ACCESSIBILITY TO URBAN PARKS IN MONTREAL FROM THE PERSPECTIVE OF CHILDREN

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ABSTRACT

Parks are elemental components of urban environments that provide environmental value and serve valuable social functions. In order to enjoy the beneficial opportunities for activities in parks, users must have reasonable access to these resources. The objective of this paper is to measure accessibility to urban parks from the perspective of children travelling by walking in the island of Montreal, Canada. We evaluate the relationship between the distribution of children population and conditions of accessibility to urban parks, in order to understand the potential for use and possible spatial disparities in the distribution of valuable environmental resources. This research contributes to the assessment of the distribution of access to urban parks by children, and can inform planners and policy makers in order to improve the supply of public facilities (parks) from a transportation perspective.

Keywords: Accessibility, children, mobility, Montreal, urban parks

1 INTRODUCTION

During past decades, the issue of accessibility to urban green spaces or parks has attracted considerable attention (e.g. Talen and Anselin 1998; Nicholls 2001; Hewko, Smoyer-Tomic et al. 2002; Van Herzele and Wiedemann 2003; Lotfi and Koohsari 2009; Weiss, Purciel et al. 2011; Zhang, Lu et al. 2011; Higgs, Fry et al. 2012). A common characteristic of many of these studies has been the use of place-based accessibility measures (Kwan 1998) that consider the spatial and/or physical characteristics of cities but have been more limited in terms of accounting for variations in mobility between different users, due to age, gender, income level, and other socio-economic and demographic attributes (Paez, Scott et al. 2012).

For this research, the concept of accessibility is defined as the number of opportunities, also called "activity sites" available within a certain distance or travel time from the perspective of users (Hanson S. 2004). In that sense, accessibility could be used as an indicator of social equity (Paez, Mercado et al. 2010; Lucas 2012; Lucas and Jones 2012). The notion of equity is paramount in research that focuses on determining what factors account for, or are correlated with, spatial variation in public services. Accessibility is also a tool used to discover whether or not equity has been achieved (Talen and Anselin 1998) considering that accessibility measures are typically comprised of two basic components, the cost of travel (determined by the spatial distribution of travelers and opportunities) and quality/quantity of opportunities.

From a geographical viewpoint, the spatial configuration, distribution and number of parks in urban areas, represents the basic park access potential for local residential populations. Thus, it is not surprising that the spatial accessibility of neighborhood parks, mainly based on park proximity, location and size, is usually used to estimate the contribution of parks to physical and social activities (Zhang, Lu et al. 2011). In this sense, it is fundamental to understand that urban parks are key components of urban environments (Barbosa, Tratalos et al. 2007) not only for their green urban structure for leisure or distraction but also for the social contributions (Burgess, Harrison et al. 1988; Lindsey, Maraj et al. 2001; Cutts, Darby et al. 2009; Potestio, Patel et al. 2009; Seaman, Jones et al. October 2010), health (de Vries, Verheij et al. 2003; Coen and Ross 2006; Warburton, Nicol et al. 2006; Apparicio, Abdelmajid et al. 2008; Witten, Hiscock et al. 2008; Ries, Voorhees et al. 2009; Tilt 2010; Christie, Kimberlee et al. 2011; Moore and Kestens 2011) and environmental outcomes (Jacobs 1979; Burgess, Harrison et al. 1988; Coen and Ross 2006; Babey, Hastert et al. 2008; Cutts, Darby et al. 2009; Maroko, Maantay et al. 2009; Potestio, Patel et al. 2009; Restrepo 2009).

Previous research has explored the question of inequality in accessibility to parks (Talen and Anselin 1998; Lindsey, Maraj et al. 2001; Tsou, Hung et al. 2005; Paez, Mercado et al. 2010; Zhang, Lu et al. 2011), as this may be a limiting factor in terms of usage, and a source of disparities in health outcomes. A starting point for inquiries about urban parks utilization and the potential benefits of these spaces must begin with an assessment of their geographical accessibility.

As mentioned above, urban parks help promote physical activity and thus help reduce the risk of obesity and other adverse health outcomes (Witten, Hiscock et al. 2008; Cohen, Golinelli et al. 2009; Lackey and Kaczynski 2009; Ries, Voorhees et al. 2009; McCormack, Rock et al. 2010; Tilt 2010; McCormack, Giles-Corti et al. July 2006). In fact, these green spaces are particularly beneficial for children (Maas, Verheij et al. 2009). In effect, the topic of child/youth mobility is an emerging important topic in transport geography (Buliung, Sultana et al. 2012) mainly from concerns over the decreasing rates of active travel among children and the rising rates of obesity in different parts of the world, including Canada (Cutts, Darby et al. 2009; Potestio, Patel et al. 2009; Buliung, Sultana et al. 2012). In this sense, research concerning the physical characteristics of parks in Montreal neighborhoods with contrasting health outcomes (Coen and Ross 2006) exposed that "while neighborhood parks showed a variety of feature quality ratings, those located in poor health areas displayed several pronounced material disadvantages, including concentration of physical incivilities, limited provision of facilities for physical exercise, and adjacency to industrial sites and multi-lane roads. Equalizing park quality between areas may be an important step for public health promotion". This shows that it is important to know how accessible one place is in order to quantify their potential to satisfy social functions.

The World Health Organization (WHO) recommends that cities provide a minimum of 9 sq.m of green area per inhabitant, assuming that green areas are designed so that residents live within a 15 minute walk of an open space. In the case of a study in Montreal, in 2010 the city had 12 sq.m of green area per inhabitant which follows guidelines by WHO, but the study does not describe the distribution of access to urban parks. Further, it is important to mention that the youngest inhabitants in 2006 are largely located outside the island of Montreal and Laval and composing the 'new' suburbs (http://www12.statcan.ca/census-recensement/2006/as-sa/97-551/p20-eng.cfm#montreal), but this does not mean that no children live in this area. Actually, 80 children as an average are located within Montreal's Census Metropolitan Area (CMA) of the island (Canada 2006).

The general objective of this research is to measure accessibility to urban parks in the Island of Montreal from the perspective of children, in this case from 7 to 16 years old. In Canada, the legal age for age majority, and hence the end of childhood, is 18 years. In this work, we aim to address the following questions: What is the distance, considering variations in socio-economic and demographic attributes that children typically travel by walking in Montreal? Given a typical walking trip for a defined children profile, what is the level of accessibility to urban parks at different locations in the city? And, to what extent can disparities in equity be identified due to variations in accessibility?. Responding to the questions exposed previously, it will be possible evaluate the relationship between the distribution of the population of children and the conditions of accessibility to urban parks, in order to comprehend the possible spatial disparities in the distribution of these valuable environmental resources.

2 DATA

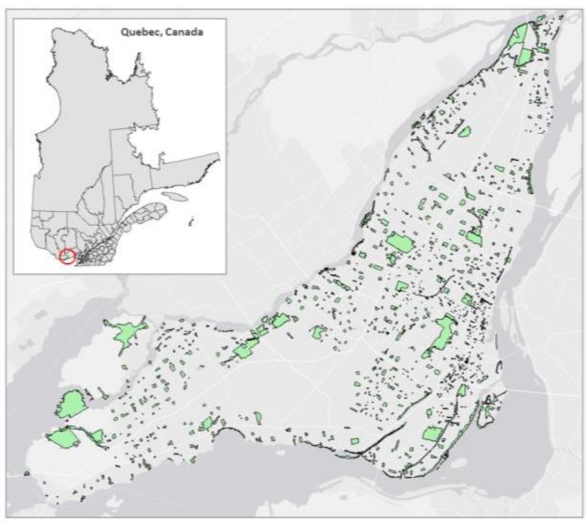
Two databases are used in order to implement the accessibility measure to urban parks in the Island of Montreal: Montreal's Household Travel Survey of 2008 and inventory of Montreal urban parks from open Street map.

Montreal's Household Travel Survey is the most complete survey of its kind in the province of Quebec, Canada. During the last 40 years, this origin-destination (OD) travel survey has been undertaken every five years, with the latest available iteration in 2008. The objective of this database is to offer data about the mobility aspects of people who live in the region to support transportation planning and research.

The survey is conducted using Computer Aided Telephone Surveys. It collects information of about 5% of all households in the region, that is, approximately 70,000 households. An important aspect of the survey is that it records information about the travel behavior of participating household members older than 5 years old, and their trips, including number, purpose, location of origin and destinations, and mode of travel. Furthermore, socio-economic and demographic information about the household and its members is obtained. Origins and destinations of trips are geocoded using structured databases on addresses, intersections, and trip generators. The result is a database comprising 122,420 individual records corresponding to individuals who performed out of home activities.

Data about Montreal public urban parks were extracted from open street map which was created by a group of researchers from the department of Civil, Geological and Mining Engineering, École Polytechnique de Montréal (see Figure 1).

Figure 1**.** Urban parks of Montreal island



3 METHODS

3.1 Estimates of travel behaviour

Estimates of trip length are obtained based on the application of multivariate linear regression. In order to assess possible variations in travel behavior due to location (in addition to other individual and contextual attributes), the expansion method developed by Casetti (1972) can be used. The expansion method is a simple tool to generate models with spatially-varying coefficients, which allow the analyst to obtain location- and person-specific estimates of distance traveled This approach has been effectively used in previous travel behavior and accessibility research to bring an explicitly spatial dimension as part of the analysis (Paez, Mercado et al. 2010; Roorda, Páez et al. 2010; Morency, Páez et al. 2011).

This analysis uses different categorical parameters and/or inputs like gender (male or female), income levels (less than 20K, 20-40K, 40-60K, 60-80K, 80-100K, and more than 100K), main occupation (fulltime, part-time, student, retired, work at home), household type (single, couple, couple with child, and single parent), class of transportation mode (car driver, car passenger, transit, school bus, walking, cycling, Kiss and Ride, Park and Ride and Other mode) and Driver License ownership (yes or no), and continuous variable such as age.

The expansion method begins with an initial model with one or more parameters. The initial model is expanded to include parameters, typically the geographic coordinates of the observations to capture the effect of geographic variation. Finally, the expanded parameters are substituted into the initial model to yield the terminal model, as show below:

Consider an initial model with a constant term constant (β_0), one explanatory variable and corresponding parameter (X_i, β_{1i}), and error term (ε_i):

$$Y_i = \beta_0 + \beta_{1i} X_i + \varepsilon_i \tag{1}$$

Now assume that the coefficient β_{1i} is a function of the geographic coordinates (u_i, v_i) . Represented as:

$$\beta_{1i} = f\,(u_i, v_i) \tag{2}$$

The equation (2) can be written as a linear form like below,

$$\beta_{1i} = \gamma_0 + \gamma_1 u_i + \gamma_2 v_i \tag{3}$$

The final model can be obtained by simply replacing the equation (3) into the equation (1) as shown below,

$$Y_i = \beta_0 + (\gamma_0 + \gamma_1\, u_i + \gamma_2\, v_i\,)X_i + \varepsilon_i = \beta_0 + \gamma_0\, X_i + \gamma_1\, u_i\, X_i + \gamma_2\, v_i\, X_i + \varepsilon_i \tag{4}$$

Clearly, the expansion method is simply a systematic approach to introduce variable interactions. Its power lies in the ability to model contextual variations, in this case due to location. Lastly, it should be clear that implementation in the case of more explanatory variables, and/or higher-order expansions (e.g. quadratic, cubic), is straightforward.

In the present case, the independent variable is the logarithm of the average trip length, based on all trips and purposes conducted by individual respondents (with the exception of the return home trip) during the day. Average trip length can be used as a basic measure of revealed mobility (Morency, Páez et al. 2011), and constitutes an indicator of everyday competence navigating one's environment (Mercado and Páez 2009). This variable was defined as the Euclidean distance from origin to destination. Although many studies argue in favor of using network distance, straight line distance is simple to compute, and in the case of Montreal is highly correlated with network distance (Apparicio, Abdelmajid et al. 2008). A logarithmic transformation is appropriate to ensure that the model predicts strictly positive trip lengths, and helps to compress the scale of the variable, which has a long tail. In terms of the expansions, the following variables are selected for estimation of expanded parameters: age, age squared (to account for a potentially non-linear relationship with trip length), gender, income levels and driver license. The expansions are given in terms of six geographic attributes viz. latitude, longitude, latitude squared, longitude squared, latitude times longitude, and distance from Central Business District (CBD). A specification search was conducted beginning with a fully specified model, and following a backward stepwise search. Variables were removed based on the significance of their corresponding parameters, in such a way that all variables retained for the final model have coefficients that are significant at the $p \leq 0.5$ level. It important to note that explanatory variables were selected based on theoretical considerations and a survey of the previous literature on distance travelled. For detailed discussions concerning the selection of variables appear, we refer the lector to Mercado and Páez (2009), and Morency et al. (2011).

3.2 Estimates of accessibility

In order to estimate the level of accessibility to public urban parks of children living in the Island of Montreal, we may relate their travel behaviour pattern with location of these parks.

This is achieved by first creating a child profile considering age, gender, transportation mode, main occupation, income class and family status. In this case, the advantage of the approach is that the analyst can select different attributes of travelers to obtain estimates of trip length. This is done to suit the objectives of the research. For example, if the interest is in analyzing and comparing socio-economic differences in access between a 10 year old child of low income and a child of the same age but of high income, estimates for each of these profiles can be obtained for comparative analysis.

Second, the geographic location of the public urban parks is represented by a centroid from data which was obtained from a group of researchers of the École Polytechnique de Montréal, as was mentioned before.

Third, travel behaviour is estimated in addition to the geo-localization of public urban parks which allows us to calculate the area of urban park that is accessible within the distance of a typical walking trip from the perspective of children.

Finally, the level of accessibility to public parks is expressed as a cumulative opportunities measure, that is, the total area urban green space available expressed in meters squared within the distance of the aforementioned typical walking trip.

3.3 Geographical representation

One of the best means to appreciate the level of accessibility to urban parks is to generate a grid with centroids that shows the area of urban parks as a function of travel behaviour patterns.

The procedure begins by defining a square grid for parks and for other land uses using a GIS system. In this case, is considered for urban parks a grid with centroids of 25*25 meters (m). In order to represent locations of potential travelers, a second grid of 250*250 m is also created. It is important to note that these selections for the grids are for representation purposes only, and can be refined as desired. After experimenting with different grid sizes we found that these gave the most effective visual representation of accessibility variations.

4 RESULTS AND DISCUSSION

4.1 Estimates of travel behaviour

The expansion method is used to generate estimates of travel behaviour and spatial location of Montreal inhabitants. The dependent variable is trip length after using a log-transformation to generate a more compact, normal-like distribution. The coordinates used for the expansion (X: latitude, Y: longitude, X^2: latitude squared, Y^2: longitude squared, XY: latitude times longitude and distance from Central Business District: DCBD) correspond to the place of residence of each respondent. Thus, the relationship with the independent variables, distance and trip length, were positive. Table 1 shows the estimates of the variables obtained.

After estimating the model, the coefficients of the model can be used to obtain estimates of walking trip length by children. The estimates are obtained by defining a profile, which establishes the values of the variables for evaluation of the model. For instance, a profile can be defined for a child based on age (e.g. 10 years old), gender (e.g. male), income class (e.g. 20-40 thousand), occupation (e.g. student), mode of travel (e.g. walking), and household type (e.g. couple with children). The coordinates needed for evaluating the expanded parameters correspond to the centroids of the grid created for this purpose. In other words, we use the model to estimate the trip length of a child of type *p* at *m* locations, where *m* is the number of cells in the grid. The estimates obtained from the model correspond to typical walking trip lengths specific to a person-location.

Table 1. Regression Model with spatially expanded coefficients

Variable Type	Variable	Estimate	p-value
Constant	Constant	2.07544	0.0000
Trend surface	Latitude sq.	0.01783	0.0000
	Latitude	-0.26708	0.0000
	Latitude * Longitude	-0.00993	0.0000
	Longitude	0.23050	0.0000
	Longitude sq.	0.01500	0.0000
Age	Age	-18.28581	0.0000
	* Distance from Central Business District	2.41404	0.0000
	* Latitude sq.	-0.37484	0.0000
	* Latitude	4.42945	0.0000
	* Latitude*longitude	0.07315	0.0000
	* Longitude	-2.78028	0.0000
	* Longitude sq.	-0.21217	0.0000
Age sq.	Age sq.	22.03076	0.0000
	* Distance from Central Business District	-2.95525	0.0000
	* Latitude sq.	0.43802	0.0000
	* Latitude	-5.19517	0.0000
	* Latitude*Longitude	-0.09337	0.0000
	* Longitude	3.36622	0.0000
	* Longitude sq.	0.25433	0.0000

Gender	Female	0.47034	0.0000
	* Distance from Central Business District	-0.08453	0.0000
	* Latitude sq.	0.01276	0.0000
	* Latitude	-0.13024	0.0000
	* Longitude	0.05830	0.0000
	* Longitude sq.	0.00545	0.0000
Family Status	Single	Reference	
	Couple	0.05113	0.0000
	Couple with Child	-0.23032	0.0000
	Single with Child	-0.26449	0.0000
Occupation	Full-time	Reference	
	Part Time worker	-0.24677	0.0000
	Student	0.02235	0.0091
	Retired	-0.33518	0.0000
	At home	-0.49736	0.0000
	Other	-0.39801	0.0000
Income Class (CAD)	Income: <20,000	Reference	
	Income: 20,000 – 40,000 (I2040K)	0.35884	0.0083
	* Distance from Central Business District	-0.06829	0.0000
	* Latitude sq.	0.00968	0.0057
	* Latitude	-0.06810	0.0494
	* Longitude	0.06789	0.0002
	* Longitude sq.	0.00588	0.0000
	Income: 40,000 – 60,000 (I4060K)	0.33928	0.0020
	* Distance from Central Business District	-0.03666	0.0000
	* Latitude sq.	0.01128	0.0003
	* Latitude	-0.11542	0.0012
	* Latitude* Longitude	0.00230	0.0574
	* Longitude	-0.02457	0.0024
	Income: 60,000 – 80,000 (I6080K)	0.60658	0.0001
	* Distance from Central Business District	-0.02427	0.0432
	* Latitude sq.	0.00832	0.0206
	* Latitude	-0.09920	0.0128
	* Latitude* Longitude	-0.00255	0.0565
	* Longitude	0.07524	0.0002
	* Longitude sq.	0.00476	0.0017
	Income: 80,000 – 100,000 (I80100K)	0.46343	0.0000
	* Latitude	-0.06055	0.0000
	* Latitude* Longitude	-0.01042	0.0000
	* Longitude	0.05571	0.0000
	Income: Grater than 100,000 (IG100K)	0.43943	0.0000
	* Distance from Central Business District	0.02488	0.0089
	* Latitude sq.	-0.00091	0.0625
	* Longitude	0.08353	0.0000
	* Longitude sq.	0.00600	0.0001
	Incomes: Refuse	0.12359	0.0000

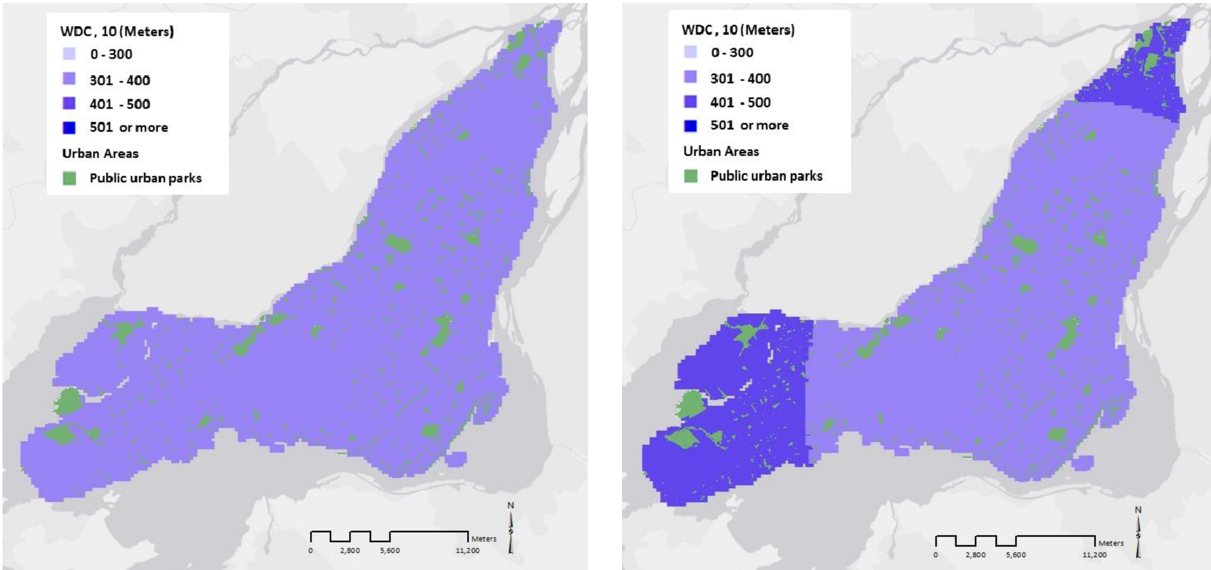
Driving License	Driving License		0.18461	0.0000
Transportation Mode	Car as a Driver		Reference	
	Car Passenger		0.01844	0.0061
	Transit		0.39636	0.0000
	School Bus		0.06512	0.0000
	Walking		-1.80475	0.0000
	Cycling		-0.68306	0.0000
	Kiss and Ride		1.10158	0.0000
	Park and Ride		1.08716	0.0000
	Other Mode		2.48917	0.0000
		R2	0.393	
		Standard error	1.074	
		n	283,615	

Note: 5% confidence level in the table that displays the results.

As discussed above, the model of travel behavior supports very flexible comparative analysis. To illustrate, we consider two walking profiles for children as in the example above (age 10, income 40-60k, student, living with two parents), with the only difference being gender (See Figure 3). It can be seen in the figure that males tend to undertake somewhat longer walking trips, something that becomes more evident in the suburban parts of the island. Whereas the longest trips by females tend to be less than 300 m, for males the maximum trip length can exceed 300 m in places. Figure 3 illustrates walking trip length for a profile defined as above, but now income class is greater than CAD 100 thousand. Compared to their lower income counterparts, walking trip lengths are considerably longer. Other things being equal, this is expected to result in greater accessibility to urban parks. Other profiles can be defined and compared as desired.

Figure 2. Walkable distance of children (10 years old), income: 20,000 – 40,000 CAD

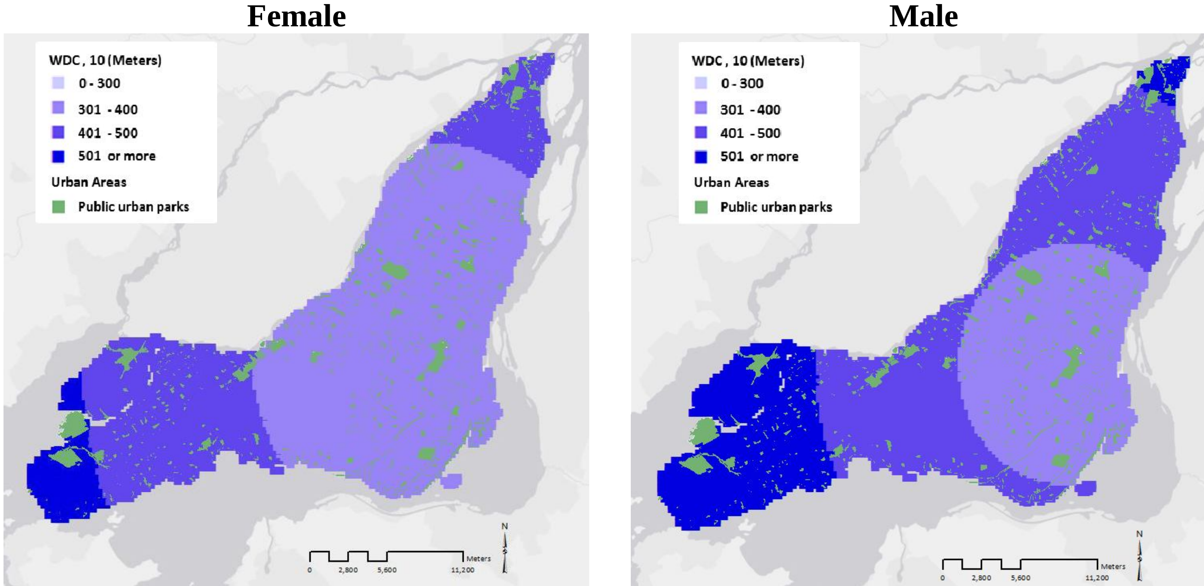
Female **Male**



Age	Gender	Income class (CAD)	Main Occupation	Class of transportation mode	Family
10	Female	20 - 40K	Student	Walk	Couple with Child
10	Male	20 - 40K	Student	Walk	Couple with Child

Figure 3. Walkable distance of children (10 years old), income: >100,000 CAD

Female **Male**



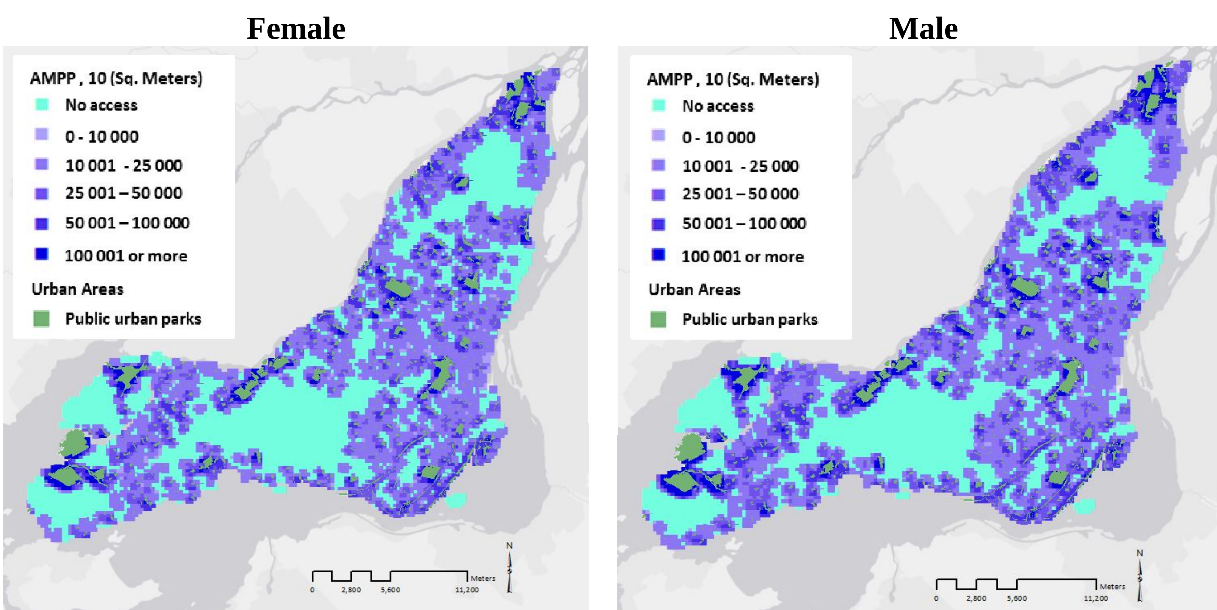
Age	Gender	Income class (CAD)	Main Occupation	Class of transportation mode	Family
10	Female	Greater than 100K	Student	Walk	Couple with Child
10	Male	Greater than 100K	Student	Walk	Couple with Child

4.2 Accessibility

Based on the estimates of walking trip length obtained above, the cumulative opportunities accessibility indicator previously explained can be implemented. The results indicate that the distance that children typically walk Montreal Island is influenced by age, gender, income class, and place of residence. Age is one factor that displays a positive association with walking distance. In other words, walking trip length tends to increase with increasing age and income. Females travel shorter distances. In general, trip lengths are shorter near the center of the city. As mentioned before, the available evidence indicates that socio-economic status is an important factor in terms of usage of facilities and a source of disparities in health outcomes. This is partly based on the fact that children without access have a lower probability of using facilities and therefore are more likely to be adversely affected by this issue (Lucas & Jones, 2012). The ability to conduct comparative analysis therefore provides a powerful tool to understand gaps in service, and disparities in potential access. Given variations in travel behavior, and a geographically non-uniform distribution of public urban parks, it follows that accessibility to these facilities must also display spatial variations. In this section, we use two examples in order to illustrate variations in the patters of accessibility to parks by children in the study area. Using the same profiles as above, we explore differences in gender and income, and their impact on accessibility to urban parks in Montreal Island. The first example corresponds to the profile with income class 20-40k. We compute the Accessibility

Measure to Public Parks, for males and females, as shown in Figure 4

Figure 4. Accessibility measure of public parks (10 years old), income: 20,000 – 40,000 CAD



Profile	Age	Gender	Income class (CAD)	Main Occupation	Class of transportation mode	Family
3	10	Female	20 - 40K	Student	Walk	Couple with Child
4	10	Male	20 - 40K	Student	Walk	Couple with Child

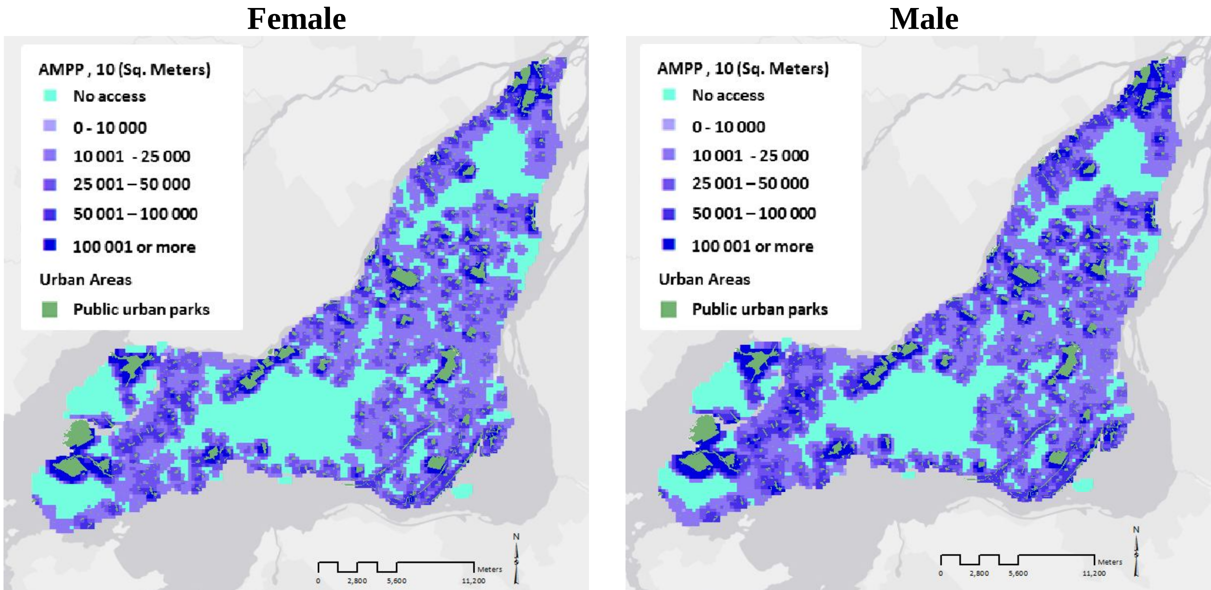
Table 2. Accessibility measure of public parks (10 years old), income: 20,000 – 40,000 CAD

Accessibility to Public Parks (sq. m)	**Profile 3**	**Profile 4**
Children of this profile without access	41%	36%
0 – 10,000	20%	19%
10,001 – 25,000	17%	17%
25,001 – 50,000	13%	15%
50,001 – 100,000	7%	9%
100,001 or more	2%	4%
Total	100%	100%

The figure shows the area available to children in correlation with the distance that children are able to walk. As expected, females have lower accessibility. Based on these accessibility calculations, Table 2 tabulates the percentage of children that have access to different amounts of park area. The numbers range from 41% (female) and 36% (male) of children who lack access to public parks within walking distance, to a few children who have access to areas in excess of 50,000 m^2.

For comparison, Figure 5 illustrates the accessibility to public parks from the perspective of children identical to the two profiles above, but who belong to the higher income class (greater than CAD 100 thousand). As expected, the level of accessibility is greater, and it can be seen in Table 3 that the percentage of children without access to urban parks within walking distance drops to 34% in the case of females, and to 30% in the case of males. Some children in this income class have in places access to urban park areas in excess of 100,000 m^2. These results indicate the existence of disparities in accessibility to parks, by gender, but more markedly, by income level. As noted above, these profiles are used for illustrative purposes only, and others could be defined as desired.

Figure 5. Accessibility measure of public parks (10 years old), income: >100,000 CAD



Profile	Age	Gender	Income class (CAD)	Main Occupation	Class of transportation mode	Family
35	10	Female	Greater than 100K	Student	Walk	Couple with Child
36	10	Male	Greater than 100K	Student	Walk	Couple with Child

Table 3. Accessibility measure of public parks (10 years old), income: >100,000 CAD

Accessibility to Public Parks (sq. m)	Profile 35	Profile 36
Children of this profile without access	34%	30%
0 – 10,000	18%	16%
10,001 – 25,000	18%	18%
25,001 – 50,000	16%	17%
50,001 – 100,000	10%	13%
100,001 or more	4%	7%
Total	100%	100%

5 SUMMARY AND CONCLUSIONS

In this paper we investigated the accessibility to urban parks from the perspective of children in Montreal Island. By using methods of spatial analysis, we obtained estimates of walking trip length specific to an individual profile and location. This approach was inspired by the relative accessibility indicators presented by Páez et al. (2010). An attractive feature of the method adopted for this research is that it allows us to evaluate accessibility in a very flexible way, by defining individual profiles of interest. Furthermore, by accounting for the mobility patterns of children, more accurate and responsive estimates of service gaps can be obtained. We would argue that customized accessibility profiles are an improvement over current practice, whereby analysts assume that parks provide access in certain influence areas that disregard well documented variations in trip length.

The analysis of children mobility is a relatively new theme (Buliung, Sultana et al. 2012), especially taking into account the active transport as a way of transportation. In fact, this research strongly contributes in understanding the relationship of children mobility patterns and their access to urban public parks, using a method based on the creation of specific profiles which had not been conducted in the analysis of access to parks so far. Moreover, the proposed method allows performing a comparative analysis between children with different mobility characteristics, gender, age, and other socio-economic factors which can be used to strengthen equity issues such as accessibility, health- related, financial- related and community-related (Lucas and Jones 2012)

One of the principal contributions of this research is that policy makers may use this methodology to provide better accessibility to public parks, to improve the land use and transportation issues as well as health outcomes of children considering their social, environmental and economic situation. In fact, the conceptual change proposed in this study lies in that the measurement of access to urban parks is analyzed from the perspective of mobility patterns, in this case of children, considering the distances that each one of these are willing to walk. This is opposite to the present form of analysis on accessibility to urban parks which considers that parks provide access in certain influence areas (direct and / or indirect) considering that the entire population has the same patterns of access to the urban parks which sometimes falls into an excess of demand for public urban parks as many people will not have that average level of mobility.

The average walking distance for children in the island of Montreal is 350 – 400 meters and this distance is highly correlated with gender and income class (socioeconomics). Additionally, the quantity of public parks (area) available to children with high incomes is greater than low incomes because children with higher incomes presented higher mobility patterns, in this case walking In the same sense, one of the points that it will be interesting to investigate in the future will be analyse if the fact that wealthier children walk farther is more likely a reflection of the street networks than income levels (wealthier areas on the island tend to have more curvilinear street patterns which tend to make trips farther) considering Origin Destination Data.

The activity standards of the World Health Organization (WHO) are perhaps too lenient. Their recommendation suggests 15 minutes, but based on a walking speed of 4km/hour, that would be 1000 m. Our research found that most walking trips were less than half of that (350 - 400 m) so that the assessment of social, environmental and economic could be overvalued thus generating, a misunderstanding in the analysis of gaps in topics like social equity and transportation disadvantage (Lucas 2012). We have to emphasize that children outside Montreal or Canada might be willing to walk more or less, because that depends on Data that are used.

Based on the assumptions made, 35% (average) of the children did not have access to public parks, mainly due to differences like gender, age and income. Therefore, the island of Montreal does not have problems with the quantity of green area per inhabitant if we contemplate the set standards (WHO); instead the issue is with the distribution of parks in the region. In this sense, the results of this study may influence the evaluation of urban parks by providing insight into the urban public policies on the region, on topics such as health, environment, social equity, social justice and integration.

From the current study, we are not sure whether children with access to public parks are actually using these parks. In order to fully understand children´s use of parks, future research could focus on relating accessibility with the health status of children to fully understand the real contribution of urban parks to child health outcomes. Similarly, field surveys could focus on the characteristics and patterns of active mobility of children accessing urban parks, to understand the distances that they travel and, with this information compare with the distances arising from the model. Additionally, we can develop a comparative analysis of these green areas through audits of city parks in order to determine the most relevant variables when choosing between different parks. This will enhance the understanding the main conditions that children and / or their parents have in mind when choosing to access urban parks.

Additionally, this research generated many questions that both the reader and the author is left wondering. Should there be more parks? Is the distribution of these urban parks equitable? Should there be better pedestrian routes to access parks? How does access to parks differ across the island of Montreal? Do more densely populated areas have more parks?. Even thought it was not a goal to respond these questions in this research, we emphasize that it will be necessary in future research explore these questions in order to assist urban or transportation policy for the Island of Montreal and for any other city, because this methodology is fully applicable to other cities which have an Household Travel Survey.

Moreover, to improve the accessibility calculation, the semi-private green areas such as schools, universities, churches, public buildings, and malls could be added to the analysis, while excluding areas impossible to use like airports, seaports, private property, etc. In the same sense, future efforts can help to measure accessibility of parks and others urban services in different ways, for example by evaluating and comparing the entire non-motorized modes of transportation using the network distance instead Euclidean distance. Finally, in the future works, it could be an opportunity to examine where children play during the year, and then look at access to those places. For instance, it might be that children play at malls, especially in winter.

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