Increasing Cycling for Transportation Through Mentorship Programs

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Policy statements and planning documents of many North American municipalities recognize the benefits of increased cycling, however, rates of bicycling for transport remain low and programming interventions have been limited and rarely rigorously evaluated.

We investigate the impact of four cycling mentorship interventions based in non-cycling partner organization on: cycling behaviour, attitudes towards cycling, and willingness to spend on bicycles and accessories. Residents, mostly newcomers to Canada, participated in 12-16 week cycling mentorship programs, involving personal support from an experienced cyclist. They were provided with safety training, bicycles, locks and helmets and publicly committed to participate in the program. 146 of the 197 participants completed entry and exit surveys.

At program exit each participant cycled on average an additional 1.8 days per week to shopping ($p \leq 0.001$) and an additional 1.35 days per week to work and school ($p \leq 0.001$) compared to program entry. At program exit, participants were willing to spend 23% more on a bicycle and 32% more ($p < 0.01$) on accessories like carriers, helmets and locks. They were more confident about the rules of the road and were aware of safe streets for riding in their neighbourhood. They were less confident of finding a safe route and more aware of the relative rarity of women cyclists.

The programs were effective in increasing cycling for transport regardless of the distance people lived from their respective central business district. These results are promising and suggest that with sufficient support people will bicycle in neighbourhoods throughout the region. Increased availability of cycling infrastructure would likely increase confidence in finding a safe route and improve these results.

Keywords: bicycling, bicycle programming, active transport, mentorship, immigrant mobility

1. Introduction

North American municipalities continue to recognize the benefits of increased cycling, including reduced air pollution (Zahabi, Chang, Miranda-Morendo, & Patterson, 2016), public health benefits (Deenihan & Caulfield, 2014; Hendriksen, Simons, Garre, Hildebrandt, 2010; Grous, 2011), and a lessened strain on infrastructure budgets (Gosling & Choi, 2015). Cycling rates in some North American cities have risen significantly since 1990, at least doubling in Portland, Toronto, Montreal, Chicago, San Francisco, Vancouver, Washington, Minneapolis, and New York (Pucher, Buehler, & Seinen, 2011). Cities have primarily focused on improving cycling infrastructure to increase cycling mode share (Pucher, Buehler, & Seinen, 2011; Pucher, Dill & Handy, 2010) while also using public bike share systems as a means to increase supply of bicycles and establish the legitimacy of bicycling as transport (Fishman, 2013). However, rates of bicycling for transport remain extremely low and bicycle programming interventions have been very limited and rarely rigorously evaluated (Sersli, Devries, Gislason, Scott, & Winters, 2018).

It is widely accepted that the supply of cycling infrastructure correlates positively with cycling uptake (Dill, 2009; Dill & Carr, 2003; Vandenbulcke et al., 2011; Winters, Davidson, Kao & Tescke, 2011), however some cities' experiences suggest that infrastructure alone is not always successful (Aldred & Jungnickel, 2014; Hume, 2017; Larsen, 2017; Morgan, 2017). The effect of attitudes and social environments on cycling mode share is acknowledged, but less well explored in research and practice (Aldred & Jungnickel, 2014; Heinen et al., 2010; Larsen, 2017). High income/high cycling countries such as Netherlands, Denmark and Germany use all possible strategies to support cycling (Forsyth & Krizek, 2010; Larsen, 2017), while in North America, programming focused on modal shift at the municipal level typically does not focus

specifically on cycling, but rather on shifting mode share away from single occupancy vehicles

to a range of options including transit, car share, walking and cycling (Pucher, Dill, Handy,

2010).

This research investigates the impact of a series of four cycling-specific, program-based

interventions in the Greater Toronto and Hamilton Area on: travel behaviour, attitudes towards

cycling and willingness to spend on bicycles and accessories. Using the theoretical framework of

cycling adoption developed by integrating bicycling adoption literature with social psychology

literature in Savan, Cohlmeyer, and Ledsham (2017), researchers worked with both an

established and a pilot bike mentorship program to include behaviour change techniques from

the model and to apply the integrated steps to increase cycling adoption.

2. Setting

The four interventions discussed in this paper occurred in the Greater Toronto and Hamilton

Area (GTHA). Stretching 170km across, the GTHA encompasses 30 municipalities and its

population of 7.2 million is larger than Denmark's; but, with an area of just over 8K square

kilometres, it covers just 20% of Denmark's landmass. The region has a varied urban form and

multiple municipal level transport networks. Regional transportation planning occurs at the

GTHA level while local municipalities are responsible for most local transport planning

including active transportation.

There are dramatic differences in cycling levels between communities. The downtown

core of Toronto had a cycling mode share of 5% in 2011 (Ledsham & Savan, 2017) with some

neighbourhoods showing cycling commute rates of 34% in the 2016 census (Cycle Toronto,

2017). GTHA neighbourhoods outside of Toronto's downtown core received less cycling

infrastructure investment and in 2011 had a much lower cycling mode share of under 1% (Mitra

& Smith Lea, 2016) and the entire Toronto census metropolitan area had just a 1.6% cycling

commute rate (Statistics Canada, 2017).

3. Methods

3.1 Theoretical Approach

This work uses the cycling adoption cycle (Figure 1) presented in Savan, Cohlmeyer, and

Ledsham (2017). This approach was developed from an extensive literature review of cycling

initiatives and aligning them with established, evidence-based behaviour change techniques from

the social psychology literature. This literature is extensively used in public health and building

energy-use reduction interventions and some work has begun on application to shifting transport

behaviours to lower carbon modes (Guell, Panter, Jones, & Ogilvie, 2012; Van Acker, Van Wee,

& Witlox, 2010). The intervention cycle developed by Savan et al, 2017, emphasizes the circular

nature of change interventions and recommends repeating steps and techniques where necessary.

The theory is unique in its ability to take existing theory and apply it directly to cycling uptake.
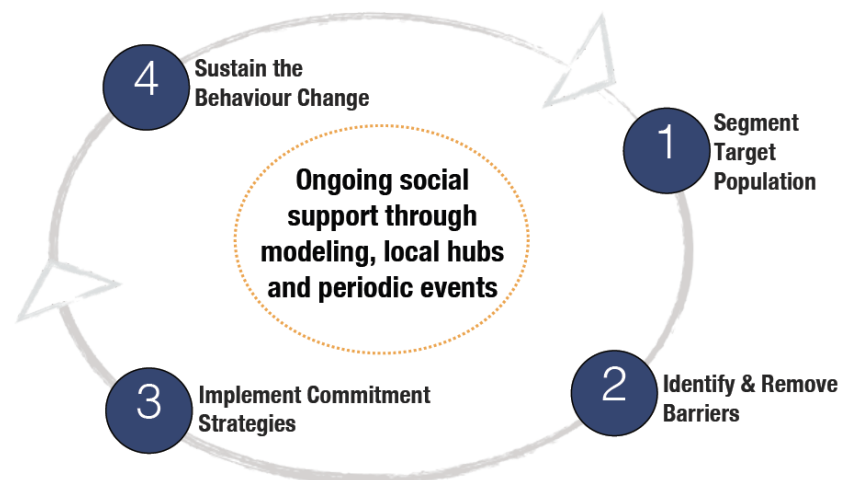

FIGURE 1. Cycling Adoption Theory Cycle: elements are presented in sequence but are circular in nature and repetition is part of the process. (Savan, Cohlmeyer & Ledsham, 2017)

Significant emphasis is placed on the importance of multifaceted approaches involving community partners and social support, making the Cycling Adoption Theory Cycle useful in developing the cycling interventions detailed and tested in this paper. CultureLink Settlement Services used the model above to refine the design of 'Bike Host', a bicycle intervention delivered in the City of Toronto. The Toronto Centre for Active Transportation used the model to design, the 'PedalWise' program, a pilot intervention delivered in the City of Brampton in the Region of Peel. The results of a comparison between matched entry and exit surveys by participants in the Bike Host program in 2015, 2016 and 2017 and the Pedalwise program in 2015 form the basis for this report.

3.2   Description of Cycling Interventions

3.2.1 Funding of Program Delivery and Research

Interventions and research were delivered and funded by a variety of agencies none of which provided consistent multi-year funding across both program delivery and research. As a result, the research was opportunistic, taking advantage of programs delivered independently of research funding which was leveraged to take advantage of program delivery by other agencies. See Table 1 for details. This funding structure made longer term research planning challenging and precluded consistent long-term follow-up. The interventions were delivered over the summers of 2015, 2016 & 2017 (June through September) and were 12 to 16 weeks in length depending on when participants were available to end the program and return their bikes.

Bike Host has been delivered in a variety of forms in Toronto since 2012. In 2015, CultureLink worked with researchers at the University of Toronto to reshape and refine the program to align with the evidence-based cycling adoption model (Figure 1). PedalWise was developed based on experience with Bike Host and the cycling adoption model.

TABLE 1Funding of Program Delivery & Research

Program	Year	Delivery Agency(s) (Lead in Bold)	Funding Source Program Delivery	Funding Sources Research
Pedalwise	2015	**Toronto Centre for Active Transportation,** CultureLink Settlement Services, Community Environment Alliance, BikeBrampton,	Region of Peel	Region of Peel, Partnership Development Grant Social Sciences and Humanities Research Council,
Bike Host	2015	**CultureLink Settlement & Community Services** & Cycle Toronto, South Riverdale Community Health Centre	Ontario Trillium Foundation	Partnership Development Grant Social Sciences and Humanities Research Council, Metcalf Foundation,
	2016	**CultureLink Settlement & Community Services**, Cycle Toronto, Toronto Centre for Active Transportation, Access Alliance, Birchmount Bluffs Neighbourhood Centre, South Riverdale Community Health Centre	Metcalf Foundation, Lawson Foundation	Insight Grant Social Sciences and Humanities Research Council, Mitacs
	2017	**CultureLink Settlement & Community Services,** Cycle Toronto, Toronto Centre for Active Transportation, Access Alliance, Birchmount Bluffs Neighbourhood Centre, South Riverdale Community Health Centre	Metcalf Foundation. Lawson Foundation, Cycle Toronto, MEC	Insight Grant Social Sciences and Humanities Research Council, Mitacs,

3.2.2 Program Elements

The four interventions consisted of the elements in Table 2 that align with the Cycling Adoption Theory (Figure 1).

TABLE 2. Program elements

Program Element	Cycling Adoption Theory Element (see Figure 1)
To enable social support, mentors:	
Were trained in safe cycling, interpersonal mentorship guidelines, inter-cultural communication and program guidelines	Ongoing social support Modeling
Committed 35 hours (including 6 hours of training) to program support over the summer.	Ongoing social support Modeling
To enable recruitment, participants were:	
Identified based on interest in a cycling mentoring program	Segment target population
To enable cycling, participants were:	
Provided a bike, helmet, lock and lights to use throughout the program	Identify and remove barriers
Trained on how to safely ride a bike in the city	Identify and remove barriers
Participants committed to the program by:	
Making a public pledge to use their bicycle by signing a large poster in front of other program participants	Commitment strategy
Having their photo taken with their bike	Commitment strategy
Agreeing to participate in 30 hours of programming over the 12 to 16 week program in order to receive a certificate of completion.	Commitment strategy
To encourage ongoing cycling participation in the program, participants were:	
Paired with an experienced and trained mentor who offered social support and encouragement of cycling behaviour	Ongoing social support Modeling
Invited to join program and community activities such as group rides, picnics, or rides with their mentors	Periodic events Modeling Ongoing social support
Helped with planning safe cycling routes in their neighbourhoods.	Ongoing social support
Encouraged to learn from cycling behaviour demonstrated by program instructors and mentors	Ongoing social support Modeling
Required to record their weekly cycling trips in a calendar (PedalWise only)	Commitment strategy
Advised to cycle on their own outside of program activities	Commitment strategy
Participants still active mid-way through the program were told a free second-hand bike would be available to them upon program completion. (Bike Host only)	Commitment strategy Identify and remove barriers

3.2.3 Recruitment of participants and mentors

Recruitment of participants was conducted by the local community organizations and the program co-ordinators they employed. Partners drew on their brand recognition and status as established community institutions to recruit participants through existing channels. The Toronto 'Bike Host' interventions were limited to newcomers to Canada who were either Convention refugees[1] and permanent residents, while the Peel 'PedalWise' intervention was open to all residents regardless of immigration status. The vast majority of participants knew how to ride a bicycle, however a few learned from their mentors during the program. Participants were expected to commit 30 hours to the program over the course of the summer. Participation was tracked and those who completed received recognition and documentation of their efforts.

Mentors were volunteers and area residents recruited through the cycling organizations who were program partners (Cycle Toronto or BikeBrampton). Mentors shared their knowledge of cycling through a relationship with a small group of 2 to 4 program participants. Prior to the beginning of the program, mentors underwent 6 hours of training involving safe cycling, interpersonal mentorship guidelines, inter-cultural communication and program guidelines. Mentors were expected to commit to 35 hours (including training) to the program over the summer and were provided with recognition and documentation of their efforts.

Mentors and participants were matched by participating organizations. The match was based both on geographic proximity and compatibility.

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[1] Convention refugees are outside their home country or the country where they normally live and are unwilling to return because of a well-founded fear of persecution based on: race; religion; political opinion; nationality; or membership in a particular social group, such as women or people of a particular sexual orientation.

3.2.4 Program Description

Participants met their mentor at 'bike day' where they attended a safe cycling workshop,
reviewed the program requirements (30 hours of participation over the summer) and were fitted
with a bike. They were also provided with a helmet, lock and lights. Bike Host bicycles and
equipment were from a high school bicycle program and used over the summer when school
programming was not in session. PedalWise bicycles were refurbished bicycles acquired by the
community partners as part of the program funding. Any bicycle that was stolen (1 over 4
interventions) required the participant to file a police report, but not to replace the bicycle. When
receiving their bicycles, participants signed a pledge to ride the bicycle and had their photo taken
with the bicycle and the pledge and agreed to return the bicycle at program conclusion.

At 'bike day', arrangements were made to meet again with their mentor. Mentors worked
with 2 to 4 cyclists addressing individual barriers and organizing small group rides and
attendance at larger program events (organized by partners and lead agencies) over the course of
the summer. Bikes and accessories were collected at the end of the program at 'bicycle return
days'. There were a variety of dates available to return the bikes, so some participants had a
slightly longer time with the bicycling equipment.

At the end of the season a celebratory evening of food and fun was organized and those
mentors and participants who met the hours required by the program received a framed
certificate. Bike Host participants were offered a free second-hand bike at program completion.
They were informed of this mid-way through the intervention.

3.3 Data Collection and Survey questions

Data collection consisted of two surveys: once participants joined an intervention group, they

completed an entry survey in hard copy or online prior to receiving a bicycle and meeting their mentor; at the end of the 12-16 week long intervention, participants were invited to complete an exit survey in hard copy or online. Data collection occurred before the final celebratory event. We matched completed entry and exit surveys together by participant and discarded incomplete or unmatched surveys.

Both entry and exit surveys included identical questions regarding mode frequency for (1) work/school and (2) shopping using two separate questions. For these questions, participants indicated how many days in a typical week they use transit, walking, taxis, getting a ride, driving, or biking to get around, either for shopping or for work/school. There were 4 answer categories available: "Never", "1 to 3 days per week", "4 to 5 days per week" and "6 to 7 days per week". This question was structured to provide respondents with the ability to describe varied mode use. There are limitations to self-reported metrics for evaluation of cycling frequency, however, due to funding constraints and potential privacy concerns associated with newcomer populations who may have experienced traumatic situations prior to immigration, researchers were unable to use GPS tracking technology on the bicycles.

At both entry and exit we also asked questions about travel distances and participants' willingness to spend on a bicycle and accessories. The latter questions asked participants to determine the "absolute MOST money [they] would spend on a bike". The same phrasing was used for bicycle accessories.

Additionally, at both entry and exit, we asked 15 questions about attitudes covering three categories: 1) participants personal feelings about cycling; 2) their perceptions of the utility of cycling; and 3) their perceptions of their community and cycling. Participants were asked to

indicate, on a 5-step Likert scale, their level of agreement with statements from strongly disagree to strongly agree.

The entry survey contained demographic questions (e.g. age, gender and home location) but the exit survey did not repeat the demographic questions.

These questions allowed us to assess: if the program resulted in changes in bicycling frequency to work/school and shopping; whether the distance from the central business district affected the change in bicycling frequency; changes in attitudes towards cycling; and changes in willingness to invest in bicycling equipment. This last change (willingness to spend) may act as an indicator of the programs' longer-term impacts (Loureiro, McCluskey & Mittelhammer, 2003).

There were significant challenges with the one opportunity for longer-term follow-up with participants. In the fall of 2017, researchers attempted to contact participants from 2015 and 2016 Bike Host programs via email and by phone to invite them to participate in a follow-up survey, offering a choice of gift cards worth $15. The same questions about cycling frequency and willingness to spend were asked as the in-program surveys. Responses were matched with each participant's original in-program surveys. Of the 98 initial participants who completed entry surveys for Bike Host 2015 and 2016, only 30 participated in the follow-up survey and of these only 21 participants had matched entry, exit and follow up surveys that contained usable data. Most were unable to be reached by phone. This challenge was compounded by the tendency for newcomers to experience challenges with precarious housing and therefore move or change phone numbers frequently during their first few years in their new countries (Preston, 2011). Section 4.5 details the results from the attempted follow-up survey.

3. 4. Statistical Analysis

In order to understand the effects of the interventions, we compared matched responses in the entry and exit surveys for: changes in mode frequency, changes in willingness to spend on a bicycle and bicycle accessories, and changes in attitudes. To better understand how household location may have affected a participant's travel behaviour during the program, we looked at distances between a participant's home and the respective central business district and changes in bicycling frequency.

The team analyzed each intervention site individually, and then as one larger dataset. Distributions of key variables were similar and therefore interventions were combined for analysis. This paper focuses on the aggregate results, but the individual intervention results can also be found in Table 5.

3.4.1 Mode Frequency Analysis

Our survey gave participants a choice between four ranges of days that they used each mode of transportation, in an average week. Their options were "Never (0 days)", "Some days (1-3 days)", "Most days (4-5 days)", and "Every day or almost every day (6-7 days)". Researchers then coded each survey to correspond to the midpoint of each range of days; these categories became, respectively: 0, 2, 4.5, 6.5. We then calculated the mean of each mode for both the entry and exit surveys and then the difference in means. Next, a paired two-tailed t-test for a difference in means was administered to each mode and intervention. Due to the low numbers of respondents who indicated they use taxis as a form of transportation, we removed the analysis on taxi mode share change. Prior to consulting with statistical experts in sociology, we explored the use of categorical analysis for this question and found very similar results. These results however

were far less easy to interpret (i.e. a shift in category rather than a shift in number of days cycled) and therefore we used the imputed value method.

3.4.2. Willingness to Spend Analysis

We examined willingness to spend on bicycles and bicycle accessories using paired two-tailed t-tests. Participants selected from a multiple-choice of monetary values at every $50 increment from $0-$800 for bicycles and $0 to $400 for accessories. Very few participants indicated the maximum option for either category, indicating that the survey choices captured the variety of preferences present in our sample. Although these values are discrete, they are evenly spaced, cover an extensive range of potential expenditures for any given participant, and correspond to underlying continuous measurements (dollars). Using a standard, two-tailed t-test for the difference of means, and treating the data as continuous, the analysis determined the correlation between the Bike Host program and the mean change in how much participants were prepared to spend on bicycles and bicycle accessories from the start to the end of the program.

3.4.3 Attitudes Analysis

We collected attitudes data for 15 questions in three categories-personal feelings, perceptions of the utility of cycling and perceptions of the community (see Table 4), Participants were asked to indicate on a Likert scale their level of agreement from strongly disagree to strongly agree. Wilcoxon signed-rank tests provides indication of whether or not the change pre- and post-intervention was significant and whether the change was positive (indicating a higher level of agreement) or negative (indicating a lower level of agreement).

3.4.4 Distance to Central Business District (CBD) Analysis

The distance from a participant's home location to the central business district served as a proxy for urban environment, as both intervention locations, Toronto and Brampton (Peel) developed outwardly from the core with land uses becoming more suburban further away from the core (Moos and Walter-Joseph, 2017). A strong relationship between a participant's home's distance to their respective CBD and their change in cycling participation pre- and post- intervention would indicate that participants from certain areas may have a higher tendency to take up cycling.

To better understand how a participant's home location may affect the program's impact on their cycling participation, the distance between each participant's home location (indicated through provided postal codes) and their respective CBD was regressed in a simple linear model against change in cycling participation for each of shopping and work/school. For participants in the Toronto-based programs (Bike Host 2015, 2016, and 2017), Toronto's City Hall was used as the location representative of the Central Business District. For participants in the Region of Peel's PedalWise 2015 program in Brampton, Brampton's main downtown intersection of Queen and Main Streets was used as the CBD location

4. Results

4.1 Survey Participation and Demographics

146 participants completed both entry and exit surveys, as indicated in Table 2.

TABLE 3. Summary of survey collection

Surveys	PedalWise 2015	Bike Host 2015	Bike Host 2016	Bike Host 2017	Total Participants
Total entry	35	51	47	64	197
Total exit	27	40	37	54	158
Incomplete entry	9	13	13	15	50
Incomplete exit	1	2	4	5	12
Matched	26	38	33	49	146
% of entry surveys matched	74%	75%	70%	77%	74%

TABLE 4. Participant demographics of matched surveys

Trait	Response	PedalWise 2015	Bike Host 2015	Bike Host 2016	Bike Host 2017	Total
# Participant surveys		26	38	33	49	146
Sex	Male	58%	47%	58%	51%	53%
	Female	38%	53%	42%	49%	47%
	No response	4%	0%	0%	0%	1%
Age	<=24	0%	16%	6%	4%	7%
	25-44	38%	63%	85%	82%	70%
	45-64	27%	21%	9%	12%	16%
	65+	31%	0%	0%	2%	6%
	No response	4%	0%	0%	0%	1%
Self-identified Cultural/Ethnic Origins, grouped	South or East Asian	69%	42%	61%	57%	56%
	Central or South American	8%	8%	0%	6%	5%
	African	0%	3%	3%	6%	3%
	European	0%	3%	3%	6%	3%
	Middle Eastern	0%	18%	9%	20%	14%
	Canadian and/or North American	15%	3%	0%	0%	3%
	No response	8%	24%	24%	4%	14%
Transportation access	Access to bike	19%	24%	6%	12%	15%
	Car in household	69%	45%	33%	31%	42%
Years in Canada	<1 year	4%	3%	30%	35%	20%
	1 to <3 years	8%	50%	36%	33%	34%
	3-5 years	8%	16%	33%	16%	18%
	Over 5 years	81%	32%	0%	0%	23%
	No response	0%	0%	0%	16%	5%
Household Size	1 person	4%	0%	3%	4%	3%
	2-4 people	50%	66%	73%	78%	68%
	5 or more people	42%	29%	21%	14%	25%
	No response	4%	5%	3%	4%	4%
Children <17 in household	No children	42%	24%	36%	55%	40%
	1 or more children	58%	76%	64%	43%	59%
	No response	0%	0%	0%	2%	1%
School	Full time school	0%	29%	36%	33%	27%
	Part time school	8%	32%	15%	12%	17%
	Not attending school	92%	39%	48%	55%	56%
Employment	Full time job	42%	26%	24%	24%	28%
	Part time job(s)	12%	16%	15%	16%	15%
	Not working	46%	58%	61%	59%	57%

4.2 Changes in Mode Frequency

TABLE 5. Mean change in mode frequency (days per week)

Purpose	Mode	PedalWise 2015 Mean change (n)	Bike Host 2015 Mean change (n)	Bike Host 2016 Mean change (n)	Bike Host 2017 Mean change (n)	Total Mean change (n)
Shop	Bus	-0.096 (26)	-0.095 (37)	0.227 (33)	-0.704 (49)*	-0.228 (145)
Shop	Walk	-0.750 (26)	-0.351 (37)	-1.000 (33)*	-0.357 (49)	-0.572 (145)**
Shop	Car pass.	-1.135 (26)**	-0.014 (37)	0.197 (33)	-0.184 (49)	-0.224 (145).
Shop	Car	0.385 (26)	0.176 (37)	-0.303 (33)	0.051 (49)	0.062 (145)
Shop	Bike	1.308 (26)**	1.716 (37)***	2.242 (33)***	1.755 (49)***	1.776 (145)***
Work/ school	Bus	-0.300 (20)	-0.324 (34)	-0.328 (32)	-0.765 (49)*	-0.481 (135)*
Work/ school	Walk	0.100 (20)	-1.245 (33)**	-1.500 (32)**	-0.112 (49)	-0.685 (134)**
Work/ school	Car pass.	-0.400 (20)	-0.314 (33)	0.344 (32)	-0.388 (49)*	-0.197 (134)
Work/ school	Car	-0.475 (20)	0.229 (33)	0.016 (32)	-0.153 (49)	-0.067 (134)
Work/ school	Bike	1.100 (20)*	0.939 (33)*	1.484 (32)***	1.633 (49)***	1.347 (134)***

Levels of significance: *** p < 0.001; ** p < 0.01; * p < 0.05

Cycling for transportation to both work/school and shopping was more frequent at the end of the intervention compared to entry and the change in cycling frequency for both types of trips was significant at p<=0.001. On average, each participant cycled an additional 1.78 days per week to shopping and an additional 1.35 days per week to work/school. Before the intervention just 25% of participants sometimes bicycled to shopping, while after the intervention, 74% of the participants bicycled to shopping at least some days. The same pattern occurred for work/school although the change was less extreme: 10% bicycled to work/school some days prior to the intervention and 45% bicycled to work/school at least some days after the intervention.

Participants reported a statistically significant decrease in walking as a mode of transportation to shop (p=0.004) and work/school (p=0.001). There was a significant decline in transit use to work/school (p=0.026). While there were declines in getting a ride and driving these were not significant. However, car ownership among the households was quite low.

4.3 Willingness to Spend

TABLE 6 Mean change in willingness to spend

	PedalWise 2015	Bike Host 2015	Bike Host 2016	Bike Host 2017	Total
Bike	75 (26)	35.985 (35)	27.273 (33)	11.984 (49)	31.818 (143)
Accessories	41.346 (143)**	14.887 (143)	9.091 (143)	7.483 (143)	15.537 (143)**

Levels of significance: *** p < 0.001; ** p < 0.01; * p < 0.05

By comparing entry and exit surveys we found that on average, over the course of the program, participants increased their willingness to spend on a bicycle by approximately $32. Willingness to spend on bike accessories had a stronger and significant positive average increase of $15.50. **Error! Reference source not found.**The willingness to spend on bike accessories increased by 32%. The amount participants were willing to spend on a bicycle increased by 23% but was not statistically significant. A larger sample size may clarify this result.

4.3 Attitudes

The questions about attitudes addressed: personal feelings about bicycling; perceptions of the utility of cycling; and perceptions of cycling and community (Table 7). The analysis of statements of personal feelings about cycling found that participants reported changes in their

levels of confidence. They were more confident that they knew the rules of the road while

bicycling in Canada (p=0.005) but less confident of finding a good route to bicycle to their

destination (p=<0.001). They experienced no statistically significant change in their comfort

levels while riding in their neighbourhood, nor in their concerns about theft.

Participant perceptions of the utility of cycling showed no statistically significant change

between entry and exit.

Perceptions of community were mostly unchanged, but participants increased their

agreement with the statements that there are not many women or girls who ride bikes in their

neighbourhood (0.001) and that there are safe streets to ride their bike in their community

(p=0.027).

TABLE 7. Summary of attitudes Wilcoxon signed-rank test results

Statement	Entry mean (1-5 scale)	Exit mean (1-5 scale)	Mean change
Personal Feelings			
I feel comfortable riding a bike on the street in my neighbourhood.	3.98	4.09	0.114
I'm afraid my bike will get stolen if I lock it up outside.	3.19	3.26	0.073
I believe it is dangerous to ride a bike in my neighbourhood.	2.2	2.11	-0.087
I feel confident that I can find a good bicycle route.[1]	4.02	3.34	-0.687***
I feel confident that I know the rules of the road when I bicycle in Canada.[1]	3.67	4.14	0.469**
Perceptions of Utility			
It is possible to visit my friends using a bicycle.	3.95	3.96	0.009
Cycling can sometimes be easier for me than using transit.	3.98	4.04	0.058
Cycling can sometimes be easier for me than driving.	3.85	3.84	-0.01
I believe that biking is a fast and convenient way to get around in my neighbourhood.	4.17	4.27	0.103
Perceptions of Community			
There are not many women or girls who ride bikes in my neighbourhood.[2]	2.67	3.08	0.413**
People from my culture think that it is important to drive a car.	3.06	3.08	0.022
Only low-income people ride bikes for transportation.	1.83	1.89	0.059
People in my family think it is dangerous to ride a bike in my community	2.53	2.48	-0.056
I see cyclists on the road in my neighbourhood.	4.23	4.21	-0.023
There are safe streets to ride your bike in my community.	3.84	4.04	0.202*

[1]only BH2016 & BH2017 data
[2]only BH 2015, BH2016 & BH2017 data
Levels of significance: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

4.4 Distance to Central Business District

We did not find a relationship between change in cycling frequency either to work/school or

shopping and the distance between a participant's home address and the central business district.

4.5 Follow-up Surveys

Results from the follow-up survey of participants of Bike Host 2015 and Bike Host 2016 suffered from a small sample size: 9 matched entry, exit and follow-up responses for 2015 and 12 for 2016. While there was a pattern of decline from program exit in cycling to work, school and shopping, the rate of cycling was still higher than program entry. However none of these results were statistically significant. The mildly significant changes in walking to work went in different directions for 2015 and 2016. The follow up means for willingness to spend on both bicycles and accessories was higher than both the entry and exit means. However, interpreting this change is challenging as it seems likely that the participants longer time in Canada may have resulted in more financial security and thus a greater willingness to spend in general. Given the tiny sample sizes of 9 for 2015 and 12 for 2016 participants, we chose to disregard these results.

5. Discussion

This work studied four cycling mentorship-based interventions delivered over the course of three summers in the Greater Toronto and Hamilton Area to determine their impact on bicycling frequency, willingness to spend on bicycles and accessories and participants' attitudes towards bicycling. These interventions followed the cycling adoption cycle presented in Savan, Cohlmeyer, and Ledsham (2017) which was developed from an extensive literature review that aligned cycling initiatives with established, evidence-based behaviour change techniques from the social psychology literature. Results showed a strong increase in cycling to shopping, work and school, accompanied by commensurate decreases in walking, getting a ride or taking the bus to these destinations. Participants reported increases in willingness to spend on bicycles and accessories and changes in some attitudes. Importantly, the increase in cycling was unrelated to

the distance from the city centre, indicating potential for mentorship programs to increase cycling in neighbourhoods throughout the region.

A greater increase in transportation cycling frequency was seen in trips for shopping over trips to work or school. Shopping destinations are often closer to home than work or school destinations, therefore this finding is not unexpected. Additionally, given that 57% of trips in the GTHA are not to work or school (Mitra, Smith Lea, Cantello, & Hanson, 2016) the potential of interventions to increase cycling to shopping and other neighbourhood destinations should not be undervalued. In the GTHA, transportation demand management (TDM) is organized through workplace organizations and focuses on work trips. Given that the vast majority of shorter trips are not to work, TDM might be more successful if it were broadened to serve a wider range of trip purposes and moved away from a workplace focus. Just as retailers have encouraged shoppers to bring their own reusable bags, they could be engaged to develop programs to encourage active transport which would reduce the large amount of expensive vehicle parking they currently need to provide.

The analysis did not find any significant decrease in driving either on an individual intervention level or when the interventions were combined. The lack of evidence of a shift from driving to biking in these four interventions may be related to the participants' low rate of car ownership and is not necessarily a reflection of changes that would be expected in the wider population. Sixty-four percent of participants reported that they did not have access to a vehicle, indicating lower vehicle ownership among the participant groups than the general population of Toronto and Peel. Just 23% of households in the City of Toronto have no car (DMG, 2011a) while in Peel just 6% of households have no car (DMG, 2011b). In the PedalWise 2015 intervention where the households of participants had a higher level of car ownership (69%)

there was a significant decline in getting a ride to shopping (Table 4). Additionally, the Bike

Host 2017 group saw a significant decline in getting a ride to work/school. All interventions saw

a decline in passenger days to shopping and work/school except for Bike Host 2016. Given the

notably low level of car ownership, this change could well prove significant in a larger sample

with interventions that recruited from households with higher car ownership. Further research

regarding the impact of cycling programming on those who live in households with a vehicle, but

are not the primary vehicle user, may reveal an appetite for increased transport independence

through cycling.

The high participation in the program by those who do not have access to a vehicle likely

indicates good potential for cycling and high levels of public transport dependence. This is

especially important in lower income, lower density neighbourhoods that lack adequate public

transportation.

The individual programs that engaged newcomers to Canada (BikeHost 2015, 2016,

2017) resulted in significant increases in transportation cycling frequency for work/school and

shopping, as did the Pedalwise 2015 program which recruited more established Canadian

residents for whom the major life change of immigration was not a factor. This suggests that the

cycling adoption model applied through mentoring may transcend the transition paradigm

suggested by many life course transition transport studies (Chatterjee, Sherwin, & Jain, 2011;

Christensen, Chatterjee, Marsh, Sherwin, & Jain, 2012; Gatersleben & Appleton, 2007).

However, immigration was the only life course event included in the study and so the

participants in PedalWise 2015, while not newcomers to Canada, may have been undergoing

other life course transitions that we did not examine. Nevertheless, the success of the model in

both groups suggests a wide range of people can be successfully engaged in behaviour change through cycling mentorship programs.

Newcomers to Canada are prone to experience declines in health related to time in Canada (McDonald & Kennedy, 2004). This decline moves the newcomer community from being in relatively better health than native-born Canadians at time of immigration, to converge with lower native-born levels (McDonald & Kennedy, 2004). Given the current and anticipated high levels of immigration into the Greater Toronto Area (Statistics Canada, 2017), and in particular to the areas outside the city core, programs that can both maintain and improve health, as well as provide access to employment and educational opportunities through transport independence are needed to ensure the migration experience to Canada is not a net life negative for the newcomer or an expensive additional cost to Canada's socialized healthcare system. These types of programs may potentially delay or even reduce car ownership among newcomers.

After the program, participants were more willing to spend on a bicycle and much more willing to spend on accessories like helmets and locks. The programs exposed people to good quality bicycles and accessories such as locks, panniers, lights and helmets. The value of high-quality accessories in making bicycling secure and comfortable may be underappreciated both by those who are not exposed to them and by those who take them for granted. The willingness to spend more money on both bicycles and accessories suggests participants experienced an increase in their perceptions of the value of a bicycle and accessories, and suggests the programs have good potential for long term impact on cycling for transportation.

Participants increased their confidence regarding their knowledge of the Canadian rules of the road. This was likely due to three factors: first, a safe cycling workshop at the beginning of the program provided an overview of the rules; second participants rode regularly with their

mentor, who modeled the rules for riding in Canadian traffic and; finally they experienced riding in larger groups, again with staff or mentors following correct traffic protocols. This finding aligns with Thigpen's 2018 results showing that even short-term bicycling experience increases bicycling skills.

At program exit participants were less confident they could find a good bicycling route. This is an important finding and consistent with the reality of bicycling in Toronto and Peel. Outside of Toronto's core, there are very few bicycle facilities and very few separated bicycle lanes. The facilities that do exist frequently end suddenly and can place the rider in uncomfortable and sometimes dangerous conditions. While bicycling participation increased in spite of this, in order for people to be confident enough to bicycle to destinations safe and connected, direct cycling infrastructure is critical and would likely magnify the effects of these interventions.

Participants reported no change in their perceptions of the utility of cycling. This may be because the people who participated in this program were already likely to see cycling as a useful transport mode, as they reported relatively high means (TABLE 7) on the measures of utility at entry. Recent research finds that attitudes tend to follow behaviour (Kroesen, Handy and Chorus, 2017; Barnett Burns and Savan, 2018; Thigpen, 2018) and were not a precursor to behaviour change. However, the nature of our program attracted people already predisposed to report positive attitudes towards cycling, making a change in these pre-existing attitudes less likely. Shorter opportunistic programming with more sceptical populations may be more likely to demonstrate that attitude change follows behaviour.

Participants reported change in the two statements regarding perceptions of community. Participants were more likely to find that few women bicycle in their neighbourhoods at program

exit. This is a realistic view of cycling in the GTHA where male cyclists outnumber female cyclists approximately 3 to 1. More exposure to the street while bicycling gives participants a more realistic view of who is actually bicycling. Exposure to bicycling in their neighbourhood increased their perception that there were some safe streets to bicycle on in their neighbourhood—the infrastructure problems noted in their lack of confidence about finding a safe route seem to be nuanced. There are some safe streets but finding a safe route to a destination is challenging.

A possible weakness of this research is that the minority of participants who did not complete both the entrance and exit survey may also have been less likely to participate in other aspects of the intervention and less likely to bicycle for any reason. The match rate for the entrance and exit surveys was at least 74%, however, and was very consistent across programs and years. The change in willingness to pay for a bicycle may be underreported due to the knowledge that they would receive a second-hand bike at program completion. Additionally, the people who participated in the program were interested in joining a cycling mentorship program and thus more motivated to make a change in their transport behaviour than the general population. While this is a caution about extrapolating the results, it is also a reflection of the model of change (Figure 1). The model increases the strength of interventions, by segmenting the population and targeting people interested in change. In a world of limited resources, focused efforts supporting people interested in change are strategically more useful. Partners found recruiting mentors was easier in higher-cycling neighbourhoods. In lower cycling areas, finding mentors was more difficult and required strategic networking and recruitment. An important source of mentors was prior program participants, so long-term implementation of mentorship programs would overcome this difficulty. Mentors sometimes had difficulty engaging their

participants and found this dispiriting. Some participants simply needed access to a bicycle and equipment and the mentorship access of the program was not relevant to them. Future programs could offer different levels of engagement.

Despite the PedalWise program not being restricted to recent newcomers, participants reported similar changes in behaviour as the interventions targeting newcomers to Canada. This suggests mentorship interventions can be effective in changing behaviour for established residents as well as for newcomers.

6. Conclusion

The four cycling mentorship interventions resulted in clear success in terms of cycling adoption. This result was not dependent on the distance to the central business district. Programming reflected the 4-step cycling adoption model presented in Savan, Cohlmeyer and Ledsham (2017): 1) targeting the population; 2) removing barriers; 3) using commitment strategies; and 4) sustaining the change. This model depends on community support and events which the community partnerships and organized mentorship aspect of these interventions provided.

Partnering with local community organizations with missions already related to health outcomes and newcomer integration was an efficient strategy – this allowed the local organizations to meet their goals while also increasing cycling. The interventions benefitted from existing community ties and resources. Starting a mentorship cycling intervention without an existing community partner would require significantly greater resources and likely find less community support. Funding inconsistencies and uncertainties mean these programs were more labour intensive and less amenable to long-term analysis than a single ongoing program would be. Consistent multi-year funding of programming would enable efficiencies in both program delivery and research.

The results demonstrate that cycling mentorship programs are an effective method to increase cycling while meeting other community goals. People will ride bikes to nearby destinations when provided with social and material support. Once exposed to bicycling for transport, they are more willing to invest in this method of transportation. Newcomers to Canada were strongly represented in our participants and while car ownership was low among this group, and so the resultant mode shift was not away from driving, this program may postpone or even reduce the tendency for newcomers to Canada to acquire cars as soon as they are able.

These results suggest that cycling mentorship interventions in areas with low current cycling levels will accelerate cycling uptake in interested populations who are given access to functioning bicycles, essential accessories and supportive communities and training. Although initially labour-intensive, the benefits of the behaviour change programming have exponential growth value in terms of behaviour normalization. Creating bicycling champions and support for training and repair grows local cycling potential and increases uptake of new infrastructure. Supporting infrastructure would accelerate the change and is required to continue growth of cycling for transportation in areas outside of the city centre.

There is great potential for the expansion of interventions of this nature. In particular, these programs demonstrate that bicycling can be supported by non-cycling organizations with missions aligned to the benefits of cycling and taken up by demographic groups that are currently less likely to cycle, including women and those without access to a bicycle and repair and training support, as well as those living in areas with less physical infrastructure to support bicycling. These areas outside of central cities contain the greatest proportion of our population in North America and thus offer the greatest source of potential demand for cycling. To achieve a sustainable mix of transportation modes, engaging these populations is necessary and we

suggest that targeting such neighbourhoods for cycling infrastructure and programs could provide the greatest increase in cycling mode share. We would welcome further testing of this hypothesis in new and varied locales with a variety of demographics. It would be especially useful for a government body/research organization to develop and fund interventions so that both program structure and long-term impacts could be evaluated using rigorous research norms.

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