Examining Travel Distances by Walking and Cycling in Montréal, Canada

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ABSTRACT

Active transportation – especially walking and cycling – is undergoing a surge in popularity in urban planning and transportation circles as a solution to the environmental and congestion issues plaguing many cities. However, in order to promote active transportation as a realistic alternative, it is necessary to better understand the distances that pedestrians and cyclists are willing to travel for different purposes. Better understanding of these distances will allow for transportation planners, designers, developers, and decision-makers to know how close destinations need to be placed to promote the use of non-motorized modes of transport. This paper focuses on how far people are willing to walk or cycle to different destinations in Montréal, Quebec, Canada. Also, it examines how travel distances vary within various geographic areas and by individuals' travel and socio-economic characteristics. This research uses the 2003 Montréal Origin-Destination Survey (O-D Survey) to calculate the network distance traveled by pedestrians and cyclists and to obtain travel and socio-economic characteristics for each individual. Primarily, the paper reveals that median walking distance recorded in the O-D survey is greater than the commonly accepted distance of 400 meters (1/4 mile). The median walking distance documented in this study is approximately 650 meters and higher for work purposes (800 meters). While no widely-held standard exists for cycling, the analysis reveals a median distance of around two kilometers with a high degree variation in distance. These findings will guide planners, designers, developers, and policy makers in promoting greater levels of walking and cycling and suggests future research directions within this field.

Introduction

As cities face the challenges of traffic congestion and greenhouse gases that have emerged from a half century of autooriented planning, cycling and walking are increasingly seen as alternatives that may come to bear a greater proportion of the transport burden. Indeed, the benefits of active transportation are manifold: while potentially reducing traffic congestion, human-powered transportation improves personal health, enhances quality of life, and has been linked to economic vitality in urban settings. The conventional wisdom related to active transportation – which generally refers to walking and cycling – is that trip origins and destinations should be brought closer together, facilitating easier access by these modes. Therefore, it is important to know how close destinations need to be placed for these transport modes. Consequently, for integrated land use and transportation planning as well as promoting active transportation, revealing the distance travelled by pedestrians and cyclists for different purposes has become an important field of research.

Data and Research Methodology

The study used the following data:

- The 2003 Montréal Origin-Destination Survey (O-D), conducted by the Metropolitan Transportation Agency (AMT).
- Census boundaries and street networks of the Montréal region, obtained from the Desktop Mapping Technologies Inc.

Montréal's O-D data contains 329,353 observations, where the modal share of walking and cycling is 9.3 percent and 1 percent, respectively. We consider these trips for pedestrians and cyclists, while excluding return to home trips. The total number of walking and cycling trips considered in this paper are 12831 and 1421, respectively. Network distance is calculated using individuals' origin and destination along a transportation network based on shortest path for walking and cycling trips in GIS. A set of distance decay functions for different purposes, namely, work, school, shopping, and leisure based on the network distances are estimated for walking and cycling trips. Spatial auto-correlation for walking and cycling trips is performed to examine the spatial patterns of clustering of long and short travel distances in different regions of Montréal. Travel and socioeconomic characteristics of pedestrians and cyclists found in the O-D survey allow analysis of travel distances with these attributes. The outcome for frequency distributions for both walking and cycling travel distances shows single-sided, long-tailed frequency curves, thus the median distance is considered rather than the mean to examine the relationships between

Purpose of Trips

Median cycling distance for all purposes (2242 meters) is approximately three or more times higher than the median walking distance (653 meters), due to the higher speeds associated with bicycle travel. Table 1 shows that the median distance is the highest for work trips for both walking and cycling. After that, individuals travel more by walking and cycling for leisure activities than for school and shopping.

	All		Purpose							
			Work		School		Shopping		Leisure	
	Walk	Cycle	Walk	Cycle	Walk	Cycle	Walk	Cycle	Walk	Cycle
Mean (m)	813	3140	993	3886	757	2273	754	2204	860	3360
/ledian m)	653	2242	801	3067	636	1550	581	1529	683	2318
35 th percentile (m)	1403	5517	1789	6442	1243	4355	132 7	3926	1572	6376
Standard Deviation	604	2792	718	3001	526	2012	605	2145	642	3158
Number of cases	12831	1421	2381	620	6259	369	259 1	205	1600	227
Percent of total	100	100	18.6	43.6	48.4	26.0	20.2	14.4	12.5	16.0
sample (%)										

TABLE 1 Walking and Cycling Distances

Distance Decay Function

A set of distance decay functions for four different purposes are estimated for walking and cycling trips using a negative exponential curve.

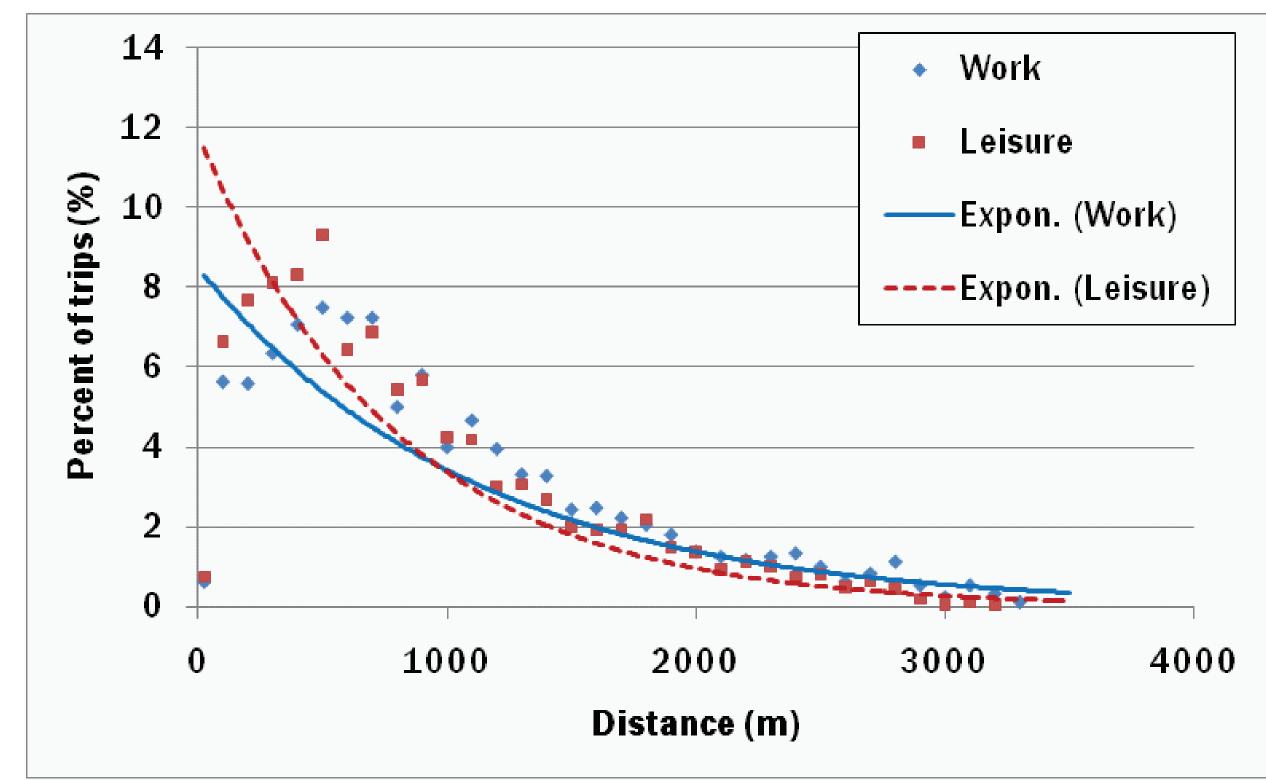


FIGURE 1 Distance Decay Curves for Walking Trips

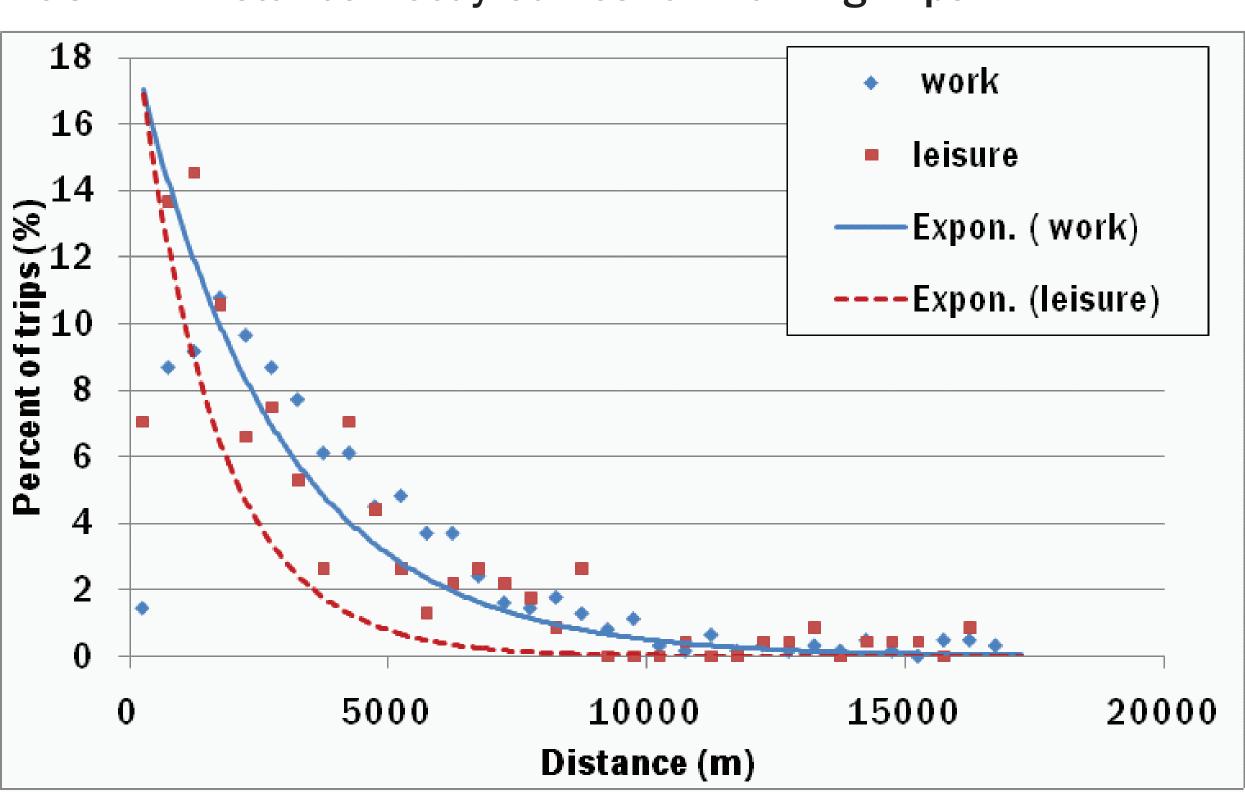


FIGURE 2 Distance Decay Curves for Bicycle Trips

Figure 1 indicates that walking trips extend up to approx. 3.5 kilometers for both work and leisure activities. For short distances, leisure activities comprise a much larger share of walking trips, however for distances greater than 1 kilometer; work trips comprise a much greater share. Revealing the more specialized nature of work activities, a higher percentage of people are willing to walk longer distances for work than for leisure activities, which can presumably be accessed closer to home. The fitted curve for cycling trips indicates that the majority of bicycle trips for work purposes are less than 5 kilometers, while curves for leisure trips are less than 3.5 kilometers. Notably, the curve for work trip distances decreases much more gradually than that for leisure trips, indicating that like pedestrians, cyclists are generally willing to travel greater distances for work than other purposes.

Trip Origin

The Montréal Metropolitan Region is divided into five regions using the city's borough and neighboring municipality boundaries as shown in Figure 3 and 4. Beginning in the city core, we identify these regions as: 1) Central business district (CBD); 2)

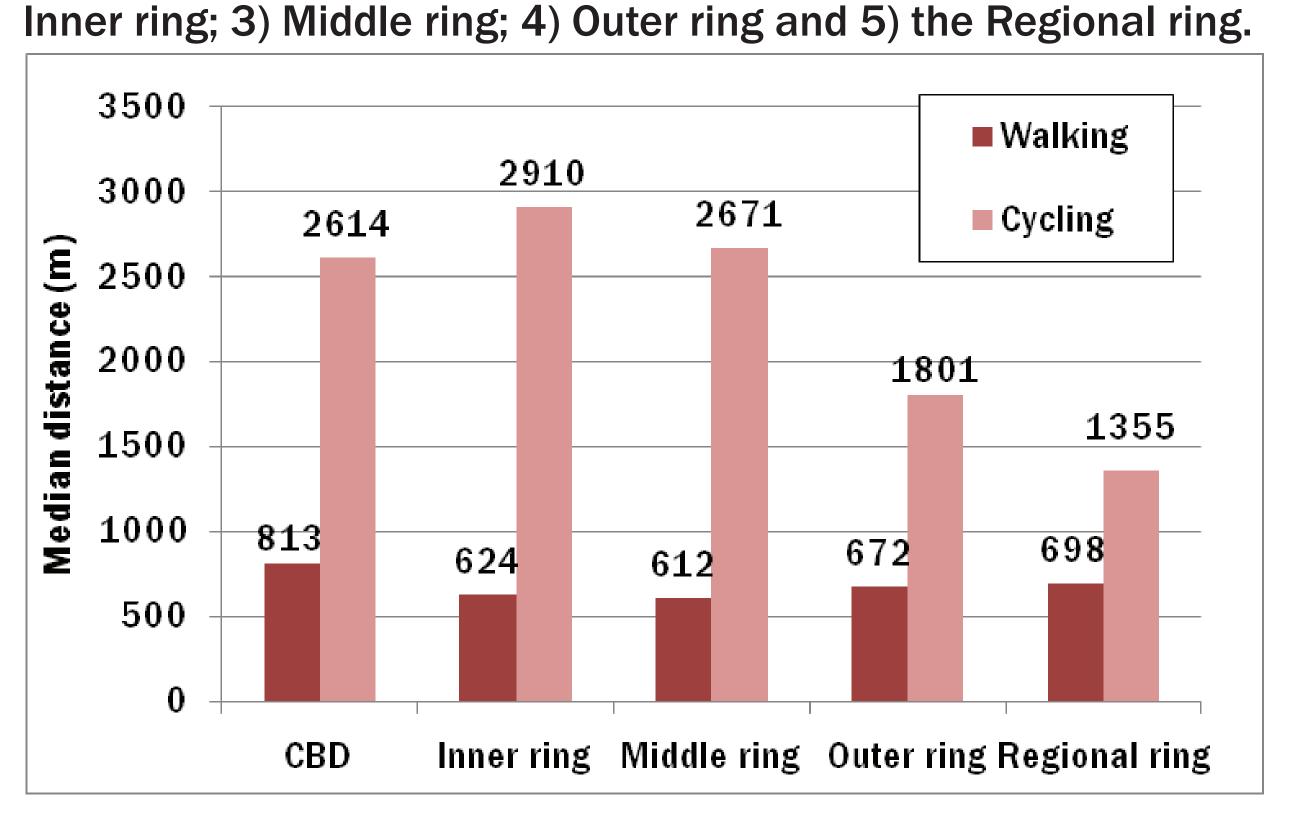


FIGURE 3 Median Walking and Cycling Distances in Different Re-

Among five regions, the CBD has the highest median walking distance (813 meters), though the percentage of walking trips originated in this region is the lowest (6.6 percent), likely due to its relatively small area and thus population. The analysis shows that with the increase of distance from CBD, the median walking distance decreases up to middle rings; then increases in the outer and regional rings. The scenario is different in case of cycling trips; the highest median distance of 2,910 meters is found in the inner ring.

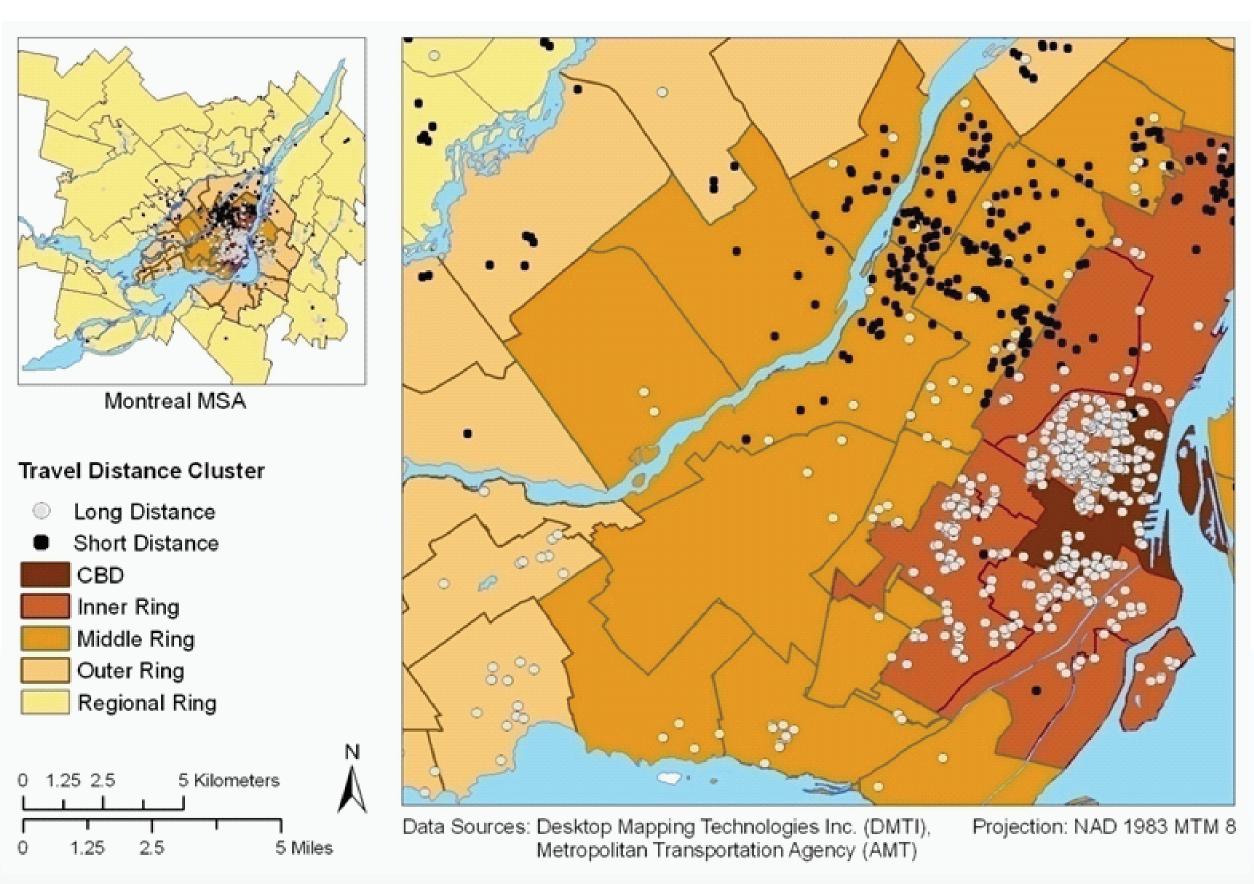


FIGURE 4 Long and Short Walking Distances Originating in Different Parts of the Montréal Region

The highest percentage of walking trips (31.5 percent) is originated in the inner ring. An especially dense cluster of low distance walking trips is observed in the middle ring which has 26.5 percent of total walking trips. Interestingly, this clustering of short distance walking trips occurs immediately adjacent to cluster of long distance walking trips in the inner ring.

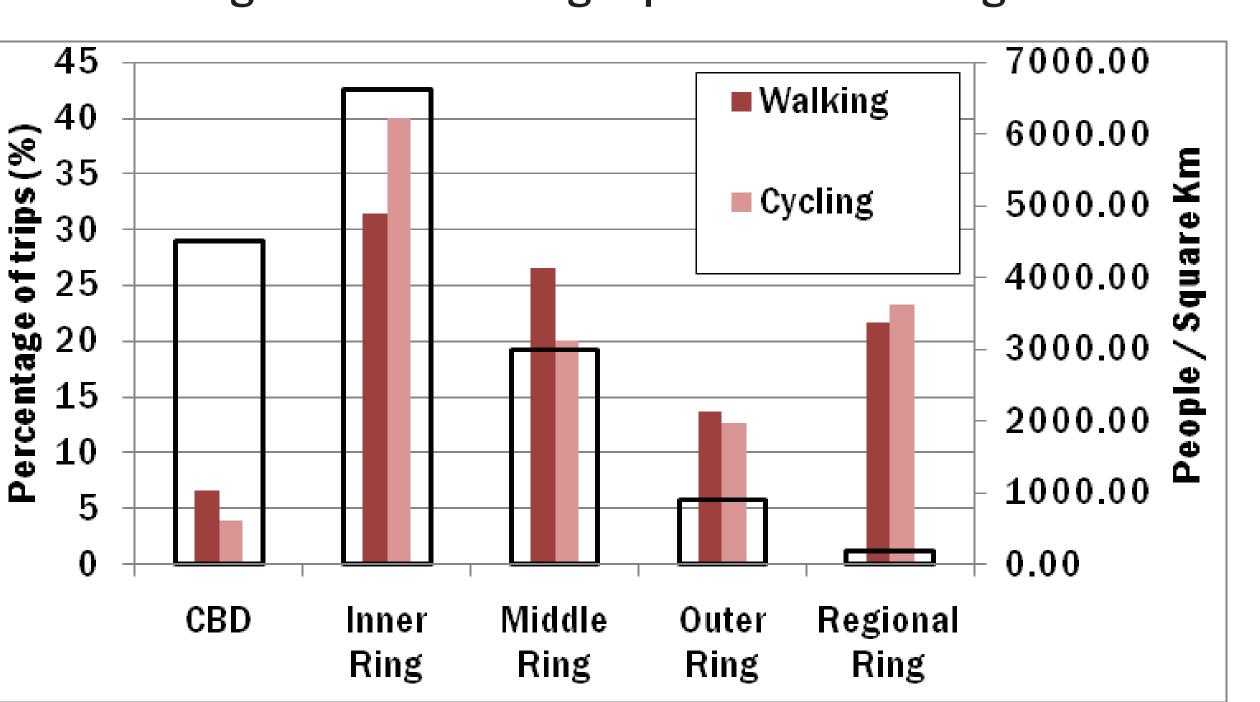


FIGURE 5 Population Density and Percentages of Walking and Cycling Trips Originating in Different Parts of the Montréal

While there is a positive relationship between population density and walking and cycling in the inner, middle and outer rings, the CBD and regional ring reveal that population density alone cannot explain the choice to walk or cycle.



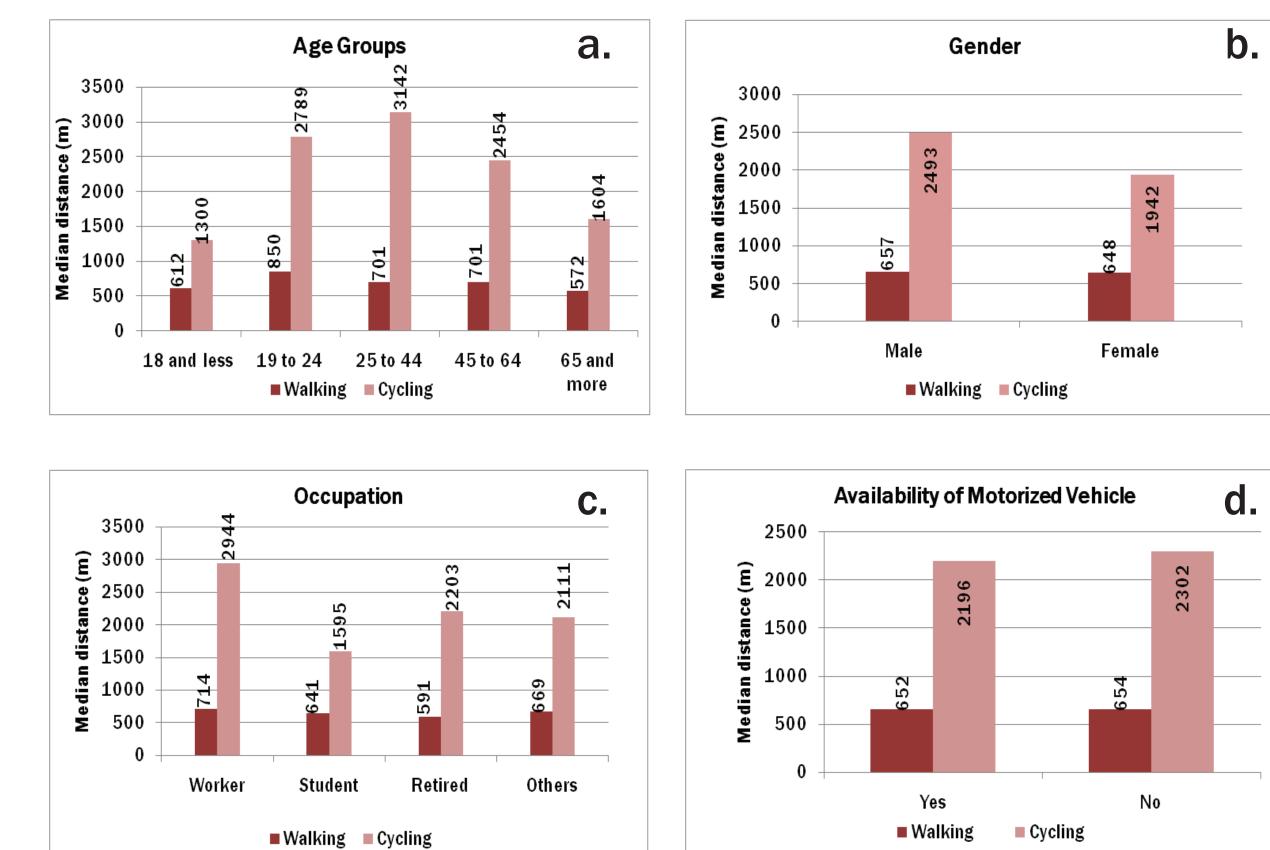


FIGURE 6 Median Distance based on Socio-Economic Character

Figure 6(a) indicates that there is a strong relationship between age of the individuals and median distance travelled by walking and cycling, requiring different strategies to promote walking and cycling among different age groups.

From Figure 6(b), it is seen that although the difference in median walking distance between men (657 meters) and women (648 meters) is low, it is statistically significant. However, the analysis shows a clear and strong difference of median cycling distances based on gender; male cyclists (2,493 meters) are willing to travel greater distances than the female cyclists (1,942 meters), an observation that supports previous findings. Figure 6(c) shows that workers travel greater distances both for walking and cycling trips than other groups. In Montreal, pedestrians and cyclists have similar rates of motorized vehicle ownership in their household. The result shown in Figure 6(d) may indicate that motorized vehicle availability has an influence on median travel distance, though less so in case of walking.

CONCLUSION

This paper reveals that median walking distance recorded in the Montréal Origin-Destination survey are greater than the commonly-accepted distance of 400 meters (1/4 mile), suggesting that people are willing to walk greater distance than the general guidelines. Also, it apperars that walking distance is influenced by other factors, especially geographic location and trip purpose. In the Montréal region, the median walking distance is approximately 650 meters and is higher for work purposes (800) meters). While no widely-held standard exists for cycling, the analysis reveals a median distance of around two kilometers with a high degree of variation in travel distance. Distance decay functions for both walking and cycling reveal that work trips have the most gradually declining curve, meaning that people will cycle and walk farther for work than they will for other purposes. However, this paper is limited to the Montréal Metropolitan Region and caution should be made when making generalizations. Since walking and cycling provide significant health benefits, travel distance may be analyzed in the light of health issues. Although pedestrians and cyclists generally use some short cuts in their routes such as walking or cycling across parking lots and other parts of land, this study only uses shortest network distances since it is not possible to model these short cuts unless we have detailed global positioning data for each person included in the survey considered in this paper. It is recommended that future research aim at modeling cycling and pedestrian behavior to that level of detail. It is hoped that drawing on the findings of this paper will allow planners, developers, and policy makers to create appropriate pedestrian and cycling facilities that support these healthful practices.

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