Active Transportation in Kingston, Ontario: An Analysis of Mode, Destination, Duration, and Season Among Walkers and Cyclists

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Background: Individuals that engage in active transportation (AT) have healthier weights and fitness levels. Most AT research has focused on work- or school-based destinations. Meanwhile, little is known about the differences between individuals that engage in the most common forms of AT—walking and cycling—and how these AT patterns vary by destination, duration, and season. ***Methods***: We recruited 1400 randomly sampled adults (350 per season) in Kingston, Ontario, Canada to complete a cross-sectional telephone survey. The survey captured the prevalence, destinations, and duration of AT, and we examined the observed differences by mode. ***Results***: The majority (72%) of respondents were AT-users; walking constituted 93% of overall mode share. Cyclists were more likely to be male, younger, and employed than walkers. Walkers tended to access neighborhood-based destinations, while cyclists were more likely to use AT to get to work. AT duration was comparable by mode, ranging from approximately 8 to 20 minutes. Overall rates of AT were lowest in the winter, but walking rates were reasonably high year-round. ***Conclusions***: Beyond commuting to work and school, policy-makers and planners should consider the breadth of destinations accessed by different modes when aiming to increase physical activity through AT in their communities.

Keywords: telephone survey, walking, cycling, adults

As developed countries the world over confront rising obesity rates,[1] public health practitioners are struggling to figure out how best to stem the tide of this epidemic. Increasing physical activity (PA) levels is an essential component to reducing the prevalence of obesity and overweight. While PA has been traditionally viewed from a recreational perspective, a growing body of evidence signals the potential of utilitarian-based activity, namely active transportation (AT), to assist individuals in meeting their recommended daily PA.[2,3]

According to the Public Health Agency of Canada, AT "refers to any form of human-powered transportation."[4] AT can take on many forms, but consists primarily of walking and cycling for transportation. AT-based activity tends to happen frequently in shorter stints, while recreation-based activity happens less often but for longer periods of time.[5] Engagement in AT has been associated with favorable health indicators, such as lower BMI and waist circumference, and higher fitness levels.[6,7] A Montreal-based study found that people are willing to travel further to work using AT than for other destination types,[8] while another study found that commuting to work by bicycle can satisfy activity level recommendations required for cardiovascular fitness.[9] Thus, given recommendations by the Canadian Society for Exercise Physiology for 150 minutes of moderate-to-vigorous PA each week,[10] as well as comparable recommendations from the American College of Sports Medicine,[11] promoting AT could be especially effective at increasing PA levels at the population level.

Countries with high rates of AT have low rates of obesity.[12] AT rates in Canada are higher than those of the USA,[13] but Canada lags behind many European countries that are known for having more AT-supportive policies and infrastructure.[14] Indeed, research suggests that investments in infrastructure that support AT (eg, bike lanes, sidewalks) may lead to increased AT engagement,[15] particularly for cycling.[16] Built environment features like street connectivity, transportation infrastructure, land use mix, and population and employment density have all been found to be important predictors of AT engagement.[17–21]

Research also suggests that values and attitudes influence one's propensity to engage in AT. One study found that environmentally conscious attitudes are key motivators for engaging in AT,[22] while another found the desire for parking convenience and transportation-related cost savings to be motivating factors.[23] A study of students at a Canadian university found that those using AT to commute to school were more satisfied with their daily commute when compared with those commuting by motorized transit,[24] suggesting potential mental health, in addition to physical health, benefits of AT.

While recreational PA is more common among higher-income populations, AT rates tend to be higher among lower-income populations,[25–27] which highlights the potential of AT to reduce socioeconomic disparities in overall PA levels.[28] Walking for the purposes of AT does not appear to vary by gender,[29] while cycling is generally more common among men.[29,30] Additionally, a Canadian study found that AT is more common among younger cohorts, unattached individuals (eg, persons living alone or in households with nonrelated members[31]), and people with lower annual incomes.[32]

While a clear picture may be emerging of the sociodemographic profile of people using AT, little is known about how walkers and cyclists differ in terms of the types of destinations accessed, or duration of time spent engaged in AT. The objective of this study was to assess the prevalence, mode, destinations, and duration of

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AT among adults in Kingston, Ontario, Canada, with a focus on the differences we observed between walkers and cyclists.

Methods

Study Setting

This study was conducted in the city of Kingston, Ontario, a mid-sized municipality with a population of 117,207,[33] and a population density of 79.9 people/km[2].[34] Kingston is located at the mouth of the St. Lawrence River, and is situated nearly equidistant between the metropolitan centers of Toronto, Ontario and Montreal, Quebec. The majority of households (76%) in Kingston own at least 1 vehicle and 82% use private automobiles as their primary mode of transportation.[34] Over half of all trips by automobile in Kingston are less than 5 km, and 23% are less than 2 km.[34] Thus, while Kingston is clearly a car-oriented city, it has significant potential for increased AT engagement among its residents.

Study Design

The study was led by the research division of Kingston, Frontenac, and Lennox & Addington Public Health, and received ethics approval from Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board. The study consisted of a cross-sectional survey administered to 4 independent random samples in each of the 4 seasons. The survey instrument was developed by DM in consultation with an AT advisory group based in Kingston, Ontario. Data collection for the study began in May 2009 and was completed in February 2011. The study sample consisted of Kingston residents 18 years of age or older who had the most recent birthday in their household.

Survey Design, Administration, and Response Rates

The survey captured the prevalence, mode, destination, and duration of AT use among respondents, and sociodemographic information. Face and content validity of the survey instrument were assessed through peer-review, by a Kingston-based AT advisory group. The instrument was also pretested and piloted, and subsequent minor adjustments were made to the instrument. The survey was administered by telephone by a private survey research firm, CCI Research Inc. Using random samples of residential numbers for the city of Kingston, the survey was administered in 4 independent cycles representing the 4 seasons in Ontario: May 2009 (spring), October 2009 (fall), July 2010 (summer), and February 2011 (winter). The target for each cycle was 350 completed interviews, for a total of 1400 respondents. Computer assisted telephone interviewing software was used to input data into a spreadsheet at the time of the interview. The response rate was calculated based on total survey completes divided by survey completes plus successful contacts, and was 21%.

Data Management and Analysis

The data were analyzed using IBM SPSS version 20. 'AT users' were defined as those that had engaged in AT to access at least 1 destination in the 7 days before participating in the survey, while 'Nonusers' had not used AT to access even a single destination. 'Cyclists' were defined as those AT users that had engaged in at least 1 cycling trip in the 7 days before participating in the survey, while 'Walkers' were AT users that had not engaged in any cycling in the 7 days before the survey. Associations with sociodemographic variables were tested using the Chi-square statistic, while differences in mean duration by mode were measured using independent samples t-tests.

Results

Sample Characteristics

The majority of survey respondents were female (64%) and employed (60%), and close to one-third of the sample (31%) earned a midrange household income (Table 1). Survey respondents were more likely to be female and older, but had comparable employment and income levels, when compared with City of Kingston residents overall. Compared with Nonusers, AT users were significantly more likely to be younger, employed, and earning lower incomes. Meanwhile, among AT users, Cyclists were significantly more likely to be male, younger, and employed than Walkers.

AT Patterns by Mode

Most respondents were AT-users (72%), and 86% of AT-users were identified as Walkers. When examined by destination, 92% of AT trips were by walking and 8% were by cycling (Table 2). Of all trips made by walking (N = 3512), the most common destinations were corner stores (N = 504), grocery stores (N = 420), and parks (N = 403). Of all the trips made by cycling (N = 316), the most common destinations were work (N = 56), grocery stores (N = 34), and banks (N = 32). Seven destinations generated higher than average mode share for cycling: work (23%), recreation centers (14%), schools (13%), homes of family members (13%), personal appointments (12%), banks (12%), and libraries (10%). For all other destinations, walking accounted for over 90% of mode share.

AT Patterns by Destination

We solicited information from respondents about how they accessed up to 19 types of destinations in the 7 days before survey (Table 2).[1] A total of 9720 trips were reported, and N = 3828 of these were by AT. Five of the 19 destination types were accessed by AT a majority of the time (bus stops 100%, parks 82%, corner stores 73%, schools 62%, and libraries 52%), yet 3 of these destinations (bus stops, schools, and libraries) are among the 5 least frequented locales. The remaining 14 destinations were accessed by passive means most of the time.

AT Patterns by Duration

The mean number of minutes spent engaged in AT to reach a destination ranged from 21.3 minutes to 9.2 minutes for walking, and from 19.9 minutes to 8 minutes for cycling (Table 3). We compared the mean durations for walking and cycling for each destination to determine whether the differences were significant. Duration spent cycling was significantly higher than for walking for 2 destinations (home of a friend, park), while duration spent walking was significantly higher than for cycling for 6 destinations (school, grocery store, corner store, bank, clinic, and library). Using weighted averages, the overall mean duration was 13.1 minutes for walkers and 14.4 minutes for cyclists.

Table 1 Sociodemographics of Sample, Active Transportation (AT) Users, Nonusers, and City of Kingston[45] Residents

Variable	City of Kingston[45] (pop.: 117,000)	Survey sample (N = 1400)	AT User (N = 1006)	AT Nonuser (N = 394)	P-value	Walker (N = 867)	Cyclist (N = 139)	P-value
% male	47.7	36.1	36.5	35.0	ns	33.2	56.8	<0.001
Median age in years	40.0	51	48.8	56.0	<0.001	49.4	45.0	0.003
% full, part, or self-employed	59.6	60.5	62.4	56.9	0.058	60.5	74.6	0.001
% earning $0 to $39,999		30.8	32.4	26.1	0.022	32.6	31.3	ns
% earning $40,000 to $79,999		31.4	29.2	37.5		29.6	27.0	
% earning $80,000 and more		37.8	38.3	36.4		37.8	41.7	
Median income	$53,072							

Abbreviations: pop., population.

Table 2 Trip Frequency by Destination and Active Transportation (AT) Mode

Destination	AT mode share		AT trips (%)	Non-AT trips (%)	Total number of trips
	Walking trips, N	Cycling trips, N			
Grocery store	420 (92.5)	34 (7.5)	454 (40.5)	666 (59.5)	1120
Restaurant	276 (94.5)	16 (5.5)	292 (34.1)	565 (65.9)	857
Bank	240 (88.2)	32 (11.8)	272 (33.5)	539 (66.5)	811
Work	193 (77.5)	56 (22.5)	249 (34.1)	483 (65.9)	732
Corner store	504 (94.4)	30 (5.6)	534 (73.2)	195 (26.8)	729
Home of friend	254 (92.4)	21 (7.6)	275 (43.2)	361 (56.8)	636
Shopping mall	114 (90.5)	12 (9.5)	126 (20.1)	502 (79.9)	628
Pharmacy	256 (93.8)	17 (6.2)	273 (44.6)	339 (55.4)	612
Drop off/pickup	95 (96.0)	4 (4.0)	99 (18.0)	451 (82.0)	550
Home of family member	94 (87.0)	14 (13.0)	108 (20.6)	418 (79.4)	526
Park	403 (93.7)	27 (6.3)	430 (82.3)	93 (17.7)	523
Clinic	92 (93.9)	6 (6.1)	98 (23.6)	317 (76.4)	415
Recreation center	78 (85.7)	13 (14.3)	91 (27.1)	245 (72.9)	336
Personal appointment	88 (88.0)	12 (12.0)	100 (30.3)	230 (69.7)	330
Place of worship	47 (100.0)	0 (0.0)	47 (18.2)	211 (81.8)	258
Library	115 (89.8)	13 (10.2)	128 (51.9)	119 (48.1)	247
Bus stop	169 (99.4)	1 (0.6)	170 (100)	0 (0.0)	170
Movies	27 (96.4)	1 (3.6)	28 (18.3)	125 (81.7)	153
School	47 (87.0)	7 (13.0)	54 (62.1)	33 (37.9)	87
Total	3512 (91.7)	316 (8.3)	3828 (39.4)	5892 (60.6)	9720

Table 3 Trip Duration by Destination and Active Transportation (AT) Mode

Destination type	Total number of trips	Minutes walking (±SD)	Minutes cycling (±SD)	t-test score	Degrees of freedom	P
Grocery store	1120	14.1 (0.7)	11.6 (3.2)	4.555	33	< 0.001
Restaurant	857	13.4 (1.0)	16.3 (9.9)	–1.166	15	ns
Bank	811	13.7 (1.3)	11.7 (2.4)	4.648	31	< 0.001
Work	732	17.4 (1.7)	17.5 (2.6)	–0.270	55	ns
Corner store	729	9.2 (0.6)	8.0 (1.6)	4.065	29	< 0.001
Home of friend	636	9.9 (1.1)	16.9 (5.5)	–5.805	20	< 0.001
Shopping mall	628	19.2 (2.6)	18.0 (10.2)	0.407	11	ns
Pharmacy	612	12.4 (0.9)	11.9 (2.8)	0.745	16	ns
Drop off/pickup	550	12.8 (1.7)	12.5 (4.9)	0.122	3	ns
Home of family member	526	14.7 (2.8)	15.7 (3.4)	–1.048	13	ns
Park	523	11.1 (0.9)	17.2 (5.6)	–5.634	26	< 0.001
Clinic	415	18.6 (2.4)	11.7 (3.3)	5.065	5	< 0.01
Recreation center	336	13.9 (3.2)	19.9 (10.3)	–2.089	12	ns
Personal appointment	330	15.3 (2.0)	15.7 (6.2)	–0.223	11	ns
Library	247	14.6 (1.8)	11.5 (3.5)	3.120	12	< 0.01
School	87	17.8 (2.5)	13.6 (3.6)	3.010	6	< 0.05

AT Patterns by Season

Rates of AT were lowest among winter survey respondents (60%), and consistent across the 3 remaining seasons in which our survey was administered (ranging from 75% to 77%) (Table 4). Walking rates were highest in the fall and spring seasons, while cycling rates were highest in spring and summer. AT rates were examined by season for the 10 most frequently visited destinations (Table 5). AT rates were highest in the spring and summer seasons for 9 of the 10 destinations; only the drop off/pickup destination had higher rates of AT in the fall and winter seasons.

Discussion

Demographic Trends

Nonusers of AT tended to be older in this study, which may reflect reduced mobility with age, but could also suggest a lack of support in our study site for seniors to engage in AT. This lack of support for older adults has been observed across Canada,[32] and is a significant area for improvement given this country's rapidly aging population. Higher levels of AT engagement, for both cycling and walking, were observed among lower and higher income households. This finding reinforces the point that AT may offer a key opportunity for reducing income-related disparities in PA,[28] and that more targeted efforts are needed to increase AT among middle-income households. That cyclists were more likely to be male is supported by similar findings elsewhere,[29,30] and highlights the need to consider female cyclists in interventions and strategies aimed to increase overall ridership.

Destinations, Mode, Duration, Seasons, and Prospects for Physical Activity

A handful of destinations—namely drop off/pickup, places of worship, movies, and shopping malls—were accessed by passive means in particularly high proportions. These findings can be explained by a range of reasons, including the tendency for people to trip-chain (ie, accessing multiple destinations in one trip) to minimize travel demands;[35] the long distances required to travel to certain types of destinations (especially cinemas and shopping malls); the inaccessibility and/or pedestrian unfriendliness of particular destinations types (eg, Big Box retailers with large surface parking lots); and/or that travel by the private automobile allows the traveler to transport items or people that may not be feasible by foot or bicycle. Meanwhile, those destinations that were accessed by AT a majority of the time and in high proportions (ie, parks and corner stores) likely reflect the greater availability of, and proximity respondents have to, these destinations in their neighborhoods.

The mean durations engaged in AT were highly comparable between walkers and cyclists, suggesting that regardless of the mode

Table 4   Active Transportation (AT) Patterns by Season and Active Transportation Mode

	Season				Total
	Fall	Winter	Spring	Summer	
	N (%)	N (%)	N (%)	N (%)	N (%)
AT	263 (75.1)	213 (60.9)	268 (76.6)	262 (74.9)	1006 (71.9)
Walker	236 (67.4)	210 (60.0)	221 (63.1)	200 (57.1)	867 (61.9)
Cyclist	27 (7.7)	3 (0.9)	47 (13.4)	62 (17.7)	139 (9.9)
No AT	87 (24.9)	137 (39.1)	82 (23.4)	88 (25.1)	394 (28.1)
Total	350 (100.0)	350 (100.0)	350 (100.0)	350 (100.0)	1400 (100.0)

Table 5   Active Transportation (AT) Patterns by Season for 10 Most Frequented Destinations

Destination	Total number of trips	Percent using AT				
		Fall	Winter	Spring	Summer	Total
Grocery store	1120	44.4	27.3	47.1	42.7	40.5
Restaurant	857	37.0	24.7	38.8	34.7	34.1
Bank	811	31.2	26.2	42.1	34.7	33.5
Work	732	32.1	30.7	35.8	37.6	34.1
Corner store	729	76.8	61.3	78.4	74.9	73.2
Home of friend	636	45.8	41.1	46.4	38.8	43.2
Shopping mall	628	18.2	17.7	21.3	23.1	20.1
Pharmacy	612	43.1	30.3	50.7	55.6	44.6
Drop off/pickup	550	22.6	21.4	16.9	10.6	18.0
Home of family member	526	18.9	17.8	19.6	26.5	20.6

or destination, the amount of time people are willing to engage in AT (and/or distance to travel) is fairly fixed. For walkers, one-third of all walking trips were to neighborhood-based destinations (ie, a corner store, home of a friend, or park) in roughly 10-minute intervals. These findings highlight the importance of considering nonwork, neighborhood-based destinations as key access points for walking-based AT, and suggest that AT research focusing on work-based destinations are likely not capturing the majority of people that use walking for AT.

The most popular destination for cyclists was work, which fell on the higher end of the duration spectrum. That cycling trips to work were typically longer in duration than for other destination types corresponds with previous Canadian research that found cyclists are willing to travel further distances for the purposes of getting to work,[8] and suggests that initiatives to promote cycling to work may be particularly effective at increasing PA levels among individuals that can cycle.[36] To confer population-wide benefit however, such initiatives would need to foster greater ridership among older cohorts and females.

Analysis of AT mode by season revealed that the highest proportions of Walkers were observed in the 2 seasons with the most moderate temperatures (ie, fall and spring), while the highest proportions of Cyclists were observed in the 2 warmest seasons (ie, spring and summer).[II] It is unclear why the proportion of Walkers was lower in the summer than spring and fall seasons; it may be that summer Cyclists tend to be Walkers in other seasons, but our use of 4 independent samples limits our ability to firmly conclude this. The winter survey sample had especially low rates of Cyclists (less than 1%), suggesting significant barriers to cycling (eg, cold weather, unsafe road conditions, inadequate attire) in the winter months in Kingston. That AT rates are almost always higher in the warmer seasons for most destinations suggests that engagement in all forms of AT are more challenging in the colder seasons in Kingston.

Implications for Active Transportation Interventions

This study observed important characteristics about people that do, and do not, engage in different forms of AT, offering ideas about how to target interventions to increase AT engagement. Walking for AT was far more common than cycling and Cyclists were more likely to be male—both trends that are not unique to this study.[29,30,38] However, these findings do suggest that greater support (eg, infrastructural improvements) is needed to increase the overall rates of cycling for AT in Kingston, and that any interventions should be particularly mindful about how to increase cycling rates among women. Research has shown that high rates of female bicycle ridership are good indicators of a bicycle-friendly community.[39] Meanwhile, the consistently high rate of Walkers observed in each season of our study highlights the importance of ensuring favorable conditions for walking on a year-round basis.

Our study found that AT users were more likely to be younger and employed than Nonusers. These findings suggest that greater support is needed to engage older residents in AT in Kingston. Such supports can include supportive physical infrastructure for walking (eg, provision of sidewalks that are clear and in good repair, benches, narrow street crossings, slower traffic speeds), as well as locating key amenities (eg, grocery stores, libraries, clinics) in residential areas with large proportions of seniors (eg, condominium and retirement complexes). Similarly, we suspect that the relatively low rates of AT observed among middle-income households is due to such households living in lower-density suburban neighborhoods that

offer more affordable housing than downtown neighborhoods, but that lack key destinations and infrastructure to support AT.

Most empirical research on AT has tended to focus on commuting to work[36] or school;[40] however, a unique contribution of this study is its consideration of a much broader range of destinations. We found that destinations vary in the frequency with which they are visited, and the mode by which they are accessed. As such, municipal policy-makers and planners might consider increasing the availability of, and safe and efficient access to, neighborhood-based destinations that already promote AT (eg, parks, corner stores, transit stops), as well as destinations that may be beyond one's neighborhood of residence but are visited frequently (eg, grocery stores, workplaces, restaurants). Such an approach would foster greater land use mix, density, and connectivity, which has long been advocated by the planning profession for creating vibrant and more active communities.[41] Destinations that generate particularly low levels of AT (eg, shopping malls, places of worship) will require longer-term commitment and vision, but support is growing for initiatives to retrofit these spaces to resemble more complete communities.[42] So, while work- and school-based destinations may be accessed daily by adults and children respectively, considering a broader range of destinations provides public health officials and planners with greater options for promoting AT in their jurisdictions.

Finally, our study generated some interesting comparisons between Walkers and Cyclists in terms of the destinations they frequent and the duration they spend engaged in AT. Walking was used in high proportions to access destinations that tend to be neighborhood-based (ie, 'parks,' 'corner stores'), while common destinations for Cyclists were more commercial ones likely located at a greater distance from respondents' homes (ie, 'work,' 'bank'). These findings suggest that investments in AT-supportive infrastructure should vary depending on the type of destination that is being accessed (eg, safe walking routes to parks, end-of-trip cycling facilities at workplaces). The relative consistency of time spent engaged in AT between Walkers and Cyclists in our study offers planners and transportation engineers some insights into where best to locate amenities, and AT routes to those amenities, to capitalize on this predictable threshold for time spent engaged in AT.

Study Limitations

Although not atypical for a survey of the general public,[43,44] the response rate for this study was low, which introduces the possibility of nonresponse bias. Given the topic, we surmise that non-responders were less likely to use AT on a regular basis, and thus, the prevalence of AT-Users in this study may be overestimated. The survey also generated a higher response from women which, given our findings, may have led to an underestimate of the prevalence of cycling for AT purposes in Kingston. Our findings may also be subject to recall desirability, as respondents were asked about their behaviors over the previous week. As we were seeking information on a broad range of destinations, we choose to capture only 1-way travel details to minimize participant burden. As such, we anticipate that the total amount of time our study sample spent engaged in AT is underestimated. Finally, people defined as 'cyclists' may have only ridden once, but may have walked for the rest of their trips. We made this decision because we felt that anyone that would be willing to ride a bicycle, even for a single trip in a week, would be different in sociodemographic terms from those that never rode a bicycle in 7 days. That the sociodemographic profile of the 'cyclists' in our sample is comparable to that found in other studies leads us to believe that our assumption was valid.

Conclusions

This study observed significant sociodemographic differences between AT Users and Nonusers, as well as between Walkers and Cyclists. These findings are consistent with existing literature. Destinations accessed by AT a majority of the time tended to be neighborhood-based, suggesting opportunities for intervention at the neighborhood-level to promote AT. The duration spent engaged in AT was comparable between modes, suggesting that the amount of time and/or distance people are willing to travel for AT is fairly fixed, and that the public health benefit for these activities is roughly equal. Given the variation in destinations accessed by mode, we expect that walking-based AT could be increased through better land-use mix within residential neighborhoods, while efforts to increase cycling for AT might better focus on employer-based initiatives, end-of-trip facilities, and improvements to roadways for safe and efficient travel by bicycle.

Acknowledgments

Notes

[I] We gathered information about 19 destinations to capture a broad range of AT activity.

[II] Average high temperatures for Kingston, Ontario are –2.8°C in January (winter), 10.9°C in April (spring), 25.7°C in July (summer), and 13.3°C in October (fall).[37]

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