1.4	1.8
Mean no. of bicycles/household	2.4	2.9	3.0	3.6	2.9

* Potential cyclists, never in past year; occasional cyclists, 1–11 one-way trips per year; frequent cyclists, 12–51 one-way trips per year; regular cyclists, 52 or more one-way trips per year.

† 20.3% of responses to household income were “refused/don’t know”; all other variables had <2% “refused/don’t know/other” responses.

nificant. We have therefore not reported statistical significance, but instead focused our discussion on differences that are meaningful (i.e., percentage differences of at least 5%, mean score differences of at least .5, and trends across categories).

The population was segmented into four subpopulations: *regular cyclists* (who cycled at least once a week, i.e., cycled ≥ 52 trips/y); *frequent cyclists* (at least monthly, i.e., 12–51 trips/y); *occasional cyclists* (at least yearly, i.e., 1–11 trips/y); and *potential cyclists*, who had not cycled in the previous year, but would consider cycling in the future.

These annual trip frequencies were derived from responses for the number of one-way trips made by bicycle (for any trip purpose) in a typical week for the 4-month season prior to that study wave. Individuals who reported zero bicycle trips in that season (67%) were also asked whether they had made any trips in the year prior; these trips were also included in the annual trip frequency.

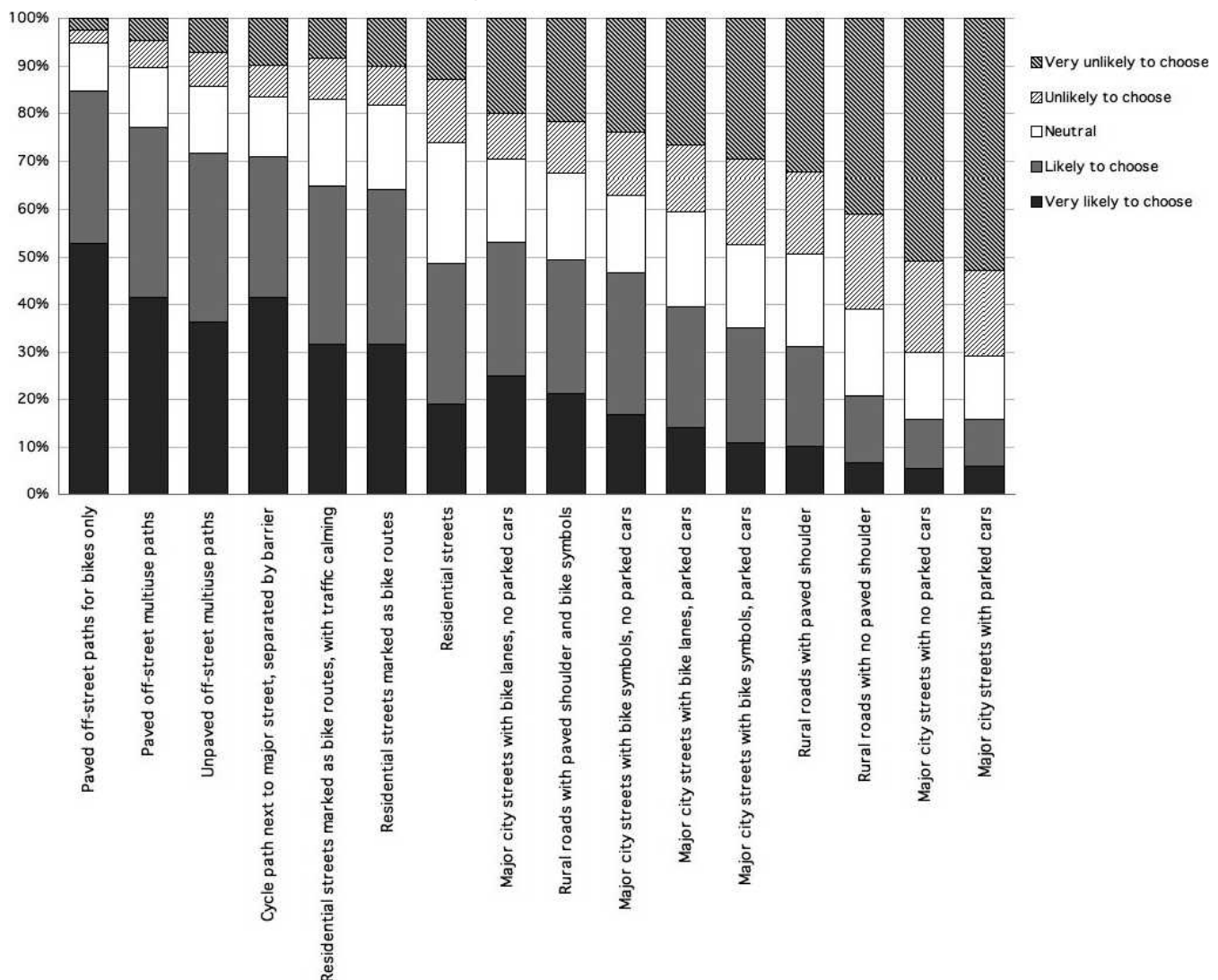
RESULTS

Demographics

Overall, 107 individuals were regular cyclists (weighted proportion = 8.1%),

481 were frequent cyclists (34.6%), 617 were occasional cyclists (43.5%), and the remaining 197 individuals were potential cyclists who had not cycled in the past year (13.8%). Demographic characteristics of each segment are summarized in the Table. Regular and frequent cyclists were more likely to be male (58.3% and 57.5%, respectively), and potential cyclists female (54.9%). Potential cyclists were older and more likely to be retired than the other segments. Most participants had access to a car (93.7%), although this percentage was lower for regular cyclists (78.4%). Regular cyclists were more

Figure 1
Likelihood of Choosing Route Type (if All Route Types Were Available) for 16 Cycling Route Types Among Current and Potential Cyclists in Metro Vancouver (n = 1402)



likely to live in the city of Vancouver (50.5%) than were other groups (26.3%–38.1% in Vancouver).

Preferences

There were clear differences in the desirability of route types (Figure 1). Off-street paths were the most preferred. Within this broad route type, nearly 85% of respondents said they would be likely or very likely to choose to ride on paved off-street paths for bikes only and 77% were likely to choose paved multiuse paths. About 71% of respondents were likely to choose unpaved multiuse paths, or

cycle paths next to major roads, separated by a physical barrier. Residential streets were the next most preferred route type (48%–65% likely to choose). Within this type, the presence of cycling facilities influenced preferences: residential streets designated as bike routes were preferred to those not designated, and routes with traffic calming were preferred to those without. Rural roads were less preferred (21%–49% likely to choose), but the value of cycling facilities was also observed within this classification; those with bike symbols were preferred to those with a paved shoulder, which

in turn were preferred to those with no paved shoulder. Among the major street route types (16%–52% likely to choose), routes with bike lanes were preferred to routes with only bike symbols, which were preferred to no markings at all. This was further modified by the presence of on-street parking; in all cases, the presence of on-street parking made a particular route type less favorable.

The two least preferred route types were major streets with no facilities, with or without parking (16% likely to choose). Only 79 respondents were “very likely” to choose to ride on

major streets with parked cars. They represented a unique subpopulation: 22.6% were regular cyclists (vs. 8.1% in the overall sample), and they were mainly male (66.5%), aged 25 to 34, with a lower likelihood of having children (22.3% vs. 46.8%).

Multiple linear regression models were run for the preferences scores for each of the 16 different route types, according to cyclist type, gender, age, education, household income, and having children. Cyclist segment and gender were consistently significant predictors of route type preferences. For example, in the model of preference score for “major city streets, with no facilities and no parked cars” (a low-preference route type), regular cyclists gave an average score .55 greater ($p < .0001$) than potential cyclists, and .23 greater ($p < .0001$) than occasional cyclists. Females scored this route type .23 lower on average. Other variables were not significant. Because results were similar across many models, the influences of demographics on preferences are best illustrated in Figures 2A and 2B.

Figure 2A shows preferences by cyclist segment. The rank order of preference for the route types varied little across cyclist type or other demographics, with one exception. Regular cyclists ranked unpaved off-street paths and residential streets without a cycling designation relatively lower than did other cyclist segments. The mean preference scores did vary by cyclist segment. For all route types, regular cyclists gave the highest scores, then frequent cyclists, then occasional cyclists, and finally potential cyclists. The largest differences were for the major street types.

Figure 2B shows preferences by sex. There were virtually no differences in mean scores between men and women for the six most preferred route types, but women scored the low preference routes even lower than men. Similarly, respondents with and without children in their household scored the six preferred route types the same, but those with children scored the low preference routes lower than those without (data not shown).

Current Use Patterns

For calculating the mean frequency of route use, each route use response

Figure 2
Mean Preference Score for 16 Route Types According to Cyclist Segment (A) and Gender (B)

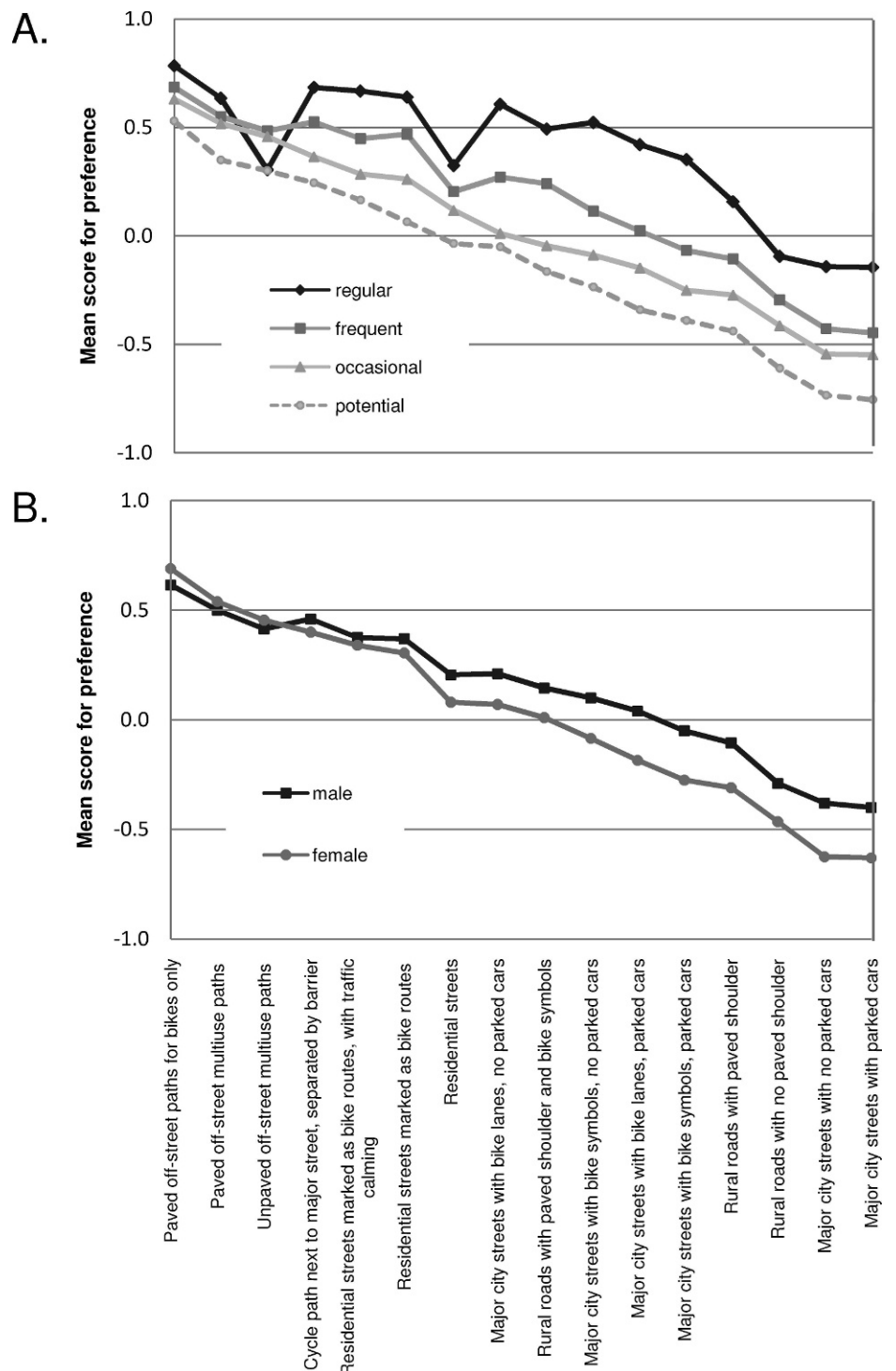
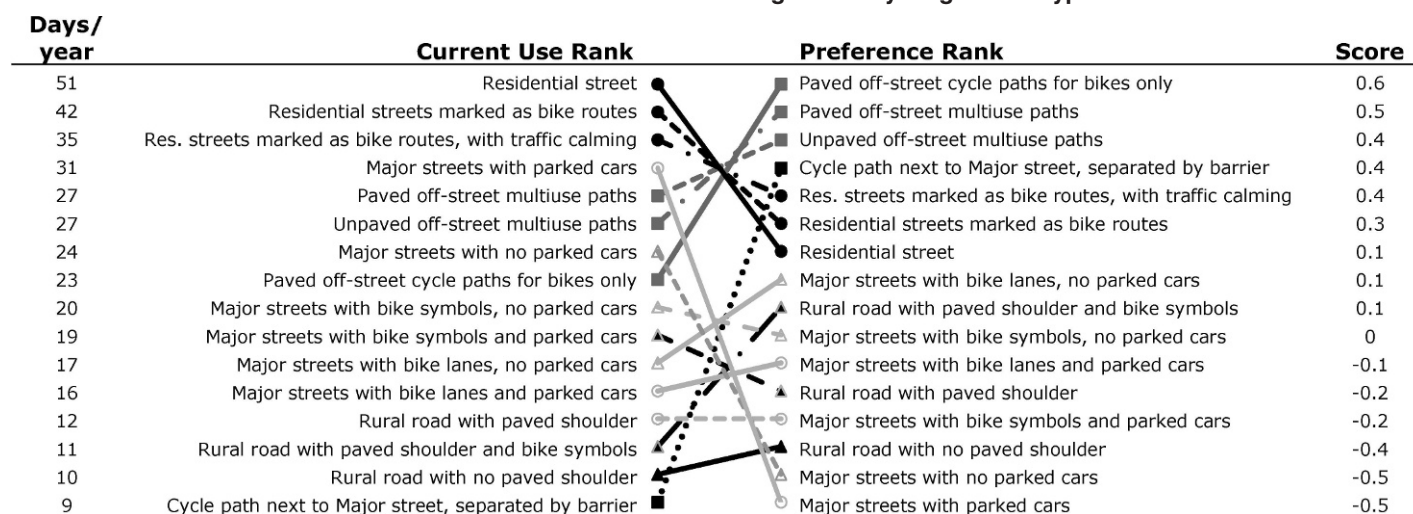


Figure 3
Current Use vs. Likelihood of Choosing for 16 Cycling Route Types



category was assigned a value slightly below its midpoint (e.g., “1–10 times per year” = 4 times per year), under the assumption that the underlying within-category distributions were right skewed.

The three residential route types were the most commonly used types of infrastructure, with average usages of 40 times/y for unmarked residential streets, 33 times/y for streets marked as bike routes, and 27 times/y for streets with traffic calming measures. Rural road route types and separated cycle paths next to major roads were the least commonly used (all <10 times/y). Usage patterns are included in Figure 3.

Current Use Versus Preferences

Figure 3 compares current use of the 16 route types to the route preferences. The crossing lines indicate a marked discrepancy between where people currently ride and where they would choose to ride were all route types available. For example, the most commonly used route type in the current street network, residential streets without bicycling features, ranked seventh of the 16 route types in terms of preference. Major city streets with parked cars were the fourth most commonly used route type, but were the least desirable.

Many route types that respondents would be very likely to choose were not routes with high current use, likely because these route types are not

widely available in Metro Vancouver. The most striking example is cycle paths next to a major street but separated by a barrier; these were third highest in preference, but the least used, because they are not commonly available in the region. As a route type group, off-street paths were the most likely to be chosen, but current usage was only moderate (ranked 5, 6, and 8 overall).

DISCUSSION

The Near Market for Cycling

This study characterizes the cycling patterns and preferences of the near market for cycling in the Metro Vancouver region. This population, comprised of those individuals who reported having cycled in the past year, or who were willing to cycle more in the future, represents those most likely to make a travel behavior shift that could increase cycling mode share. In total 31% of those contacted fit into this near market. Projected to the adult population of the region,²⁴ this represents about 500,000 adults; changing travel patterns in this population could have sizable health and environmental impacts.² Although 80% of survey respondents had cycled at least once in the past year, over half of these were only occasional cyclists, further indicating a great potential for change within this group.

Route Preferences

This survey asked about preferences for 16 different route types, allowing for differentiation between broad classes of routes (off-street, major roads, residential routes, and rural roads) by characteristics of the facility (presence of road markings, signage, car parking, and traffic calming). In general, off-street and separated paths were the most favored route types, followed by residential routes, then major and rural roads. Within each route type, those with more cycling facilities were preferred to those without, and for each case considered, a route type without parking was preferred over one with parking. For off-street paths, paved routes were preferred over unpaved routes, especially among regular cyclists.

These findings add enhanced detail to available evidence on route preferences. A study of current cyclists in Edmonton, Canada (n = 1128), quantified the relative burden of three different route types¹⁹ and found that cycling in mixed traffic (i.e., no facilities) was the least preferred: 1 minute in mixed traffic was equivalent to about 4 minutes on an on-street bike lane, or 3 minutes on a multiuse off-street bike path. A study of 167 university employee cyclists and noncyclists found that they preferred off-road facilities to bike lanes, bike lanes to no bike lanes, and routes without parking to those

with.²⁶ Our results differ from a U.S. survey that found that frequent cyclists were more likely to want on-road bike lanes than off-street paths, whereas infrequent cyclists did not differentiate between route types.¹⁶ The difference may be in the limited options provided to respondents in the U.S. survey.

To increase cycling mode share, one must motivate those who cycle least often to cycle more. This study found similar route preferences across frequent, occasional, and potential cyclists, making it straightforward to focus future infrastructure development. The top route types were paved off-street paths; cycle paths next to major streets separated by a barrier; and residential streets marked as bike routes, with traffic calming. Even among women and respondents with children in their household, subpopulations that were unlikely to choose many route types, these routes were highly ranked. This set of preferred route types would provide a variety of options to cyclists and transportation facility designers. The data on the least preferred route types also provide clear guidance to transportation planners on facility designs that are less likely to be effective additions to the bicycle network.

Some preferences of the regular cyclists differed from those of other cyclist types. Regular cyclists, on average, had a higher preference for nearly all route types. The one exception, unpaved multiuse paths, may be attributable to poor road surface conditions. It is notable that regular cyclists rated all major street route types substantially higher than did other cyclists. This concurs with other findings that those with more experience tend to be less averse to cycling in mixed traffic.¹⁹ These regular riders are a specialized group: they are avid cyclists, cycling at least once per week, and tend to be a young, mainly male population. Given their high preferences for nearly all route types, this group may not require special consideration in cycling network planning; they can be considered the “first wave” of cyclists, those who will cycle regardless of conditions.

Current Use Patterns Versus Preferences

The most commonly used routes were residential, followed by major streets and off-street paths, then rural roads. This order differs from the

findings of Aultmann-Hall et al., who mapped 397 trips by commuters in Guelph, Ontario, Canada, and found that 60% of total travel distance was on major roads, 35% on local streets, and only 5% on off-road paths or trails.²⁷ The contrast may be because of differences in the underlying transportation network and the availability of different route types between the two regions. In our study, the route type with the lowest reported current use was the physically separated cycle path next to a major route. Although the most highly used route types, residential streets and major streets without markings, are widely available, the physically separated cycle paths are very rare route types in Metro Vancouver (<500 m total at the time of this study) and indeed, much of North America. Variations of this type of facility appear in certain Canadian cities (e.g., Montreal) and are widely available in many European centers (e.g., Copenhagen and the Netherlands) where cycling modal shares are much higher.

There was great disparity between the route types that were in high use and those that were preferred. The most extreme case was the physically separated cycle path next to major streets: it was least commonly used, but just as desirable as unpaved off-street paths, or residential streets with bicycle facilities. This finding highlights one clear way to adapt the current road network so that it is more supportive of cyclists. Cyclists may perceive this route type as a safe way to access the many destinations located on major streets.

Study Strengths and Limitations

Strengths of this survey were that it included 16 different route types and used photos clearly illustrating the infrastructure types. The eventual use of a given route will depend on the subtleties of its design and placement within the road network. The connectivity of routes is key: another study showed commuter cyclists deviate very little from the shortest route between the origin and destination and that for off-street paths, well-connected paths with good surfaces were used significantly more than others.²⁷

Our survey was conducted in three waves throughout the year to ensure that route preferences and reported use were not influenced by the season

of questioning. The design of the questionnaire may have resulted in some misclassification of cyclist segment. Individuals who had made zero trips in the 4-month survey season were also asked whether they had made trips in the past year, and this was used to derive annual trip frequency. However, those individuals who reported at least one bike trip in the survey season ($n = 712$) were not asked about travel the past year, and their annual trip frequency was calculated solely from the number of trips in that season. This may lead to some misclassification of yearly, monthly, or weekly cyclists if this group of respondents cycled differently in the past 4 months than they had in the 8 months prior to that.

Finally, this study surveyed the near market for cycling, i.e., the 31% of individuals contacted who were current cyclists or would be willing to cycle in the future; thus, findings are not representative of the 69% of the population who did not have a bicycle or were unwilling to ride. Because the latter individuals were not currently willing to change their travel behavior to include cycling, there would be little immediate benefit in targeting interventions to them. We expect that with future development of the cycling infrastructure, the climate and culture for cycling across the region will become more inviting, and a greater number of people may become open to cycling.

In summary, these findings show that current and potential cyclists in Metro Vancouver express preferences for routes separated from traffic, in line with cycling infrastructure design in European centers with high cycling mode shares. This survey included two additional pieces that will be presented in future articles: responses to survey questions about the potential influence of 73 potential motivators and deterrents on the decision to cycle or not; and an analysis of trip data reported in the telephone survey with objectively mapped features of the trip environment (population density, land use mix, elevation changes, proximity to bicycling routes, route density, trip distances, etc.) to determine which influence actual choice of cycling. Combined, these subjective and objective data will provide an important body

of evidence that is crucial to guide policy decisions on bicycle infrastructure planning. We hope that continued research will build on our work, with the aim of quantifying how changes in cycling infrastructure impact cycling mode share and public health.

SO WHAT? Implications for Health Promotion Practitioners and Researchers

What is already known on this topic?

While safety and comfort have been identified as influences for bicycling, previous research on infrastructure has focused on the opinions or behavior of regular commuter bicyclists, and has used very general categories of route types (e.g., bike paths).

What does this article add?

This survey of 1,402 current and potential bicyclists in Metro Vancouver examined 16 route types and found a marked discrepancy the types of bicycle routes that are currently available, and what is preferred. Preferred routes are those separated from motor vehicle traffic, or, where routes are along the road network, those with enhanced bicycle amenities such as bike lanes and traffic calming. In all cases, the presence of on-street vehicle parking made a route type less desirable.

What are the implications for health promotion practice or research

Since these preferences were especially important to women, adults with children and others who cycle less frequently than the young male population, the findings provide key direction for urban planners and public health practitioners on how to design the transportation infrastructure to increase cycling modal share and support active transportation.

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