

Equapolis: A Tracker for Exposure and Awareness of Inequity in Toronto

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Mission Statement

Toronto is Canada's largest city and serves as the capital of Ontario. This Canadian metropolis contains a population of over 2.9 million throughout its 140 neighbourhoods covering an area of 630.2 km². Toronto represents Canada as a diverse world leader that roots for culture and ethnicity^[11], however; the city has failed to take accountability regarding issues of neighbourhood equality. The city of Toronto specifically has come under fire for having high levels of disparity in quality of life between primarily white neighbourhoods and neighbourhoods where primarily visible minorities reside^[2]. The 2019 Vital Signs of Toronto report confirmed that Toronto neighbourhoods are racially segregated, with the highest concentration of visible minorities living in the lowest-income neighbourhoods^[10]. The reason for these disparities is a positive feedback loop of systemic racism. A single act of discrimination - whether it be someone failing to attain a job, a loan, or housing - can have a significant ripple effect, which affects the socioeconomic status of visible minorities to a great extent. This issue needs to be exposed and addressed, which is what Equapolis aims to do.

It is 2021 and now more than ever, the federal, provincial, and municipal governments of Canada are facing scrutiny for institutional racism as outdated policies have negatively affected marginalized communities. From more well-known examples such as rural Indigenous communities going without clean water to more obscure but equally harmful examples such as black Torontonians being 20 times more likely to be shot by police than their white counterparts^[8], it is clear that systemic racism is a problem here in Canada, no matter how “nice” our international reputation may be.

Another result of inequity found within the population would be food insecurity. It affects almost 1 in 5 Toronto households. This is largely a byproduct of inequity among neighbourhoods. Essentially, the worse a family's socioeconomic status is, the more likely they are to be severely food insecure, and in Toronto, these families happen to disproportionately be visible minorities. A lack of access to and awareness of food bank programs in Toronto have reduced the efficacy of community support efforts for those facing food insecurity. Equapolis considers these factors and makes food bank

searching simple by providing the option to locate nearby local food banks^[5]. This tool also provides information on areas where community support may be lacking.

Our app aims to expose disparities between neighbourhoods in Toronto by creating a Neighbourhood Inequity Index (NEI) so that residents can see exactly what is happening in their own backyard. It aids in providing a broad quantitative assessment of wellbeing across the 140 neighbourhoods in Toronto ^[3]. It is a toolset to support the advancements of equity solutions. Our team believes that the term equity means ensuring both the wellbeing of individuals and communities, as well as moving towards closing racial gaps. By displaying the NEI on our application, we provide a snapshot into the state of each community and wellbeing of residents^[1]. This must not be mistaken as an indicator of service inputs or population groups, rather the index is based on overall neighbourhood outcomes^[3].

The purpose is to support community resilience in overcoming disparity among the overall population. We are aiming to reduce inequality by first exposing primarily racially-based inequality in Toronto^[4]. We have created an app where users can see neighbourhood-based data pertaining to the quality of life of residents, and compare it to other datasets such as the concentration of visible minorities. Users can effectively identify these disparities, in order to fully understand racial inequality and move towards addressing these issues in the community. Food insecurity, neighbourhood disparities, and racial inequity are intertwined and complicated issues. We hope for a city in the near future where everyone is equal - an Equapolis.

App description and Features

This app helps users identify communities in Toronto that are facing inequity compared to their neighbours. Using the Neighbourhood Inequity Index, you are able to examine neighbourhoods facing unequal circumstances, and view all the factors that lead to this inequality.

Search by Neighbourhood

This feature allows users to choose a neighbourhood from the drop-down menu to zoom in and display their equity indicators

Compare Neighbourhoods

This feature displays a column chart to compare inequity indicators between neighbourhoods

User can specify a spatial extent by drawing on the map to compare user-defined neighbourhoods

Compare Layers

Note: The "Neighbourhood Equity" and "% Visible Minorities" layers must be turned on in Layers for this feature

This feature allows the user to visually compare neighbourhood equity with concentration of visible minorities

Swipe the center bar to compare the layers, and view the legend for the layer symbology

Visible minority populations refer to; South Asian, Chinese, Black, Filipino, Arab, Southeast Asian, West Asian, Korean, and Japanese

Locate Nearby Food Banks

Living in a low equity neighbourhood is an indicator for food insecurity, which affects 1 in 5 Toronto households. However, food banks are underused because of lack of knowledge of their existence.

This feature allows the user to enter their address or drop a pin to locate food banks near them and display their contact information

Default search radius is 5 km, user can scroll the bar to increase or decrease it

Users can also click the "Directions" button to access full directions from their location to any food bank

Calculations

Calculations for the Neighbourhood Equity Index (NEI) were done following the procedure outlined by the Social Policy Analysis and Research team for the City of Toronto^[12]. All calculations were made using Microsoft Excel and the Field Calculator in ArcGIS Pro.

The NEI was calculated using 15 indicators that were weighted and combined to form the index. The 15 factors are outlined in detail in Table 3 of the "Geospatial Open Data Sources" section.

Part 1 - Indicator Standardization

Because the 15 NEI indicators were presented in different units, they had to be standardized so that they all ranged from 0-1, where 1 is inequitable and 0 is equitable. For indicators where higher values indicate high inequity (such as Low Income), the following formula was used for standardization:

$$\text{Standardized Value} = [\text{Indicator Value} - \text{Min}(\text{Indicator Value})] / [\text{Max}(\text{Indicator Value}) - \text{Min}(\text{Indicator Value})]$$

Sample Calculation with Low Income (Bridle Path-Sunnybrook-York Mills Neighbourhood):

$$\begin{aligned} \text{Standardized Value} &= [8.019441 - 5.579399] / [49.847095 - 5.579399] \\ &= 0.05512 \end{aligned}$$

For Indicators where the low values signify inequity (such as Postsecondary Completion), the following formula is used to standardize to reverse the direction of the underlying indicator:

$$\text{Standardized Value}_{\text{reverse}} = (\text{Max}[\text{Indicator Value}] - \text{Indicator Value}) / (\text{Max}[\text{Indicator Value}] - \text{Min}[\text{Indicator Value}])$$

Sample Calculation with Postsecondary Completion (Bridle Path-Sunnybrook-York Mills Neighbourhood):

$$\begin{aligned} \text{Standardized Value} &= (89.1 - 37.5) / (91.7 - 37.5) \\ &= 0.04797 \end{aligned}$$

Part 2 - Assigning weights and weight standardization

Each indicator was assigned a weight reflective of its proportion to its contribution in describing the inequity between neighbourhoods. Weights were derived by the Social Policy Analysis and Research for the City of Toronto using a principal components analysis with varimax ^[12].

The final weights were assigned by the Social Policy Analysis and Research for the City of Toronto after consulting with community agencies, leaders, City divisions and other partners ^[12].

Table 1. Standardized indicator PCA results (rotated factors) ^[12]

Indicator	Factor 1	Factor 2	Factor 3
Unemployment	0.798	0.244	0.154
Low Income	0.808	-0.196	0.22
Social Assistance	0.769	0.11	0.509
High School Graduation	0.546	-0.174	0.543
Marginalization	0.843	0.027	0.111
Post Secondary Completion	0.812	0.216	0.239
Municipal Voting	0.73	-0.083	-0.454
Community Places for Meeting	-0.064	0.805	-0.384
Walk score	0.264	0.872	-0.204
Healthier Food Stores	-0.035	0.863	-0.228
Green Space	-0.065	-0.755	-0.213
Premature Mortality	0.189	-0.324	0.825
Mental Health	0.56	-0.081	0.202
Preventable Hospitalizations	0.43	-0.12	0.776
Diabetes	0.826	0.323	0.218
Eigenvalue	5.378	3.147	2.559

Factor 1 refers to neighbourhoods with high socioeconomic challenges, such as high unemployment and lower incomes. Factor 2 describes neighbourhoods with physical infrastructure challenges, such as low walkability and a low number of healthy food stores. Factor 3 refers to neighbourhoods with acute vulnerabilities, such as higher premature mortality and unnecessary hospitalizations. These factors correspond to the research done by Urban HEARTS@Toronto as common challenges faced by Toronto neighbourhoods, making these factors appropriate for calculating inequity.

Because the Neighbourhood Equity Index is meant to identify differences between neighbourhoods, the factors explaining the most variance were weighted more heavily. Weights for the 15 indicators (listed in Table 1 above) were derived by the Social Policy Analysis and Research for the City of Toronto based on the Eigenvalues and community consultations ^[12].

The composite weight for each indicator was calculated using the following formula, which was done in Microsoft Excel by Team McRaster:

$$\text{Indicator Weight} = (\text{Factor Score}_1 \times \text{Eigenvalue}_1) + (\text{Factor Score}_2 \times \text{Eigenvalue}_2) + (\text{Factor Score}_3 \times \text{Eigenvalue}_3)$$

Sample calculation of the Indicator Weight for Diabetes:

$$\begin{aligned} \text{Indicator Weight} &= (0.826 \times 5.378) + (0.323 \times 3.147) + (0.218 \times 2.559) \\ &= 6.017 \end{aligned}$$

Once the indicator weights were calculated, they were standardized so the sum of all weightings equal 1, using this formula:

$$\text{Standardized Indicator Weight} = \text{Indicator Weight} / \text{Sum of all Indicator Weights}$$

Sample calculation of the Standardized Indicator Weight for Diabetes:

$$\begin{aligned} \text{Standardized Indicator Weight} &= 6.017 / 51.213 \\ &= 0.117 \end{aligned}$$

Table 2. Final weights (in %) of all 15 indicators

Domains	Indicator	Weight	Domain Weight
Economic Opportunities	Unemployment	10.6%	30.3%
	Low Income	8.4%	
	Social Assistance	11.3%	
Social Development	High School graduation	7.4%	28.0%
	Marginalization	9.6%	
	Post Secondary Completion	11.0%	
Participation in Decision Making	Municipal Voting Rate	4.9%	4.9%
Physical Surroundings	Community Places for Meeting	2.3%	6.9%
	Walkability	7.1%	
	Healthy Food Stores	3.8%	
	Green Space	-6.4%	
Healthy Lives	Premature Mortality	4.1%	29.9%
	Mental Health	6.4%	
	Preventable Hospitalization	7.7%	
	Diabetes	11.7%	

Part 3 - Calculating the Neighbourhood Equity Index (NEI)

Weighted Neighbourhood Equity index was first calculated so that the resulting scores ranged from 0 to 1, where 1 is inequitable and 0 is equitable:

Weighted Score = Sum of (Standardized Indicator Value_{*i*} × Standardized Indicator Weight_{*i*})
Where *i* is one of the 15 indicators

Sample calculation of the Weighted Score for Diabetes (Bridle Path-Sunnybrook-York Mills Neighbourhood):

$$\begin{aligned}\text{Weighted Score} &= 0.040404 \times 0.117 \\ &= 0.169223\end{aligned}$$

Finally, the scores were reversed and multiplied by 100 so that the final Neighbourhood equity Index would range from 0 to 100, with 0 being least equitable (worst outcomes) and 100 being most equitable (best outcomes):

$$\text{Neighbourhood Equity Index} = (1 - \text{Weighted Score}) \times 100$$

Sample calculation of the Neighbourhood Equity Index (Bridle Path-Sunnybrook-York Mills Neighbourhood):

$$\begin{aligned}\text{Neighbourhood Equity Index} &= (1 - 0.169223) \times 100 \\ &= 83.08\end{aligned}$$

Note: The equations were provided by the Social Policy Analysis and Research for the City of Toronto, but all calculations were re-done by Team McRaster in Microsoft Excel and the ArcGIS Pro Field Calculator to display the data spatially. The intention of Team McRaster is to display this data in an interactive and transparent manner, to reach the citizens of Toronto and key decision makers.

Geospatial Open Data Sources

Table 3. Data for Visible Minorities Layer

Data Layer	Data Source
% Visible Minorities	2016 Neighbourhood Profiles (Toronto Open Data)
Population of each neighbourhood	2016 Neighbourhood Profiles (Toronto Open Data)

Table 4. Data used to calculate the Neighbourhood Equity Index (NEI). Data was compiled by Urban HEART@Toronto and the NEI was calculated by Team McRaster using ArcGIS Pro and Microsoft Excel.

Data Layer	Data Source
Unemployment (Number of unemployed persons age 15+)	2011 National Household Survey
Low Income (Percentage of persons living below the after-tax low income measure)	Statistics Canada
Social Assistance (Percentage of persons who are recipients of Ontario)	Toronto Employment & Social Services

Works, persons on ODSP participating in OW employment programs and non-OW persons receiving assistance with medical items)	
High School Graduation (Composite measure of four indicators predicting the rate of youth graduation from high school (2006-2011))	2006 Census
Marginalization Index (A combined measure of 18 variables representing residential instability, ethnic concentration, dependency and material deprivation)	Ontario Marginalization Index
Post-Secondary Completion (Percentage of persons age 25-65 with post secondary certificate, diploma, or degree)	2011 National Household
Municipal Voting Rate (Percent of eligible voters who voted in the last municipal election)	Toronto Election & Registry Services, Toronto Open Data
Community Places for Meeting (Average number of meeting places within a 10 minute walking distance measured from each residential block in the neighbourhoods [including libraries, recreation facilities, and places of worship])	Toronto Open Data
Walkability (A walkability score between 0 (not very walkable) and 100 (very walkable))	Walkscore.com
Healthy Food Stores (The average number of healthier food stores within a 10 minute walking distance from each residential block in a neighbourhood)	Toronto Open Data, Toronto Dinesafe
Green Space (Average amount of green space (including parks and public areas) per km ² in a 1 km circular buffer from each residential block in the neighbourhood)	DMTI (University of Toronto)
Premature Mortality (Age-adjusted number of deaths under age of 75 per 100,000 population age under 75)	Ontario Mortality Data 2005- 2009, Ontario Ministry of Health and Long-Term Care
Mental Health (Percentage of those age 20+ reporting very good or excellent mental health)	2005-2011 Canadian Community Health Survey
Preventable Hospitalizations (Age and sex adjusted number of ambulatory care sensitive condition hospitalizations per 100,000 population)	2009-2011 Discharge Abstracts Database, Canadian Institute for Health Information
Diabetes (Age and sex adjusted number of persons age 20+ with diabetes per 100 population)	Ontario Diabetes Database, Ontario Registered Persons Database, Ontario Ministry of Health and Long-Term Care

Note: The Food Banks layer was created by Team McRaster.

Reference

- [1] <https://nationalequityatlas.org/research/index-findings>
- [2] <https://www.thestar.com/news/gta/2018/09/30/toronto-is-segregated-by-race-and-income-and-the-numbers-are-ugly.html>
- [3] <https://www.toronto.ca/wp-content/uploads/2017/11/97eb-TSNS-2020-NEI-equity-index-methodology-research-report-backgroundfile-67350.pdf>
- [4] <https://www.toronto.ca/legdocs/mmis/2014/cd/bgrd/backgroundfile-67382.pdf>
- [5] <https://www-cambridge-org.libaccess.lib.mcmaster.ca/core/journals/public-health-nutrition/article/assessing-the-relevance-of-neighbourhood-characteristics-to-the-household-food-security-of-low-income-toronto-families/7CCCA5930BA7171F2C893188671BEC3F>
- [6] https://datacommons.org/place/wikidataId/Q172?utm_medium=explore&mprop=count&popt=Person&hl=en
- [7] <https://www.toronto.com/news-story/10111865-this-is-a-fact-systemic-racism-makes-life-harder-for-many-ontarians/>
- [8] <https://globalnews.ca/news/7029694/canada-systemic-racism/>
- [9] <https://globalnews.ca/news/7015522/black-neighbourhoods-toronto-coronavirus-racism/>
- [10] <https://torontofoundation.ca/wp-content/uploads/2019/10/VitalSigns2019.pdf>
- [11] <https://www.canadapopulation.net/toronto-population/>
- [12] <https://www.toronto.ca/wp-content/uploads/2017/11/97eb-TSNS-2020-NEI-equity-index-methodology-research-report-backgroundfile-67350.pdf>

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