Equity Analysis of The 2051 Regional Transportation Plan

Research Summary and Partial Report

Prepared originally for **Metrolinx**

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Revised for Mobilizing Justice on May 21, 2026

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Executive Summary

In the fall of 2023, Drs. Steven Farber and Willem Klumpenhouwer were retained by Metrolinx to conduct a quantitative analysis of the current state of transit equity and the impact of the 2051 Regional Transportation Plan (RTP) Update on the state of equity in the GGH region.

This document is a partial reproduction of the report. It includes some chapters as originally produced, along with some illustrative substitutions to replace removed information. It represents a combined research report and methods summary intended as a resource for future work.

The main outputs of the evaluation included:

- A comprehensive set of metrics to evaluate the equity performance of existing conditions and scenarios (Chapter 2). *This chapter is reproduced in its entirety from the original report.*
- A review of existing population groups being used in analyses and suggest changes where needed. This included facilitating a community engagement session (Appendix B) to work towards a consensus on measures and defining population groups. *This content has been reproduced in its entirety from the original report.*
- Analyzing Statistics Canada's Survey of Household Spending data to gain an understanding of transportation affordability in the GGH (Section 1.4). *This section is reproduced in its entirety from the original report.*
- A map of under-served areas intersected with marginalized populations, identifying areas of transport poverty. (Chapter 3). *This chapter is reproduced in its entirety from the original report.*
- A measurement of the changes in the distribution of benefits and their equity metrics for various forecasted scenarios (Chapter 4). *This chapter has been substantially changed to use illustrative results from a different dataset, and is not reflective of the planning scenarios used by Metrolinx.*

- A simulation of the sensitivity of equity results to changes in the spatial distribution of population groups that might occur due to processes such as gentrification and displacement. *This chapter was included in the original report but has been removed from this document. This approached generally followed the work by Jeff Allen and Steven Farber in their 2021 analysis of the Ontario Line*[1]

The analysis of both the current state of transit equity and the 2051 scenarios yielded the following high-level insights:

- Zero-car households are more likely to live close to higher-order and regional transit stops, while those at risk of marginalization in the housing, immigration, and means population dimension categories are slightly more concentrated around transit stops than the average individual.
- In Toronto, racialized residents (particularly Black residents) live in areas with higher levels of transport poverty than average and when compared with other marginalized groups.
- Outside of Toronto, Indigenous populations face the most extreme levels of transport disadvantage and inequity compared to all other population groups.
- Large portions of the non-urbanized GGH experience zero or negligible access to important destinations via transit. This is especially true for non-employment destination types.
- In non-urban GTHA areas, transit access inequities and disadvantages are largely experienced by Indigenous people and tenants living in subsidized housing (which may overlap).

Based on our analysis of inequality and transport disadvantage in the GGH, we have listed some recommendations below. Note that these recommendations are focused on region-wide equity considerations. They are intended to be incorporated with others as part of a standard business case or planning exercise:

- Continue to measure and benchmark measures of equity in the GGH, especially after service improvements are delivered and after new censuses are conducted. These benchmarks and the framework used here can be incorporated into project prioritization, business cases, and other studies of the current and future state of transit in the GGH.
- Prioritize transit service improvements that work to lower transport disadvantage, while minimizing or improving region-wide inequality.
- Specifically study and prioritize transit connections that serve Indigenous groups, especially in rural or peri-urban areas of the Greater Toronto and Hamilton Area (GHTA) and on reserves.

1. Introduction

1.1 Background and Context

This work is part of a deliberate approach to include explicit quantitative and qualitative evaluation of transportation equity in long-range planning at Metrolinx. A 2016 report reflecting on Metrolinx' *The Big Move* from an equity perspective[1] recommended the addition of social equity (with a clear definition) as a stated pillar in addition to a "strong economy" and "clean and healthy environment". In particular, the report recommended that the definition and measure of access should be broadened beyond physical access to infrastructure and include the ability of vulnerable residents to use transit to reach their desired destinations. The report states that "[access] (related to people), not mobility (related to infrastructure) is the better and more meaningful measure of how successful a transit system is".

While the 2041 RTP[2] does not add a specific pillar of social equity as recommended, it does adapt some measures of access to opportunities (specifically to employment opportunities) as a stated outcome of the plan, and speaks to challenges faced by low-income residents that rely on transit. The Ministry of Transportation Ontario Plan *Connecting the GGH: A Transportation Plan for the Greater Golden Horseshoe* provides policy direction that is more explicit in its vision for equity in the region and provides direction for this work. It calls for "improved services and greater access across the transit system for underserved areas and communities" as well as making "transit and other transportation services more convenient and affordable for a full range of users."[3] The 2051 RTP will be looking for opportunities to improve transit equity and access to opportunities for equity deserving groups across the region, including First Nations and Indigenous communities. This report will inform the specific actions to address this in the RTP as well as methods to measuring progress to that effect.

1.1.1 PREVIOUS DISTRIBUTIVE EQUITY ANALYSES AT METROLINX

Over the past few years, Metrolinx has worked to develop and incorporate more sophisticated measures of access and equity when evaluating large-scale transportation projects.[4] This body of equity-related work includes evaluation of a proposed Ontario Line alignment, training of staff on data analysis and technical approaches to evaluating access and equity,[5] and the development of specific regional measures and suggested population groups.[6] This report builds on previous work, adapts it for a regional transportation planning context, and advances the state of practice to reflect updated approaches to regional evaluations.

In related work, Metrolinx developed an equity index using the Ontario Marginalization Index (ON-Marg), which was tested as a means to measure equity when prioritizing between unfunded projects for future business cases. ON-Marg uses four dimensions of marginalization: Material deprivation, ethnic concentration, dependency, and residential instability. Specifically, the aim was to consider equity-deserving neighbourhoods in proximity to infrastructure projects. This method parallels one of the four measures (proximity to transit) used in this analysis. The Ministry of Transportation Ontario has also implemented an equity that will "influence its decision-making and operationalize its equity mandate."[7] The framework includes four key strategies:

- Equitable distribution of benefits and costs resulting from transportation decisions
- Safe and secure transportation for all Ontarians
- Access to opportunities for all Ontarians to enable them to effectively participate in society.

1.2 Approaches to Distributive Justice

There are a number of theoretical and philosophical frameworks through which to discuss distributive equity or justice, each with their individual outcomes, benefits, and potential drawbacks.[8] These approaches largely ask the question of how to define or identify equity goals for, and problems existing within, the transportation system.

- **Sufficientariansim** is focused on ensuring that all individuals have reached or are provided a minimum level of benefit, or see a maximum amount of burden. For example, ensuring that "all individuals in a city are able to reach half of all available jobs within one hour's travel" uses a sufficiency approach to access and equity evaluation.
- **Egalitarianism** aims to raise the level of services provided to the people in the worst-off positions in society. In this context, providing improving access for marginalized populations would be the primary goal.

- **Prioritarianism** focuses on providing benefits to areas or individuals with the current lowest levels of access to opportunities.
- **Utilitarianism** aims to lift the average or aggregate amount of benefit in society. In this approach, plans which increase the overall average level of accessibility would be prioritized.
- **Capacity approach** attempts to include individual abilities and barriers to ensure that everyone is able to access opportunities.

Traditional large-scale economic and business case evaluations focus on utilitarian arguments, considering populations largely as a whole and providing minimal comparisons within or between groups. This equity assessment draws on key aspects of egalitarianism, prioritarianism, and sufficientarianism. In particular, the measures described below quantify how proposed changes in the transportation system can help reduce gaps between marginalized and non-marginalized groups and, additionally raise people out of transport poverty, while prioritizing groups that are especially vulnerable. These themes and approaches were discussed in a fall stakeholder workshop with participants from across the GGH, which is summarized in Appendix B (page 47).

1.3 Project Overview

This report is organized as follows: After an overview of transportation affordability in Canada and the GGH, we provide an overview (Chapter 2) of what we measured in our analysis of regional transport equity. Chapter 3 sets the context of the current state of transit-focused transportation equity in the GGH and provides an external validation of the GGHM's usefulness in evaluating equity as a long-term ridership forecasting tool. Chapter 4 provides a hypothetical evaluation of planning scenarios based on how the benefits are distributed among population groups throughout the region.

While some broad recommendations are made with respect to continued analysis and potential future study in the Executive Summary, this is a technical report and therefore remains silent on direct policy outcomes and advice with respect to the design of the RTP or other future planning.

1.4 Transportation Affordability in Canada

After housing, transportation is the second largest spending category for most households in Canada. In the current climate of rising prices across all areas of the household budget,

the high costs of transportation make it difficult for some households to afford the basic necessities of life. Similarly, the high costs of transport can result in reduced trip-making and participation in daily activities. As such, it is imperative that transportation remains affordable for the entire population, with special attention provided to lower-income residents.

In the GGH, a region largely characterized by automobile dependence outside of the core of Toronto, measurements of transportation affordability are largely driven by the relatively high costs of automobile ownership, maintenance, and use which has been recently estimated at averaging over $1,300/month across Canada.[9] As compared below, the costs of transit fares and monthly passes are more affordable to the majority of low-income households. What drives unaffordability is the degree to which households remain dependent on automobile use despite its high cost relative to transit. This suggests that continued investment in transit infrastructure and service delivery will have the biggest impact on transportation affordability in the GGH over the long term, as more and more households will be able to maintain desirable levels of trip-making without incurring the high costs of automobile ownership.

Despite this, the costs of transit can constitute a significant burden for lower income households, but when taking a regional view, transit expenses are outweighed by the costs of forced car ownership due to the relative utility of owning and using cars throughout the majority of the GGH. It is quite difficult to assess the price burden of fares on low-income households without specialized data collection, but previous reports show that the costs of transit for GGH residents have grown rapidly, with TTC passes increasing from $109 to $156 between 2009 and 2023 and the single fare rising from $2.25 to $3.35 in the same period. These fare increases correspond to 43% and 49% respectively, compared to an inflation of 38% during the same period.[10] We note that the difference between the growth in fares compared to inflation was much higher in the years preceding the rapid inflation experienced in Canada as a result of the COVID-19 pandemic, and that there have been recent strides towards fare integration across regional municipalities and Metrolinx.[11]

One way to assess the affordability of transportation using existing datasets is to examine household expenditures on transportation relative to their overall spending using the Statistics Canada Survey of Household Spending. With this survey, Statistics Canada estimates annual household expenditures on hundreds of items within 14 major expenditure categories, including a category for transportation. Given the sample size of the survey, we could obtain expenditure estimates for residents of the largest Census Metropolitan Areas (CMAs) and Census Divisions (CDs) in Canada, disaggregated by income quintile and by household poverty status using the Market Basket Measure. We use these estimates to examine the cost burden of transportation for households with different incomes, and generate equity measures using ratios of spending between income groups.

As can be seen in Figure 1.1, Toronto CMA households in the lowest quintile of annual income spend just over 12% of their income on transportation, a higher percentage than any other income quintile, and about 40% more than households in the highest income quin-

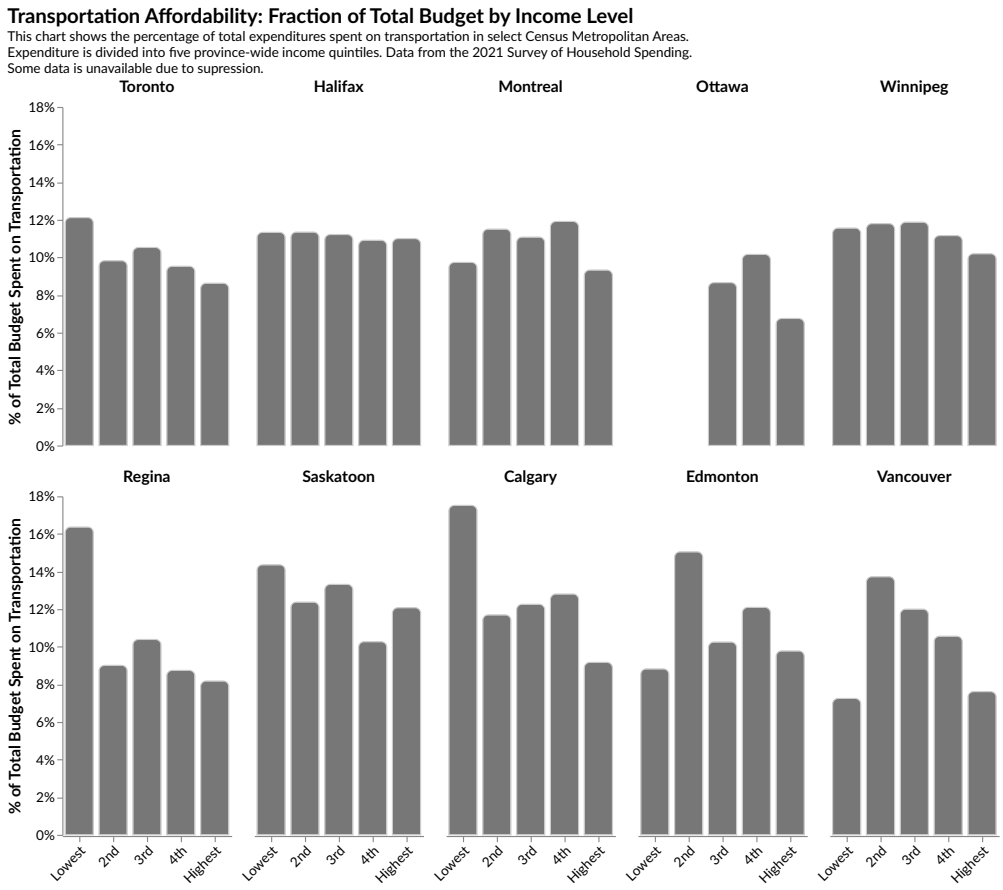

Figure 1.1: Percent of total expenditures spent on transportation by provincial income quantile for select metropolitan areas.

tile, despite lower income households demonstrating lower rates of automobile ownership. Recommendations for how much a household should spend on transportation varies between 10-20%, and the combined expenditures on housing and transportation should not exceed 50%. Given these guidelines, transport expenditures in the Toronto CMA are within acceptable levels, even for the lowest income quintile. It is necessary to drill down below the quintile level to determine if those in the bottom 5 or 10 percent of the income distribution have even higher shares of expenditures on transportation. It is not possible to do this given the available sample, which is limited due to requirements to use large geographies and combined attributes to avoid data suppression for privacy reasons. It is important to track this measure over time to ensure that overall expenditures on transport do not become more unaffordable in the future.

By comparing the transportation expenditures between income quintiles, we can observe that the Toronto CMA has the third highest inequality ratio of about 1.42, lower only than Calgary and Regina (see Figure 1.2). Interestingly, Montreal has a far lower ratio of about 1.04, while Vancouver and Edmonton have ratios of 0.95 and 0.90 respectively, indicating that lowest quintile households spend a smaller share of their income on transportation compared to the wealthiest households in those CMAs.

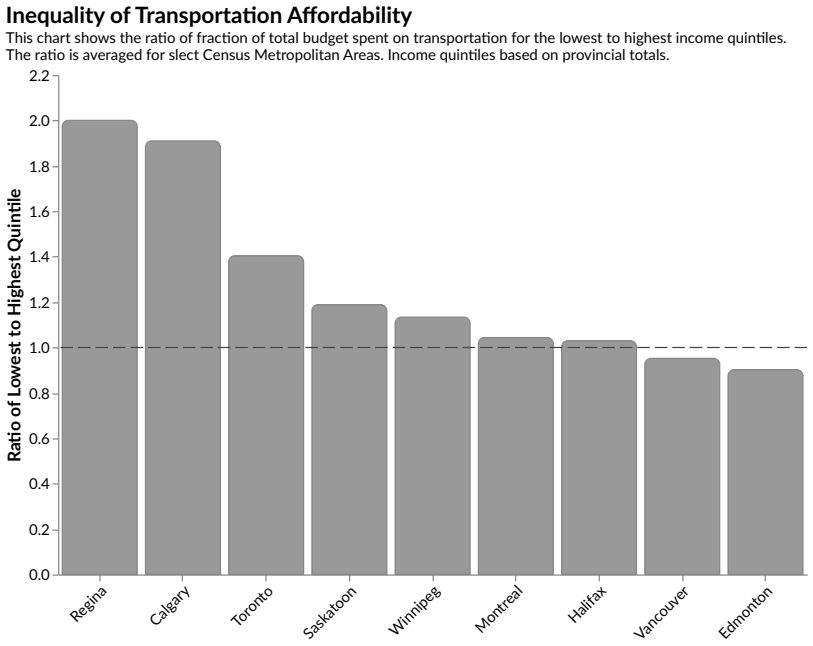

Figure 1.2: The ratio of lowest to highest income quintiles in a measure of total expenditures spent on transportation (CMA).

When examining the data for CD areas that are more transit-supportive and less wealthy than Canada's more expansive CMAs, we find that transport inequalities are even higher (Figure 1.3). Of particular concern is that the inequality ratio jumps to 1.74 within the Toronto CD, indicating that the lowest quintile of households in City of Toronto fare even worse relative to wealthier residents when compared to those in the broader CMA. This jump in inequality is visible regardless of employing the quintile or MBM thresholds for defining income categories. This means that the differences are likely driven by expenditures rather than income levels.

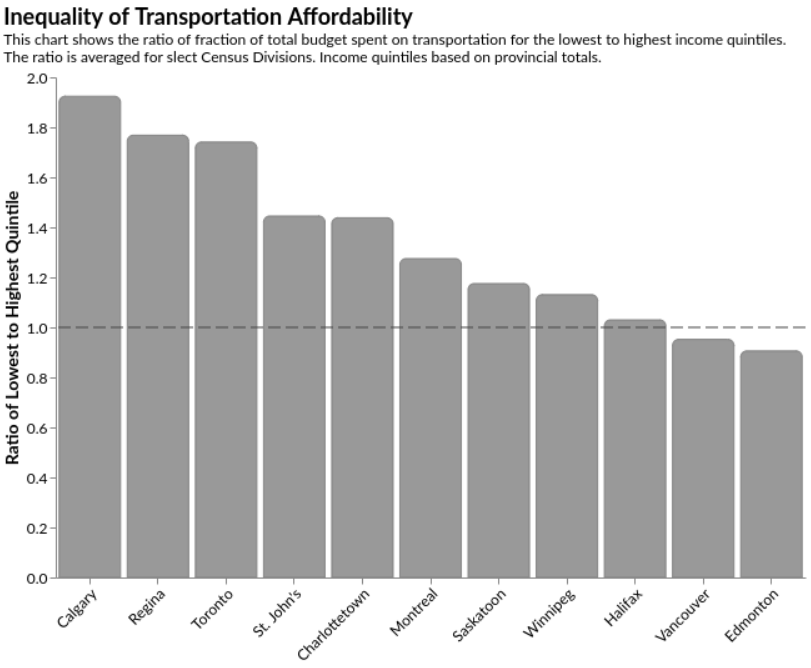

Figure 1.3: The ratio of lowest to highest income quintiles in a measure of total expenditures spent on transportation (CD).

2. What We Measured

The goal of this analysis is to ensure that transportation plans benefit marginalized groups in an equitable way. To do this, we must define a benefit, provide a definition of equity, and establish definitions of marginalized population groups across which to measure differences in benefits.

2.1 Summary

- We divided the GGH into five geographic areas based on Statistics Canada urban area definitions.
- We defined measures of access to opportunity and proximity to transit.
- We defined two families of equity measures: Inequality ratios, which measure how the average benefit is distributed among marginalized populations in direct comparison to non-marginalized populations, and transport poverty measures which determine spatially and cumulatively what portions of marginalized population groups experience the worst access.
- Based on previous work and stakeholder feedback, we defined 18 marginalized population and household groups, which are categorized into seven dimensions of equity: language, age, means, housing, immigration, race, and transportation.

2.2 Study Area

Region-level analysis of transport equity requires acknowledging differences in the needs and expectations of individuals in different urban and regional contexts. This is especially true for regional public transit planning: rural areas may not have the same expectation

of transit service as urban areas, and mandates that drive an agency's planning approach might differ in different contexts.

The GGH contains a wide variety of urban, suburban, exurban, and rural areas. Our goal is to account for these differences in some capacity while still maintaining large enough areas to study both spatial and population-based differences and inequalities throughout the region. Instead of relying solely on political and administrative boundaries, we divided our study area into five mutually exclusive planning areas based on a combination of political jurisdictions and urban area definitions provided by Statistics Canada:

1. The **City of Toronto** is the most densely populated area of the region. The available transit and employment opportunities make the City of Toronto a dominant force in the study of access and often is the driving influence for aggregate statistics on populations and access. For this reason Toronto is considered as its own entity.
2. The **urbanized GTHA**: includes urbanized areas in the regional municipalities of Hamilton, Halton, Peel, York, and Durham.
3. The **non-urbanized GTHA** includes non-urbanized areas in the counties of Hamilton, Halton, Peel, York, and Durham.
4. **Urbanized regional areas** include urbanized areas within the regional municipalities of Niagara, Haldimand, Brant, Waterloo, Wellington, Dufferin, Simcoe, Kawartha Lakes, Peterborough, and Northumberland.
5. **Non-urbanized regional areas** include non-urbanized areas within the regional municipalities of Niagara, Haldimand, Brant, Waterloo, Wellington, Dufferin, Simcoe, Kawartha Lakes, Peterborough, and Northumberland.

These regions encompass all land in that area, including First Nation reserves.

2.3 Access to Opportunity

This report assembles a big-picture view of both the current state of transportation equity and the impacts that planned and potential outcomes of the 2051 RTP have on advancing transportation equity in the Greater Golden Horseshoe region.

Our main measure of transit benefit is **access to opportunities** (often referred to as accessibility and henceforth shortened to "access"), which attempts to quantify the amount of possibility or freedom that a transit system provides a resident. The Access measures we deploy describe how many destinations are reachable within a reasonable amount of effort, or how far away a specific type of destination is. More detail on why access matters is found in Section 2.4 on page 12.

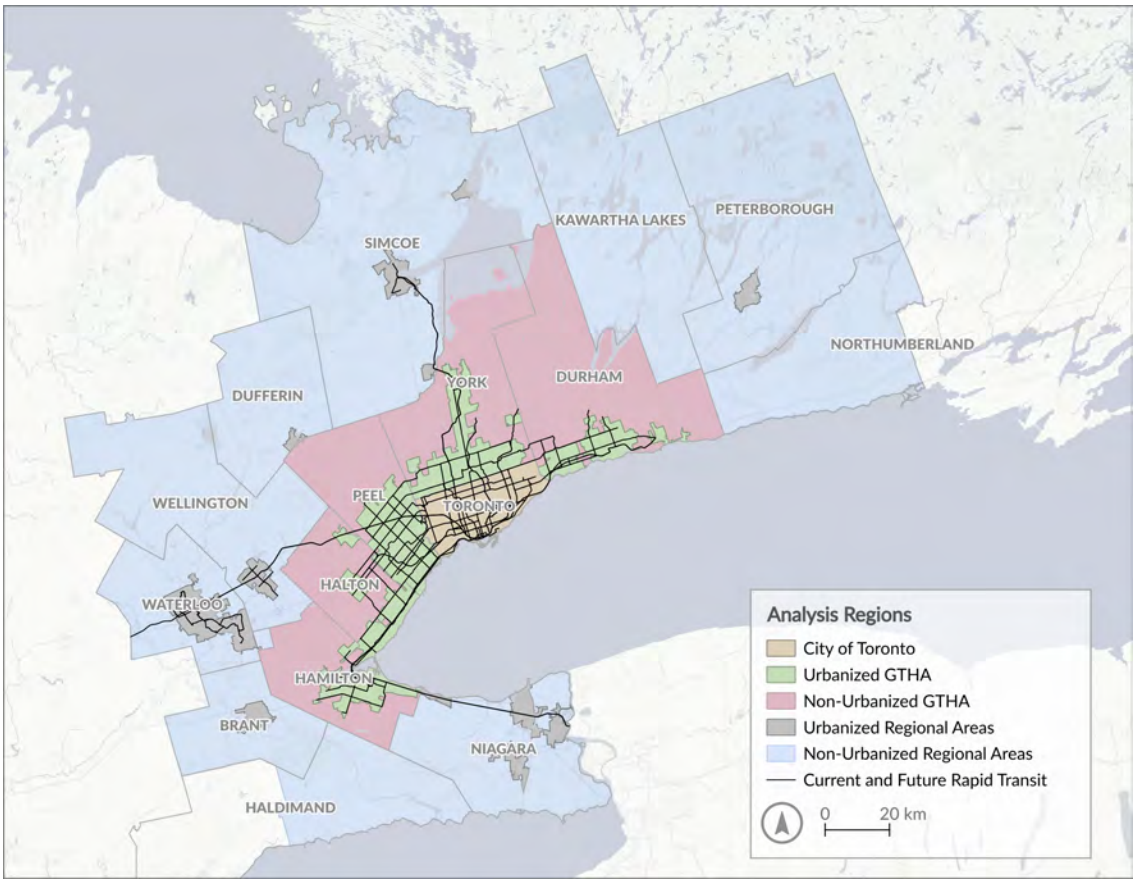

Figure 2.1: Five study areas throughout the GGH.

In addition to access, we also measure the number and sociodemographic distribution of individuals who are considered to live “near” regional or rapid transit, which in this case is within 800m walk of a higher-order transit station. We refer to this measure as "Proximity".

2.4 Why Access Matters

One of the basic economic principles of transportation is that travel is a derived demand, meaning that it is a result of wanting to participate in the activities at the end of the trip, rather than gaining utility from the trip itself. While each individual has specific priorities and destinations, most people share a common set of everyday activities and amenities to travel to. These include workplaces, grocery stores, healthcare facilities, schools (from primary to postsecondary), city and other government services (libraries, post offices), entertainment and commercial activities (theatres, shopping centres), and other residents.

Access allows us to represent the potential freedom or flexibility of choice for people to visit these destinations and carry out their everyday life. Measures of access are affected

by land use conditions (where these destinations and the people wishing to visit them are located) and the design and operation of the transportation system (how easily and quickly travellers can move about the region).

Access measures are gaining traction with planning professionals as an alternative to ridership-based performance measures. A 2017 survey of practitioners around the world[1] found that just over half used some form of access measures in their work. Some of the barriers to including more access measures were a lack of knowledge and data.

Importantly, access measures provide a different perspective from typical measures of system performance which are focused on mobility such as travel time savings, congestion, and cost-effectiveness. For example, it is possible to improve access within a region without lowering congestion if there are improvements in land use that increase the number of desired destinations in the area.

There is also growing evidence that improving access can reduce social exclusion.[2] This means that investments in transit in areas with historically marginalized populations and low overall transit access can provide additional benefits in the form of social participation. This type of benefit is directly understandable and intuitively positive but hard to quantify economically.

Because access directly quantifies the level of choice and freedom of activity participation in a region, it is an excellent measure to evaluate systemic barriers or gaps between population groups. Seeing how the level of access is distributed across marginalized and non-marginalized groups can help reaffirm or question plans and proposals made using other goals and processes. While this is useful for understanding equity in the current situation, it can also be used to compare future scenarios when applied in tandem with other forecasting and modelling analyses.

Access is the most effective measure of the large-scale ability of a transportation system to meet its goals of connecting people with destinations. For that reason, access is used as the primary measure throughout this evaluation.

2.5 Equity Measures

When considering equity specifically, we chose two families of measures to focus on: an egalitarian-based measure of *equity ratios* and a sufficientarian measure of *transport poverty*. The measures in this report reflect updated thinking on the relatively poor ability of commonly used measures (e.g. Gini coefficients, gaps analyses) to properly reflect the level of inequity in a transport system. Specifically, Gini coefficients focus on equality — not equity — where in some cases different groups might require different levels of access to "achieve the egalitarian standard of equal opportunity".[3] They also do not allow comparisons *across* various population groups, only within them. This limits our understanding of

systemic differences between groups.

2.5.1 INEQUALITY RATIOS

The goal of egalitarian measures in the context of examining regional transportation scenarios is to determine whether, and by how much, the proposed plans close the gap between marginalized and non-marginalized groups.

Specifically, the egalitarian summary measures we propose draw from a restorative justice approach by recognizing that the ultimate goal is not to ensure that all population groups receive equal service in the region, but that any proposed improvements to the system are distributed either equally across groups or with an additional benefit to marginalized populations. This approach specifically recognizes the compounding historical and non-measurable barriers faced by marginalized populations and proposes that any future change should work to counteract or at least not worsen these barriers.

We define the inequality ratio as the population weighted change in the performance measure for a representative non-marginalized group divided by the population weighted change in the performance measure for a marginalized group.

An inequality ratio greater than one indicates a benefit more concentrated towards non-marginalized groups, while a lower number indicates the opposite. While it is mathematically possible to have negative inequality ratios (benefits are negative for one of the two groups), in the context of the GGH and an additive regional transportation plan it is in unlikely to occur.

For example, we might compute the weighted average access to employment for Black individuals, and the same weighted average for white individuals, and compare them.[1] Table 2.1 shows an example of the computation when comparing a proposed change with a business as usual scenario. The inequality ratio less than one indicates that the marginalized group has better average access to employment than the non marginalized group.

Table 2.1: An example of how an inequality ratio is computed for a specific population group under a proposed change.

Population Group	Average Jobs Accessible in 60 Minutes		Change in Access
	Business as Usual	Proposed Change	
Black individuals	157,250	167,800	10,550
White individuals	165,470	172,200	6,730
		Inequality Ratio	**0.64**

A similar approach can be used to compute inequality ratios for other benefits such as

[1]Further discussion on population groups is found in Section 2.6 on page 16.

proximity to transit, travel times, and transit attractiveness. It can also be used to evaluate existing conditions by comparing existing access between groups (Chapter 3).

2.5.2 TRANSPORT POVERTY

For an individual to be considered in transport poverty, they must both be transport disadvantaged (under-served by transit in this particular case), and belong to a population group at risk of marginalization. The transport disadvantage measures introduced here allow for a regional understanding of the levels of transport disadvantage, an understanding of the level of poverty across various forms of marginalization (whether by income, race, gender, or other sociodemographic factors), and identify and cluster key areas where transport is poor and there is a high proportion of residents belonging to marginalized groups.

Measuring transport disadvantage requires two key steps: Defining a transport disadvantage line, and computing how many people in a group (or what proportion of a group) fall below that disadvantage line, and by how much. A popular family of measures used in disadvantage analyses by economists are the Foster-Greer-Thorbeck (FGT) metrics introduced in the 1980s. In particular we use two versions of these metrics to examine transport disadvantage: The *rate* of transport disadvantage (e.g. what proportion of a population group falls below a defined disadvantage line), and the *severity* of transport disadvantage (e.g. how far below the defined disadvantage line an area or individual falls).

In our case, our disadvantage measure is transport related. For this reason we refer to a "poverty line" as a *transport disadvantage line* to keep the definition separate from that of transport poverty, which requires both transport disadvantage *and* other forms of marginalization. Since FGT measures are decomposable by individuals and therefore groups, we can examine whether certain population groups experience higher severity levels of transport disadvantage than others.

Our definition of an exact disadvantage line based on accessibility required exploratory analysis of the existing state of transportation and equity in the GGH. From this analysis (Section 3), we have defined an existing disadvantage line based on the lowest 25% of access in a given regional analysis area. Where appropriate, this line has been adjusted to accommodate data constraints, especially in more rural areas where the 25th percentile for some destination types is zero.

Defining the exact disadvantage line for access requires some exploratory analysis of the existing state of transportation in the Greater Golden Horseshoe. This analysis sets a regional transport disadvantage line based on a level of sufficient access to specific longer-distance or regional opportunities through an examination of access to these destination types for different modes and through stakeholder feedback. A disadvantage line for each access-based metric will be established and used throughout the equity analysis of proposed plans to determine the extent to which the proposed scenarios lift individuals out of transport disadvantage or reduce the severity of their transport disadvantage.

2.6 Population Groups

To measure the distribution of existing gaps and plan benefits across a broad set of possible forms of marginalization, we used a set of 18 population groups across seven dimensions. These population groups draw on previous work in academia, at Metrolinx, and at the City of Toronto,[4] and have been presented during consultation both previously and during this project as part of a workshop with community stakeholders on measuring transportation equity. Details on this workshop can be found in Appendix B on page 47, and the list of population groups can be found in Table 2.2. When equity metrics are computed, individual metrics are computed for each population group, and then averaged for each dimension.

Table 2.2: Marginalized population groups and respective population dimensions.

Equity Dimension	Population or Household Measure
Language	Non-English speakers
Age	People under 15 years of age People 65 years and older
Means	Single-parent households People considered low-income People unemployed
Housing	Households living in homes in need of major repair Households living in housing considered not suitable Households who spend 30% or more of income on shelter Households living in rented subsidized housing
Immigration	People who recently immigrated (2016-2021) Non-permanent residents People with refugee status
Race	People with Indigenous identity Racialized people Black people
Transportation	People whose journey to work exceeds 60 minutes Households with zero car ownership

Inequality ratios require a reference group to compare with. For simplicity and consistency, each population group within a dimension uses the reference group, even if that group is not directly complimentary to all of the equity groups in the dimension. Table 2.3 indicates the population group used as a comparison group for each equity dimension.

Totals for each group are given in Table 2.4

Table 2.3: Equity comparison groups used for inequality ratios.

Equity Dimension	Comparison Group
Language	People proficient in English
Age	People age 35 to 54
Means	People not in poverty
Housing	People living in acceptable housing
Immigration	People who are non-immigrants
Race	White people
Transportation	Households with one or more cars

Table 2.4: Counts of population groups used in this study throughout the GGH, based on the 2021 census and 2011 baseline GGHM data for auto ownership.

Group	Approximate Total
Total Population	**9,697,000**
Total Households	**3,620,000**
Non-English speakers	311,000
English speakers	*9,622,000*
Under 15	1,533,000
65 and older	1,685,000
Age 35-54	*2,584,000*
Single parent	470,000
Low-income	549,000
Unemployed	660,000
Not low-income	*9,032,000*
Home needs major repair	178,000
Unsuitable housing	284,000
30%+ of income on shelter	966,000
Subsidized housing	137,000
Suitable housing	*3,619,000*
Recently immigrated	465,000
Non-permanent residents	287,000
Refugee	450,000
Non-immigrant	*5,733,000*
Indigenous	121,000
Racialized	4,143,000
Black	598,000
Non-racialized	*5,442,000*
Commute exceeds 60 minutes	326,000
Zero-car households	430,000
1+ car households	*2,764,000*

3. Current State of Transit Equity

3.1 Summary

3.1.1 OUR APPROACH

Our analysis of the current state of transit equity aimed to answer the following questions:

- Whether and where there are concentrations of marginalized groups facing inadequate access to transit or access to destinations via transit in the region,
- Whether marginalized groups have higher or lower levels of access to transit or access to destinations via transit in the region, and
- Whether the outputs of the GGHM are able to provide relatively useful equity insights compared with the more granular access to opportunity measures of the Spatial Access Measures.

In this section we focused on two measures: The proximity of population groups to existing rapid transit stops, and the relative access to destinations available for various population group categories. In particular, access to employment, healthcare facilities, and post-secondary education were considered in this section as they enable a reasonable comparison between the Spatial Access Measures and the GGHM.

3.1.2 HIGHLIGHTS

Our analysis of existing conditions found that:

- Zero-car households are highly concentrated close to higher order and regional transit stops, while those in the housing, immigration, and means population dimensions are slightly more concentrated around transit stops than the general population,
- In Toronto, racialized residents (in particular Black residents) experience higher levels of transport disadvantage than average, and compared with other marginalized groups,
- Outside of Toronto, Indigenous populations face the most extreme levels of transport disadvantage and inequity,
- Large portions of the non-urbanized areas of the GGH experience zero or negligible (especially destinations that are not employment), and
- The Spatial Access Measures and model-based measures compare well for inequality ratios, but poorly for transport disadvantage measures. This emphasizes the usefulness of both datasets and the importance of comparing like-for-like model forecasts when doing scenario analysis.

3.2 Analysis Findings

3.2.1 OVERALL FINDINGS

Access to Opportunities

A region-level map of transport disadvantage severity for access to employment using the Spatial Access Measures is shown in Figure 3.1. As expected, areas experiencing some form of transport disadvantage by our measure are concentrated on the fringes of each of our five regions, and especially so in the most rural areas. It is important to remember that transport disadvantage scores are relative to the five individual study areas, as the intention is to compare similar urban contexts. This means that some areas with very little transit access (rural GGH) may be classified as not in transport disadvantage despite having far lower levels of access than urbanized transport poor areas in the City of Toronto like Scarborough and north Etobicoke.

Peterborough and Brant stand out as the areas of the urbanized GGH that experience the highest concentrations of transport disadvantage, compared with other urbanized regional areas such as Guelph, Waterloo, and Simcoe.

Figure 3.2 shows the rate of transport disadvantage across the seven population dimensions for each of the five study areas in the region, and Figure 3.3 shows the inequality ratios for comparative non-marginalized groups across the same dimensions and areas. By examining these summary charts, we can observe that although certain recurring themes

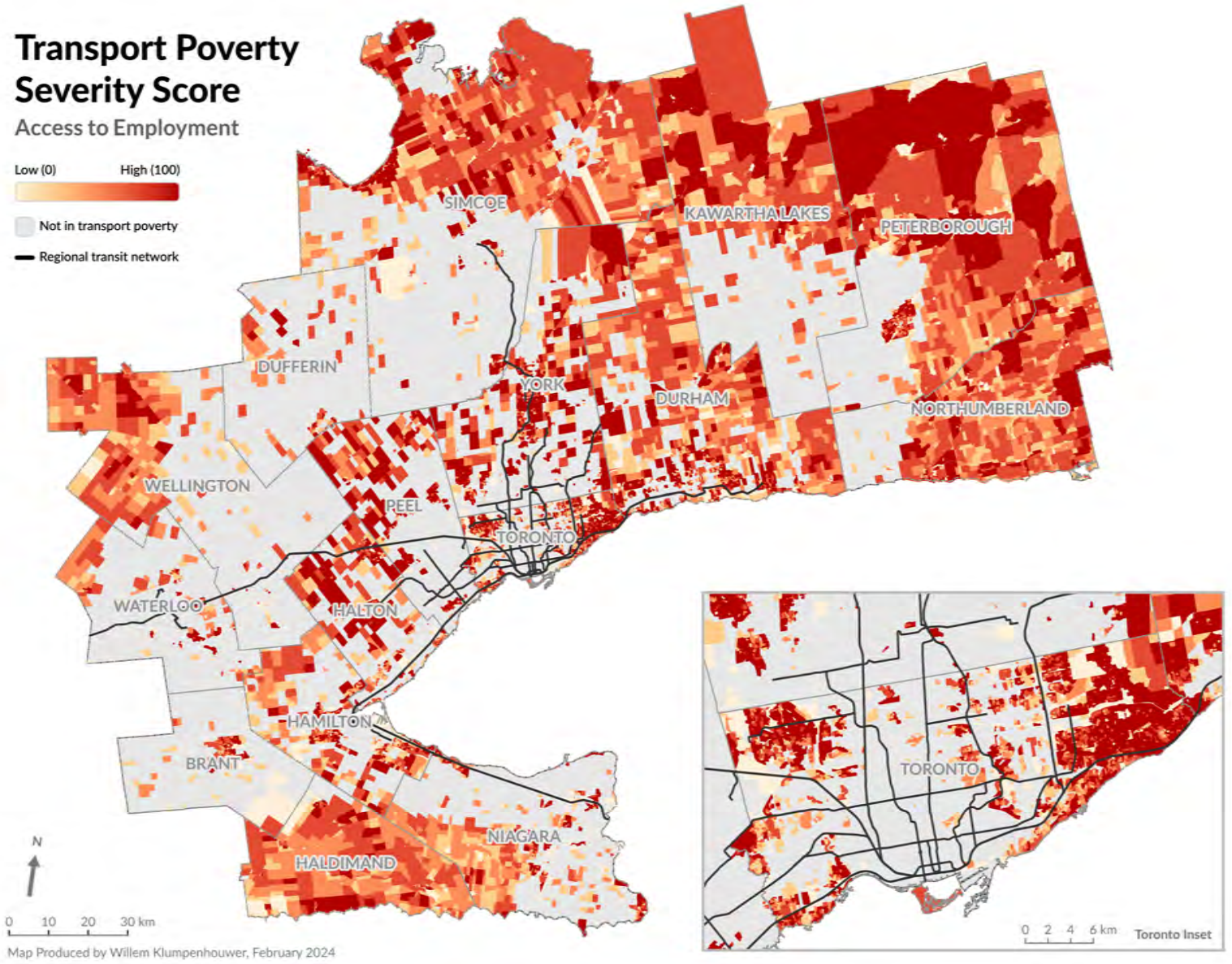

Figure 3.1: Severity score of transport disadvantage normalized by study areas throughout the GGH.

persist across regions within each population dimension, there is considerable variation in some categories.

Figure 3.2: Transport disadvantage rates by population dimension for the five regional study areas. Note that the urbanized regional area's transport disadvantage line is set differently due to low population levels.

For example, the age dimension sees consistently higher rates of transport disadvantage across all five study areas for both metrics. In contrast, the language dimension shows a large variation between regions and within a measure (the highest rate of transport disadvantage in Toronto, but only 6th highest in the urbanized GTHA), while the means category scores relatively high on transport disadvantage in the non-urbanized GTHA, and lower for the same area on the inequality ratios measure.

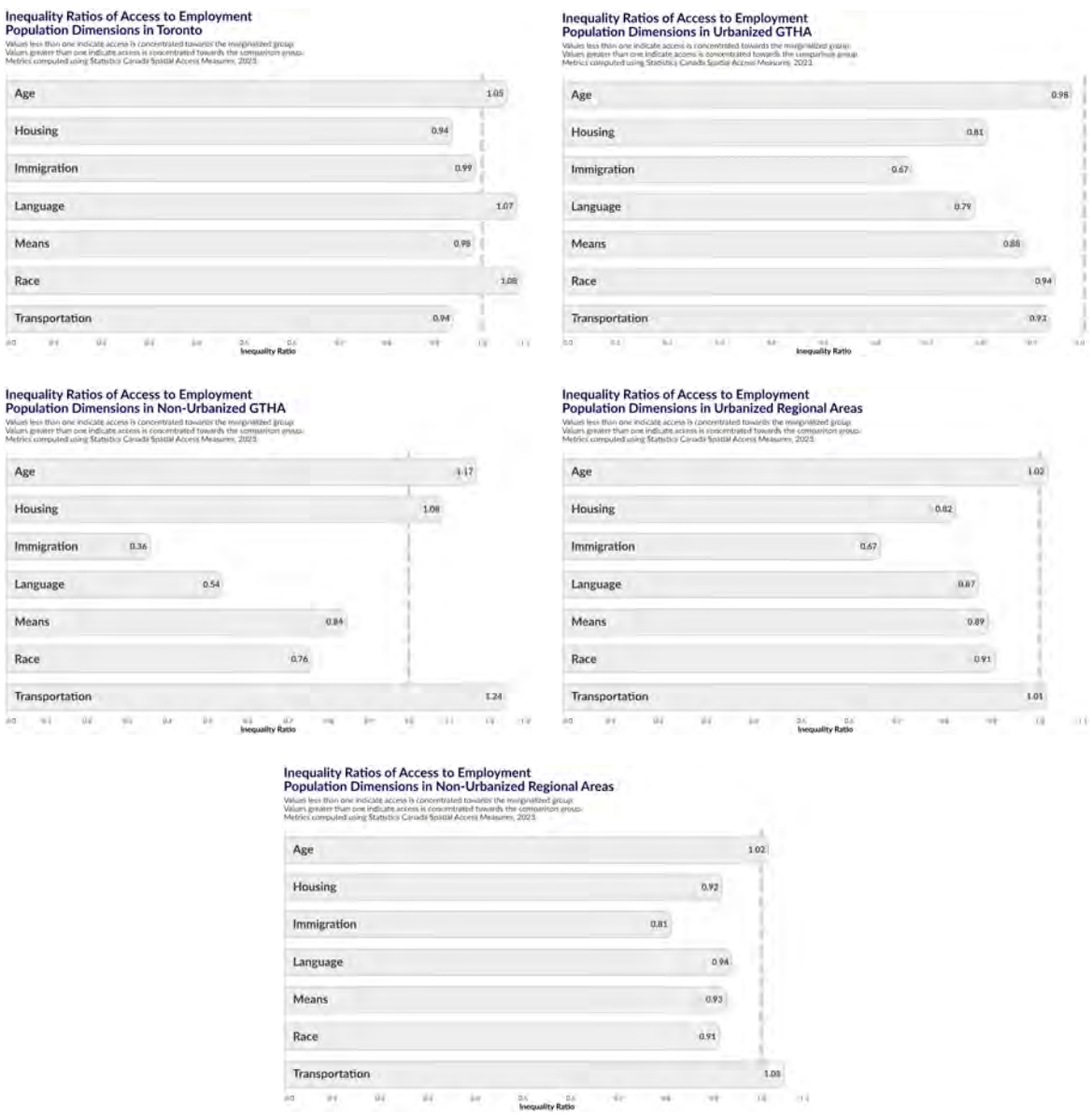

Figure 3.3: Inequality ratios by population dimension for the five regional study areas

Proximity to Regional Transit

Using 800m walking distances from the existing rapid transit network, Figure 3.4 shows the average percentage of a population dimension that lives near a stop on the regional transit network.

The age and race dimensions fall below the population average of 9.1%, with means, housing, and immigration dimensions typically more concentrated around the existing network. Of note, only 5.5% of the Indigenous population in the GGH lives near a regional transportation network stop, well below the population average and all other population groups. Nearly 30% of zero-car households live near a regional transportation network stop.

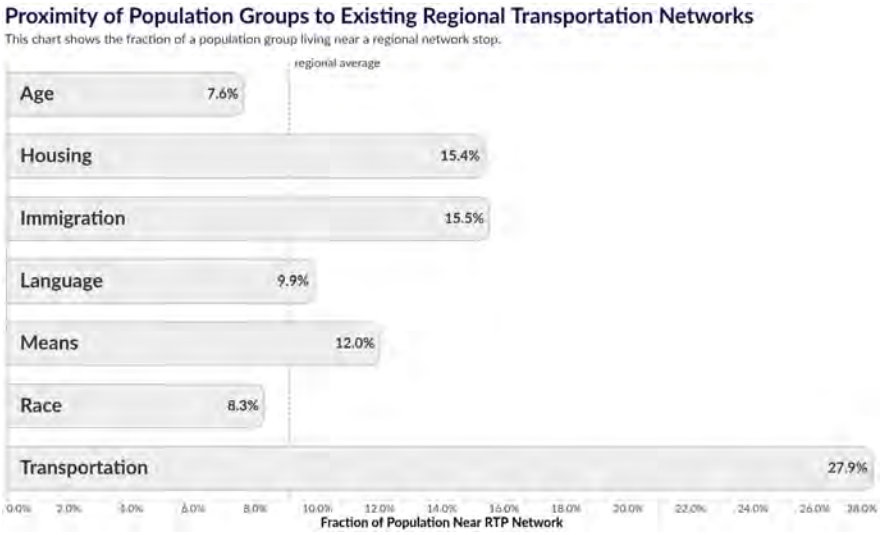

Figure 3.4: Average fraction of a population dimension living within 800m of a higher order or regional transit stop as defined by the existing Regional Transportation Plan network. Approximately 9.1% of the population lives near such a stop.

As a component of access, the proximity to the transit network explains the low levels of access for Indigenous groups and the age dimension discussed in the subsequent sections.

3.2.2 REGION-SPECIFIC FINDINGS

Toronto

In Toronto (Figure 3.5), the areas with a combination of relatively low access and higher numbers of marginalized groups are located in the western and north-eastern areas of the city (Scarborough and northern Etobicoke). Specifically, the population groups living in these areas result in a relatively high over-representation of racialized (and specifically Black) populations and refugees in transport disadvantage. Population dimensions of ability, age, gender, and race are over-represented in our measure of transport disadvantage in Toronto.

This finding is reinforced by the inequality ratio measures (Figure 3.3). For example, the race population dimension inequality ratio for access to employment is 1.17, meaning as a current measure white people have higher average access than racialized and Indigenous people. The population dimensions of immigration, means and transportation have inequality ratios slightly below the parity value of 1, while zero-car households fare much better with an inequality ratio of 0.81.

In Toronto, there are fairly large discrepancies within two population dimensions: Im-

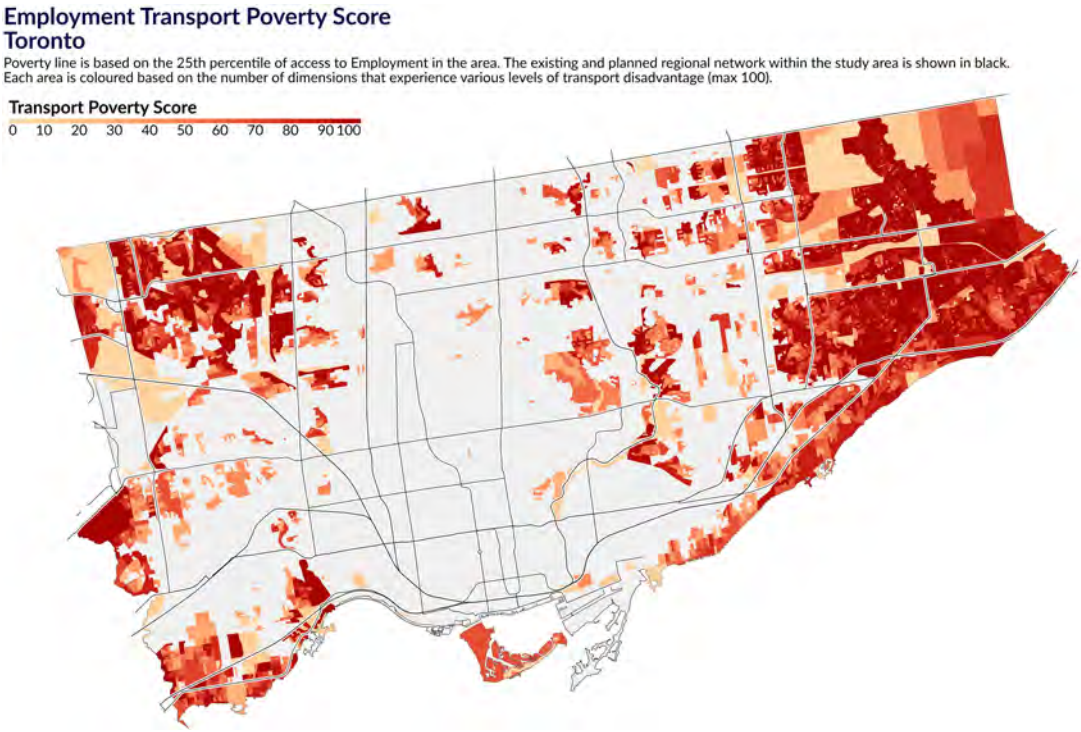

Figure 3.5: Areas in Toronto with high levels of poverty of access to employment. This map is an inset of Figure 3.1.

migration and race. Refugees see much higher rates of transport disadvantage than non-permanent residents and recent immigrants. Indigenous people see lower rates of transport disadvantage than other racialized groups.

Urbanized Greater Toronto and Hamilton Area

The urbanized GTHA's more severe areas of transport disadvantage are mainly located on the outer edges of the contiguous areas or concentrated in outlying urban areas such as Stouffville, Georgetown, and Milton (Figure 3.6). Of note is a high level of transport disadvantage across most dimensions in Aurora and Newmarket for access to employment. This is likely due to the relatively long travel times to downtown Toronto compared with other areas of the urbanized GTHA, as well as to other employment centres such as Pearson Airport.

All of the population dimension inequality ratio metrics in the urbanized GTHA (Figure 3.3) fall below the parity value of 1.0, favouring the marginalized groups slightly, meaning that as a current state marginalized population groups experience on average slightly better access to employment than their reference groups. In comparison with other study areas, these values are relatively consistent across all population dimensions. Most population dimensions also see relatively low levels of transport disadvantage, with the exception of age and race.

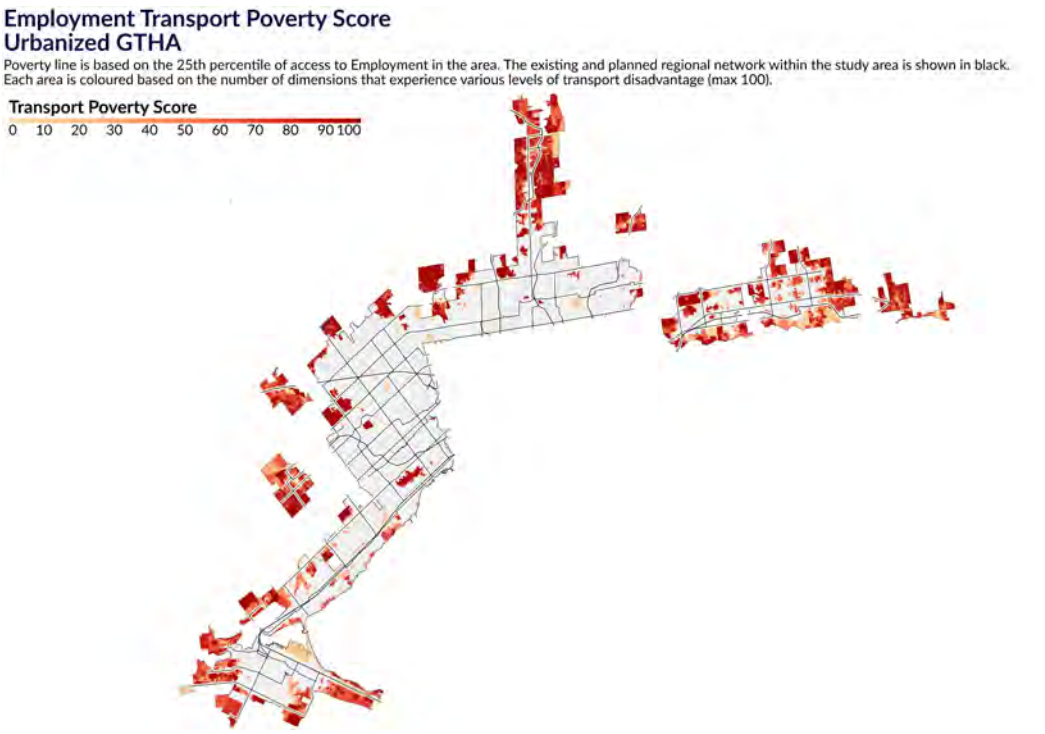

Figure 3.6: Areas in the urbanized GTHA with high levels of poverty of access to employment. This map is an inset of Figure 3.1.

In contrast to Toronto, 33% of Indigenous residents and 19% of the black residents of the urbanized GTHA are classified as in transport disadvantage compared to the race dimension average of 24%. Compared with Toronto, most population dimensions see a larger variation between individual population groups that make up the overarching dimension. This is true across both metrics of equity.

Non-Urbanized Greater Toronto and Hamilton Area

Lower levels of access in the non-urbanized GTHA area are more broadly spread around the area (Figure 3.7). In particular, large portions of the non-urbanized GTHA have zero access to destinations other than employment, meaning that for destinations such as access to health care or post-secondary institutions, the majority of the region is classified as transport disadvantaged.

In these more rural areas, age and transportation related categories fall well above the 1.0 parity value of inequality ratios. Seniors (age 65+) and those living in homes in need of major repair are significant outliers with inequality ratio values above 1.4. Indigenous residents are again outliers with higher inequality ratios (1.1) compared to other racialized populations, including Black people (just under 0.4). Of note also are relatively low inequality ratio values for the immigration population dimension.

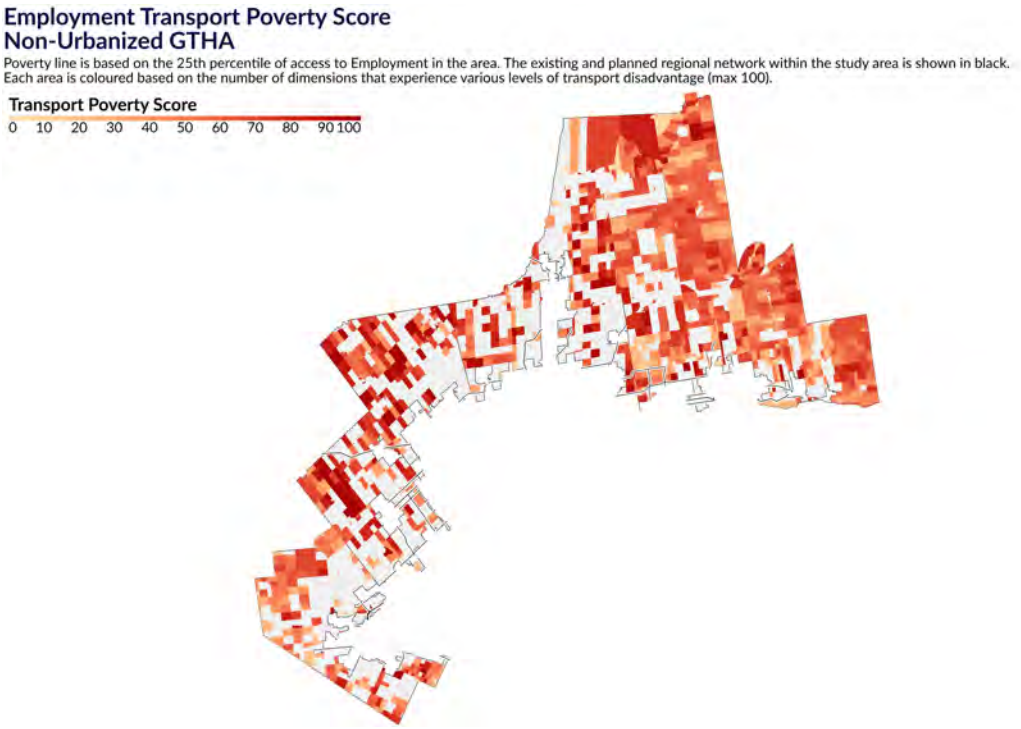

Figure 3.7: Areas in the non-urbanized GTHA with high levels of poverty of access to employment. This map is an inset of Figure 3.1.

Transport disadvantage measures in the non-urbanized GTHA show transport disadvantage and inequality is distributed more evenly across marginalized groups, though all of the seven population dimensions average at or below the total population disadvantage rate of 25%. Indigenous people, Seniors (age 65+), and those living in houses in need of major repair are again outliers within their respective dimensions in the transport disadvantage measure, with households in need of major repair exceeding a disadvantage rate of 35%.

Urbanized Regional Areas

Within the outer urbanized regional population centres (Figure 3.8), instances of higher transport disadvantage are concentrated in Grimsby, Brantford, Bradford, Peterborough, and some areas of Welland.

While the age dimension shows higher levels of transport disadvantage and inequality ratios compared with other dimensions, Indigenous people are highly over-represented in the urbanized regional areas in both measures. For example, Indigenous people experience a disadvantage rate of almost 35% compared to other racialized individuals (18%).

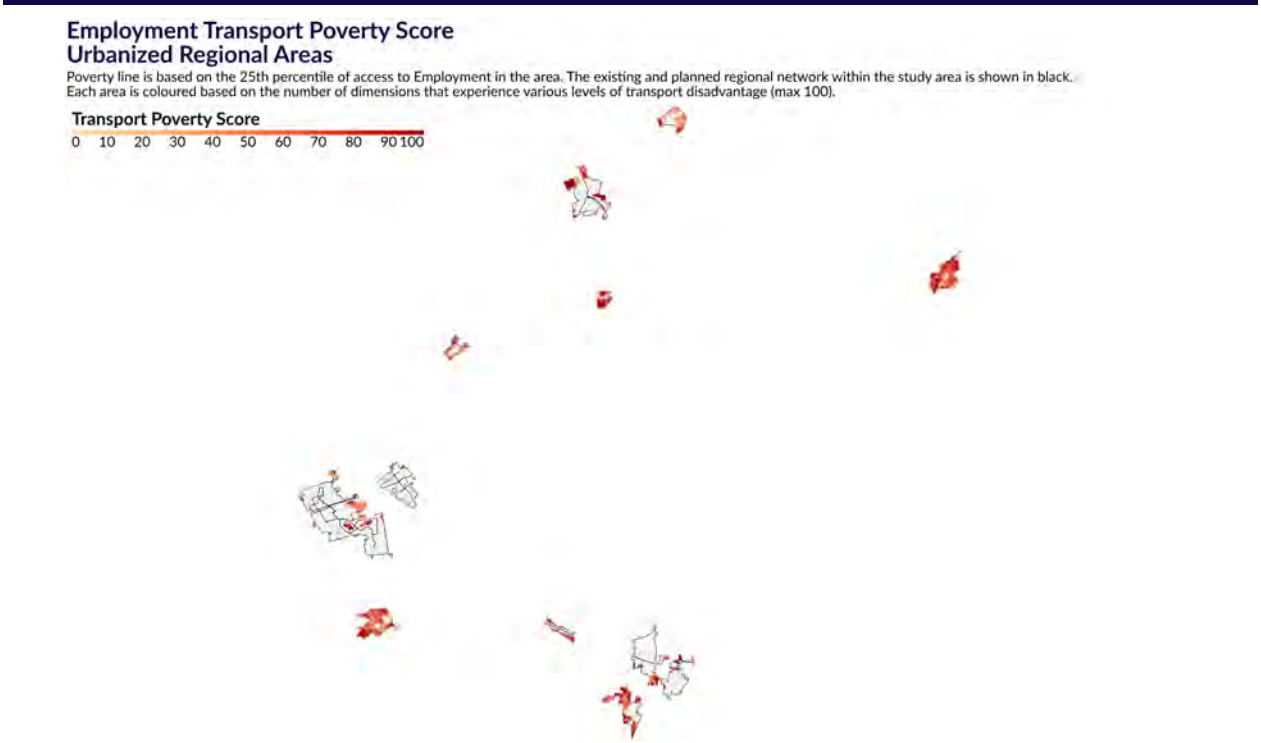

Figure 3.8: Areas in the urbanized regional areas with high levels of poverty of access to employment. This map is an inset of Figure 3.1.

Non-Urbanized Regional Areas

Non-urbanized regional areas largely have zero access to destinations outside of employment, and minimal access to employment at that. The demographics of the rural areas however lead to fewer overlapping occurrences of severe transport disadvantage, and as a result Figure 3.9 shows fewer instances of very high transport poverty scores.

In these rural areas, the highest amount of transport poverty is located at the outer edges of the region, in particular in Kawartha Lakes, Peterborough, and Northumberland.

The age dimension again shows as the most disadvantaged and the only category with an inequality ratio above the parity value of 1.0. In particular, zero-car households see very low values of transport disadvantage and low inequality ratios. This is likely due to the extremely low rate of zero-car households in the area, and their concentration near population centres. Indigenous people are especially over-represented in the transport disadvantage measure (45%).

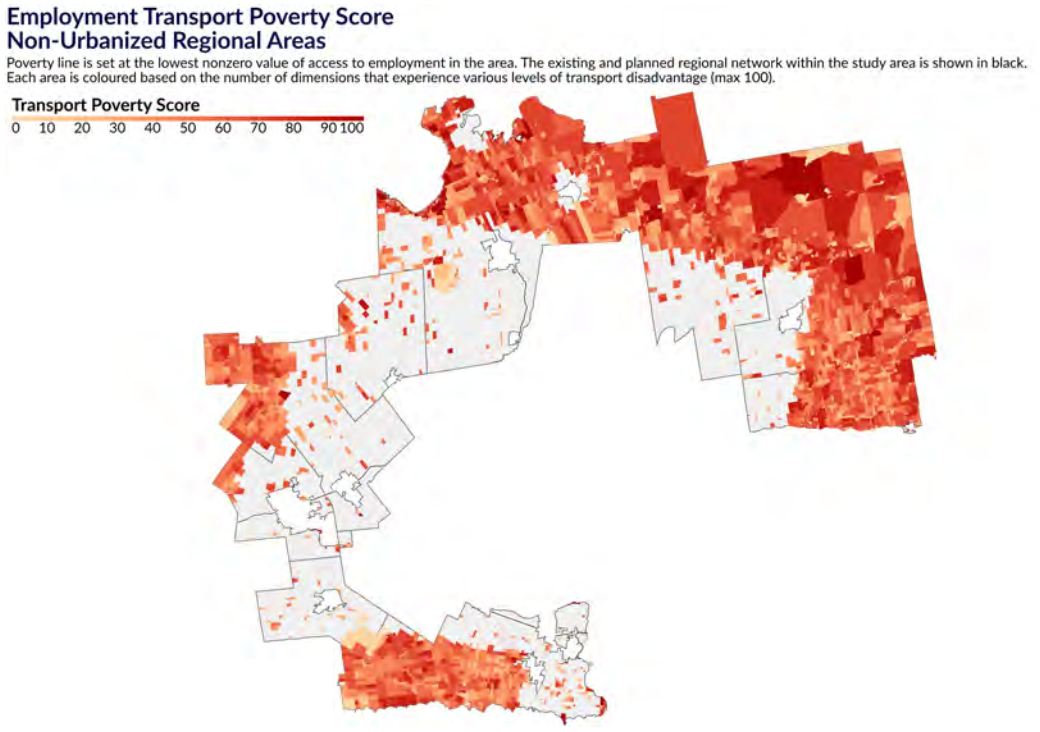

Figure 3.9: Areas in the non-urbanized regional areas with high levels of poverty of access to employment. This map is an inset of Figure 3.1.

3.2.3 MODEL AND SPATIAL ACCESS MEASURES COMPARISON

To compare the model's ability to capture measures of transport equity and transport disadvantage, we conducted the same analysis described above with the Spatial Access Measures, but instead using travel times and destination data from a modelled 2019 existing scenario from the GGHM.

Figure 3.10 provides a comparison of inequality ratio results between the GGHM and Spatial Access Measures data for two of the five regions. These sets of charts show a strong level of similarity in inequality ratio metrics; the comparison is similarly close for the other three regions. These additional comparisons are provided in Appendix C.

Figure 3.11 shows a comparison of transport disadvantage measures for the Spatial Access Measures and GGHM data. In this case, there is less agreement between the measures, with some dimensions reversed between the two comparisons.

This discrepancy between GGHM and Spatial Access Measures data is likely due to the way in which the population threshold is applied combined with the differences in how access to employment is computed. The use of a specific threshold cutoff for transport disadvantage is more susceptible to differences in how employment is measured and as a result the overall "amount" of access available in a given area. For example, the Spatial Access Measures use binned categories of total employment, which may lead to under-

Figure 3.10: Comparative inequality ratio results between Spatial Access Measures and GGHM. GGHM results are on the left, Spatial Access Measures results are on the right

estimation of overall total accessible employment opportunities, especially in downtown Toronto where large financial firms employ tens of thousands of workers. This may in turn result in a percentile disadvantage threshold that is spatially and numerically very different.

While this difference is unfortunate, our analysis still allows us to identify current state geographies using the Spatial Access Measures, and to rely on like-to-like comparisons between models of the same year under different scenarios. Caution should be taken when using GGHM model data as a standalone source for identifying existing conditions rather than as a comparative tool.

3.3 Discussion

With a few exceptions, both the inequality ratio measures and the transport disadvantage measures indicate that marginalized population groups' access to opportunities are competitive or better than the average resident of the GGH. In particular, zero-car households are strongly linked with higher levels of access and lower levels of transport disadvantage. On the other hand, Indigenous people experience much higher levels of transport disadvantage and inequality ratios than average, especially outside of Toronto.

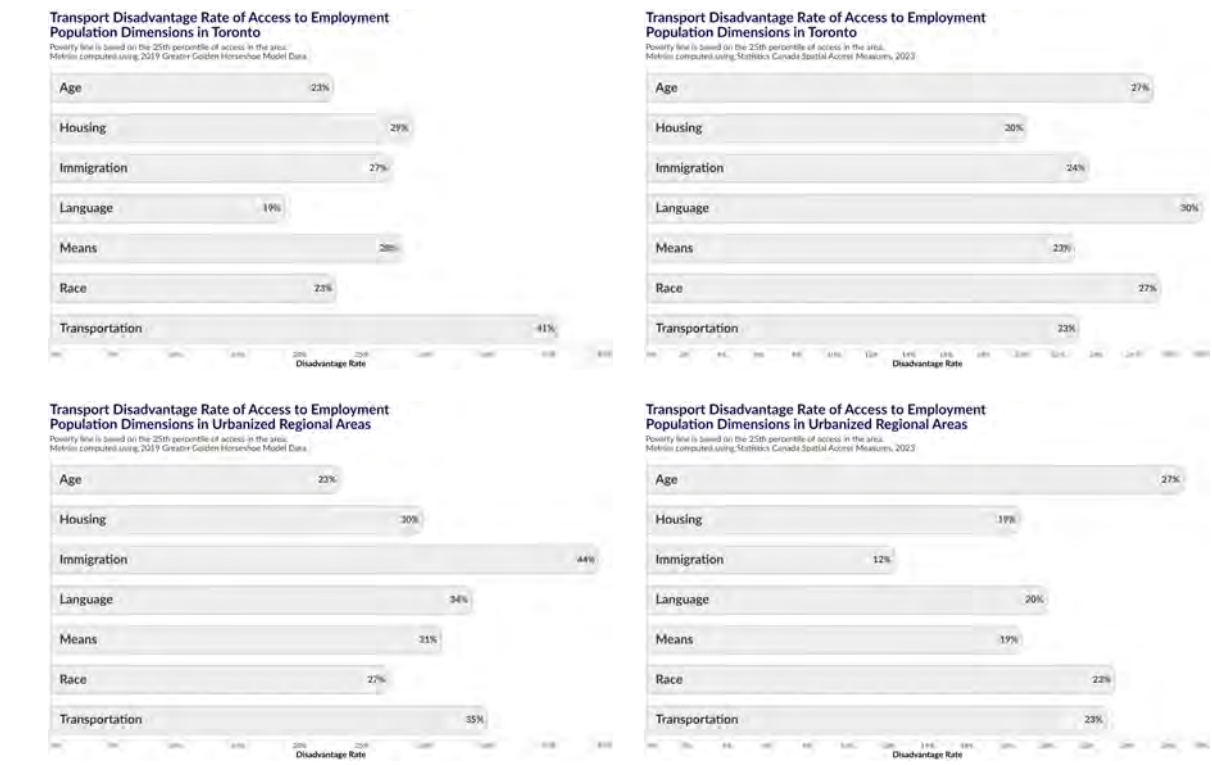

Figure 3.11: Comparative transport disadvantage results between GGHM and Spatial Access Measures. GGHM results are on the left, Spatial Access Measures results are on the right

Beyond the Indigenous populations, age-based dimensions of marginalization experience the most consistently higher levels of inequality and transport disadvantage. This can partially be explained by the suburbanization of larger families due to the lack of adequate and affordable family housing in more central and urbanized areas. This is especially true for children 14 and under.

Racialized individuals experience higher levels of inequity in transit access and transport disadvantage in Toronto specifically. This is reflected spatially (Figure 3.1 on page 21) with transport disadvantage concentrated very strongly in Scarborough and eastern Toronto as well as north-west Toronto. These are areas with higher concentrations of racialized populations.

3.3.1 MEASURE EFFECTIVENESS

The two measures of inequality ratios and spatial access measures provide complimentary insights into the state of transit equity in the region. In particular, inequality ratios are able to capture systemic differences in averages across study areas, while transport disadvantage measures are more reflective of the spatial clustering of transport disadvantage. For example, an area with consistently high levels of transport disadvantage may not be weighted highly in the population averages computed for the inequality ratios due to the

sizes of populations living in that area.

Transport disadvantage measures also provide a good spatial understanding of which geographical areas might benefit most from increased or new service from an equity perspective. For example, this analysis identified northern York Region as a corridor which despite having higher levels of transit access than many other areas of the urbanized GTHA still experiences transport disadvantage. Peterborough and Brantford are examples of urbanized regional areas which are currently experiencing lower transit access and higher levels of transport disadvantage.

3.3.2 BOUNDARY EFFECTS

One of the artifacts of studying five distinct regions within the GGH is that some boundary effects occur between the regions. Boundary effects occur near the borders of our five regions because of the differences in the way zones on either side of these boundaries are relatively compared. For example, a zone just north of Toronto's northern border is being compared with other zones in the urbanized GTHA, while a zone just south of that boundary is being compared with other zones in Toronto. A zone that is relatively disadvantaged in the context of Toronto may not be in the context of the GTHA and so there is a sharp change in the measure of disadvantage at these boundaries. This is particularly evident on the northern boundary between Toronto and the urbanized GTHA.

This is not easily remedied; combining areas together would create other spatial problems due to large differences in transit access, e.g. between Toronto and Mississauga. Instead, we recognize that differences exist between these study areas and that these differences should be reflected on in an overall policy of prioritization (e.g. rural and urban transit, core Toronto service and regional service).

3.3.3 OTHER DESTINATIONS

Appendix C contains similar results as shown above for post-secondary education and health care. Similar trends exist across these other two destinations, however some key observations are listed here:

- Both non-urbanized areas have virtually no access to post-secondary education. Approximately 90 to 95% of the population in these areas have zero access.
- Approximately half of the population of non-urbanized regional areas have no access to health care by transit.
- The transportation dimension in particular sees larger inequality ratios for access to post-secondary education. This is largely driven by those who travel longer distances to work.

3.3.4 CONCLUSIONS FOR ANALYSIS OF FUTURE SCENARIOS

The existing gaps analysis has identified broader geographic areas of concern from a transport disadvantage perspective: Scarborough and north-western Toronto, northern York Region, Brantford, and Peterborough. While it is encouraging that the region is starting from a place of relatively low levels of inequity when comparing marginalized and non-marginalized groups, it is important that future projects work to further reduce that inequality ratio, and lift individuals across all seven population dimensions out of transport disadvantage. Identifying and providing for the needs of racialized residents of Toronto, and Indigenous residents throughout the rest of the GGH should be prioritized, given their currently high levels of transport disadvantage relative to other groups.

Non-urbanized areas have across most of their geography zero or negligible access via transit, especially for destinations other than employment. In these areas, minimal service would provide connections to employment, health care, education, and other amenities and lift a significant fraction of the relatively small population out of transport disadvantage.

The natural next step in this analysis is to evaluate how these broader trends change with the implementation of additional transit service — and in particular, whether the distribution of the *additional* benefits afforded by improved transit are equitable.

The following chapter illustrates how this evaluation is structured and what its outputs look like, using a demonstrative scenario comparison drawn from a separate study area and model. These results are intended to show the form and interpretive logic of the analysis rather than to report findings specific to the 2051 RTP; the corresponding RTP scenario results are not included in this report.

4. Future Scenario Comparisons

4.1 Summary

4.1.1 OUR APPROACH

In addition to identifying current system and spatial gaps in transit access across demographic groups, this report also considers planned improvements to the regional network and evaluates whether these improvements work towards the defined equity goals of distributing more transit benefits to marginalized populations and providing sufficient transit access to marginalized populations. We evaluated the following four scenarios (a "business as usual" scenario and three network improvement scenarios) in Table 4.1 as follows:

- To what extent the modelled future network scenarios close or widen the gap between access provided to marginalized groups and their counterparts
- To what extent the modelled future network scenarios lift marginalized groups out of transport poverty, and
- To what extent the modelled future scenarios address areas specifically identified in the current state analysis (Chapter 3).

4.2 Scenarios

We considered four hypothetical futures from modelling done of the SmartTrack program using the Greater Toronto Area Model (GTAM) for this illustrative example.[1] These four scenarios all use forecasted population and employment data for 2051, along with modelled travel times for that scenario year used to compute access scores. Table 4.1 provides a list of the scenarios and their names.

Table 4.1: Illustrative SmartTrack scenarios considered as part of this equity forecast analysis

Scenario Name	Details
BAU	Baseline business-as-usual model, with existig and in-delivery transit service at the time of modelling.
Scenario A	SmartTrack with 5 minute headways, using a base transit fare.
Scenario B	SmartTrack with 15 minute headways, using a base transit fare.
Scenario C	SmartTrack 15 minute headways, using a premium fare based on GO Transit fare structures.

When comparing scenarios our goal is to consider how the proposed networks *change* the inequality ratio and transport poverty measures compared to the BAU scenario. This allows us to minimize the overall discrepancies that might come with modelled data as identified in Section 3.2.3 (page 29). It also allows us to focus specifically on how the plan itself might change measures of equity in the region. To compare changes in transport disadvantage, the transport disadvantage line was set using the BAU scenario's population-weighted 25th percentile of access.

4.3 Access to Employment Findings

4.3.1 TORONTO

Figure 4.1 shows inequality ratio and transport disadvantage rates for the four scenarios. In Toronto, inequality ratios across all three improvement scenarios shift minimally compared with the BAU scenario. Some improvements in inequality ratios are seen for the language dimension, while some worsening of inequality ratios are experienced by those in the transportation dimension. A minimal shift indicates that the service improvements seem to benefit all groups equally.

[1] A guide using this illustrative data and analysis is available at `github.com/wklumpen/equity-transport-futures`

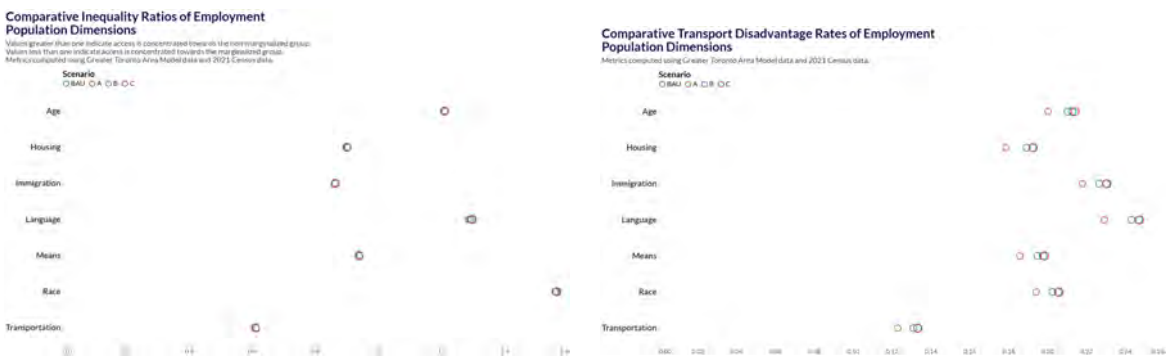

Figure 4.1: Inequality ratios and transport disadvantage rates of access to employment for four scenarios in Toronto.

Transport disadvantage rates drop significantly due to added access in Scenario A (5 min headways) compared to the BAU baseline, and marginally in Scenario B (15 minute headways). This change is similar across all seven population dimensions.

Note on Chapter Content: This chapter has been substantially revised from the original report and no longer presents results from the 2051 Regional Transportation Plan equity analysis. The purpose of this chapter is to demonstrate the form, structure, and interpretive logic of a scenario comparison analysis using the equity measures described in Chapter 2. The results shown here are not findings of the Metrolinx RTP evaluation, are not intended to be actionable, and do not constitute recommendations to Metrolinx or any other agency.

The geography of this illustrative analysis also differs from the broader GGH study presented in Chapters 2 and 3. Rather than five sub-regions, this chapter focuses exclusively on the City of Toronto, and compares three scenarios: a business-as-usual baseline and two SmartTrack network configurations. This narrower scope is appropriate for a demonstrative exercise and reflects the coverage of the source model.

The destination set in this illustrative example is also limited to employment. The original analysis included the destinations measured in Chapter 3, but are not considered for this example. Using multiple destinations allows for an understanding of how access to employment does or does not correlate on a regional level with access to other key destinations.

5. Conclusion and Recommendations

This report consists of a comprehensive investigation of systemic transit access to opportunities across the GGH and the disparities between population groups of this access. In this report we investigated both the current state of transit equity using contemporary and 3rd party measures of access, and how the proposed changes to the transit network affects access and the distribution across marginalized groups (*in this report, the proposed changes are from an illustrative example and are not reflective of Metrolinx planning scenarios*).

The goal of this report, in addition to the analysis above, was to solidify a framework for future spatial equity analyses for Metrolinx, and provide a consistent set of measures that could be used to continue to evaluate the state of transit equity in the GGH and what Metrolinx is doing to address any gaps or issues. In particular, we found the following broad themes while conducting this analysis:

5.1 Indigenous Populations

Outside of the Toronto area, Indigenous populations face the most extreme levels of transport disadvantage and inequity compared to other marginalized groups. While the overall number of Indigenous residents of the GGH is low relative to other marginalized populations, low transit access to reserves or other Indigenous communities in the outer GTHA and other regions means that they are over-represented in our measures of transport poverty. In particular, almost all Indigenous residents of the non-urbanized GTHA fall within the bottom 25th percentile of transit access to employment in that area.

Our recommendation, then, is to *specifically study and prioritize transit connections that serve Indigenous groups, especially in rural or peri-urban areas of the GTHA and on reserves.*

5.2 Racialized Residents in Toronto

In Toronto, we observed that racialized residents (particularly Black residents) live in areas with higher levels of transport poverty compared with other marginalized groups and the population as a whole.

Our recommendation is to *work with the City of Toronto and other partners to continue to measure and report on access to opportunity measures for marginalized residents within the city, including Black residents.*

5.3 Equity-Focused Transit Prioritization

In addition to the specific groups discussed above, our larger recommendation is to *prioritize transit service improvements that work to lower transport disadvantage, while minimizing or improving region-wide inequality*.

Improvements in transit service have the ability to significantly lower the barriers in access to opportunities experienced by individuals throughout a given region. It is important, however, that work continues to identify areas with both low levels of access and higher concentrations of marginalized populations. Linking these areas with employment and other opportunities would lower levels of transport disadvantage in the region and positively shift measures of inequality as well. At a first level, care should be taken to ensure that proposed transit services are not distributed inequitably towards non-marginalized groups.

5.4 Future Work

There are a number of directions for future work, some of which have been detailed in the sections above. In addition to further work to understand challenges specific to demographic groups (i.e. Indigenous populations), this work can be extended to other projects, scenario planning, and municipal-level work.

One of the challenges with studying a region as large as the GGH is that certain simplifications must be made to keep the level of analysis to a level that supports region-wide planning decisions. Individual municipalities may wish to undertake their own studies of the challenges and specifics in their region, and this work could serve as a framework or starting point for those investigations. Some municipalities have started this work independently.

Another limitation of this work that lends itself to future work is the nature of demographic change in the region. While population forecasts are conducted by Metrolinx as part of the modelling process, they are silent on the nature of demographic change. This is understandable, prescribing how and where marginalized groups will or should live is a difficult proposition.

Glossary, Acronyms, and Initialisms

CD Census Division is a group of neighbouring municipalities joined together for the purposes of regional planning and managing common services (such as police or ambulance services). These groupings are established under laws in effect in certain provinces of Canada. Census division (CD) is the general term for provincially legislated areas (such as county, municipalité régionale de comté (MRC) and regional district) or their equivalents. In other provinces and the territories where laws do not provide for such areas, Statistics Canada defines equivalent areas for statistical reporting purposes in cooperation with these provinces and territories. Census divisions are intermediate geographic areas between the province/territory level and the municipality (census subdivision). In Ontario, census divisions are equivalent to upper-tier municipalities. 6, 8

CMA Census Metropolitan Areas are formed by one or more adjacent municipalities centred on a population centre (known as the core). A CMA must have a total population of at least 100,000, based on data from the current Census of Population Program, of which 50,000 or more must live in the core based on adjusted data from the previous Census of Population Program. 6

DA A **dissemination area** (DA) is a small, relatively stable geographic unit composed of one or more adjacent dissemination blocks with an average population of 400 to 700 persons based on data from the previous Census of Population Program. It is the smallest standard geographic area for which all census data are disseminated. Dissemination Areas cover all the territory of Canada. 46, 54

DB A **dissemination block** (DB) is an area bounded on all sides by roads and/or boundaries of Statistics Canada's standard geographic areas for dissemination. The dissemination block is the smallest geographic area for which population and dwelling counts are disseminated. Dissemination blocks cover all the territory of Canada. 54

FGT **Foster-Greer-Thorbecke** measures are a family of formulas for computing the rate and severity of poverty in a given population. They are detailed more in Appendix A.2. 15

GGH **Greater Golden Horseshoe.** The broader study area region, which includes areas of the GTHA as well as Niagara, Haldimand, Brant, Waterloo, Wellington, Dufferin, Simcoe, Kawartha Lakes, Peterborough, and Northumberland. iii, v, 1, 2, 5, 6, 10–12, 14, 15, 18, 20, 23, 30, 32, 37, 38

GGHM **Greater Golden Horseshoe Model.** A long range transportation forecasting model covering the Greater Golden Horseshoe Region. The model forecasts transportation demand across multiple modes, and models how transportation behaviour and transportation network use might change over time with changing land use, roads, and transit expansion. iii–v, 5, 18, 19, 29–31

GTHA **Greater Toronto and Hamilton Area.** An urban area covering greater Toronto and Hamilton, typically defined as including the City of Toronto and the regional municipalities of Halton, Peel, York, Durham, and Hamilton. 2, 11, 22, 25–27, 32, 37, 41

inequality ratio A method of comparing marginalized groups with a relevant comparison group. Specifically, the inequality ratio is the average benefit of a comparison group divided by the average benefit of a marginalized group. Values greater than one favour the comparison group, values less than one favour the marginalized group. 14

Market Basket Measure The Market Basket Measure (MBM) refers to Canada's official measure of poverty based on the cost of a specific basket of goods and services representing a modest, basic standard of living developed by Employment and Social Development Canada (ESDC). The MBM thresholds represent the costs of specified qualities and quantities of food, clothing, shelter, transportation and other necessities for a reference family of two adults and two children. The square root of economic family size is the equivalence scale used to adjust the MBM thresholds for other family sizes. This adjustment for different family sizes reflects the fact that an economic family's needs increase, but at a decreasing rate, as the number of members increases. 6

RTP **Regional Transportation Plan**. A long-term planning document forecasting transportation needs and use over the coming decades. 1, 3, 5

Spatial Access Measures The **Spatial Access Measures** are a set of indicators that quantify the ease of reaching destinations of varying levels of attractiveness. There are seven destination amenities: educational facilities, post-secondary education facilities, healthcare facilities, employment, grocery stores, culture and arts facilities, and sports and recreation facilities. For each amenity, there are four variants based on the transportation mode: access via public transit during peak hours, access via public transit during off-peak hours, access via cycling and access via walking. This report

draws on these measures for evaluating the existing conditions of transit equity; in particular employment, health care, and post-secondary education. iii, iv, 19, 20, 29–31, 54, 55

transport disadvantage A phenomenon whereby an area or zone experiences a level of access or other transit service below a defined threshold (the transport disadvantage line). Transport disadvantage is used in this study to quantify the *transport* portion of transport poverty. 15

transport poverty A phenomenon whereby historically marginalized individual or population groups face additional transportation barriers such as inadequate public transit access to opportunities. 15

TTS The **Transportation Tomorrow Survey** (TTS) is a cooperative effort by local and provincial government agencies to collect information about urban travel in southern Ontario. The survey has been undertaken every five years since 1986. The data collected helps local and regional governments, as well as the province and its agencies make informed transportation decisions on future planning and investment for roads, public transit, and other transportation facilities. 46

A. Parameters and Assumptions

This appendix contains a detailed and mathematical description of formulas, parameters, and assumptions used in the computation of various access and equity measures.

A.1 Access to Opportunity Measures

There are two families of access measure types that can be used: Cumulative, or minimum cost, with the more common of the two measures being cumulative.

Cumulative measures are defined as follows: For a set of origins $i \in I$ and a set of destinations $j \in J$, we can calculate the access to opportunities with:

$$A_i = \sum_{j \in J} O_j \, f(\cdot) \tag{A.1}$$

Where $f(\cdot)$ is a function of the cost (usually travel time) to get from i to j, and O_j is the count or value of opportunities at the destination j. The properties and shape of $f(\cdot)$ depend on the model of access used, some common forms are given in Figure A.1. In this study we use a "rectangular cutoff" decay function defined as:

$$f(t) = \begin{cases} 1 & t < \tau \\ 0 & t \geq \tau \end{cases} \tag{A.2}$$

for a given travel time t, and a travel time cutoff parameter τ.

Minimum cost measures determine the minimum travel cost to reach X opportunities (e.g. what is travel time to the nearest grocery store, or the travel time to the 3rd nearest

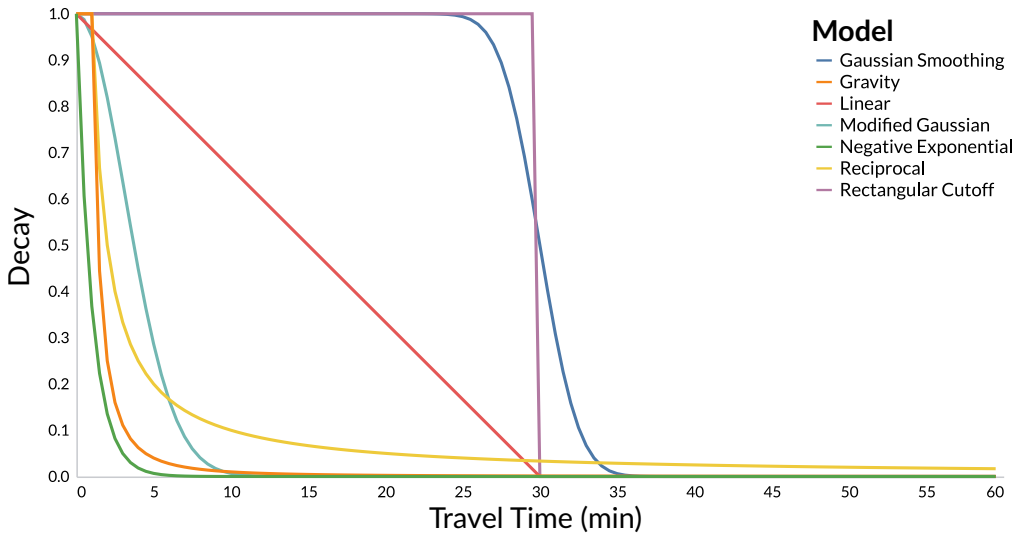

Figure A.1: Various shapes of decay functions

library). Mathematically, this access A_i' is given as:

$$A_i' = \max\{\min_n\{C_{i,j}X_j\}\} \tag{A.3}$$

where $C_{i,j}$ is the cost of travel between origin i and destination j, X_j is the number of opportunities at the destination j, and we are choosing the nth smallest cost.

A.2 Measures of Transport Disadvantage

Transport poverty measures draw on a family of measures called Foster-Greer-Thorbecke Measures (FGT). FGT measures are expressed mathematically as:

$$\text{FGT}_\alpha = \frac{1}{N}\sum_{i\in H}\left[\frac{z-y_i}{z}\right]^\alpha \tag{A.4}$$

Where N is the size of the population being measured, z is the predefined disadvantage line, H is the set of individuals *below* that disadvantage line, y_i is the accessibility or performance level of each individual i, and α is a parameter that determines how sensitive the index is to changes in the disadvantage gap.

The three most common FGT measures use the first three non-negative integer values of α. When $\alpha = 0$, the FGT measure reduces to the fraction of individuals who fall below the disadvantage line, also known as the disadvantage rate. When $\alpha = 1$, FGT measures the average percent difference between the disadvantage line and those below it (sometimes referred to as the disadvantage gap index), and when $\alpha = 2$, the measure weights the disadvantage gap index by the size of the gap itself again.

This is the most popular measure in disadvantage economics and has been used previously in transportation equity studies as well,[1] as it recognizes that there are compounding non-linear effects of being in severe disadvantage. In this study, we consider the first two values of α, namely the *rate* of disadvantage and the *severity* of disadvantage.

The term inside the sum of Equation A.4 can independently be computed for each geographical area. When $\alpha = 1$ we can compute the severity of transport disadvantage experienced by each zone i:

$$\text{Severity}_i = \begin{cases} \left[\frac{z-y_i}{z}\right] & y_i < z \\ 0 & y_i \geq z \end{cases} \tag{A.5}$$

This severity was multiplied by the number of individuals of a given population group living in an area to produce a group-specific transport disadvantage score for that region:

$$\text{Disadvantage Score}_i = \begin{cases} \left[\frac{z-y_i}{z}\right] p_i & y_i < z \\ 0 & y_i \geq z \end{cases} \tag{A.6}$$

for a population group count p_i in zone i. This transport disadvantage score can be mapped individually for each dimension, or dimensions can be combined in several ways. In this analysis we assigned 0 to 3 points to each area for each dimension based on the relative level of transport disadvantage experienced by that area, as shown in Table A.1.

Table A.1: Points assigned for each dimension based on relative levels of transport disadvantage.

Relative Severity Level	Points
No disadvantage	0
Bottom third	1
Middle third	2
Top third	3

For our seven dimensions, a maximum of 21 points was possible. The final transport poverty score shown in the analysis was re-scaled to a score from 0 to 100.

A.3 Inequality Ratios

Inequality ratios are designed to compare non-marginalized populations with similar marginalized communities. They draw on the definition of the Palma Ratio metric of income inequality, which computes the ratio of the upper class (top 10% of income) with the lowest 40% of income.

Inequality ratios in our case are defined as the average population weighted benefit across a non-marginalized or standard population, divided by the population weighted average benefit across a marginalized group:

$$\text{Inequality Ratio}_p = \frac{\frac{\sum_i p'_i b_i}{\sum_i p'_i}}{\frac{\sum_i p_i b_i}{\sum_i p_i}} \tag{A.7}$$

Where p_i is the number of marginalized individuals in zone i, p'_i is the number of non-marginalized individuals in zone i, and b_i is the benefit realized in zone i (e.g. increased access, improved travel time, etc.). Inequality ratios for each population group were computed and then averaged across dimensions.

A.4 Areal Apportionment

Census demographic information is available at the Dissemination Area (DA) level, while travel times generated by models, and some data from the Transportation Tomorrow Survey (TTS) use traffic analysis zone systems. In order to link these two datasets together, we use a process of *areal apportionment*. We compute what percentage of each DA falls within a given traffic analysis zone, and assign that number of a given group of individuals in the DA to the traffic analysis zone. With areal apportionment, we assume that the number of people of any population group in a given zone is evenly distributed within that zone, and so the fraction of the area of that population zone overlapping with another zone is equal to the fraction of population that falls within that zone.

Figure A.2 shows an example of how a population zone with 100 people gets apportioned. In this example, 35% of the blue zone (the green area) falls within the analysis zone shown in orange, and so 35 people from that particular blue zone are allocated to that particular orange zone.

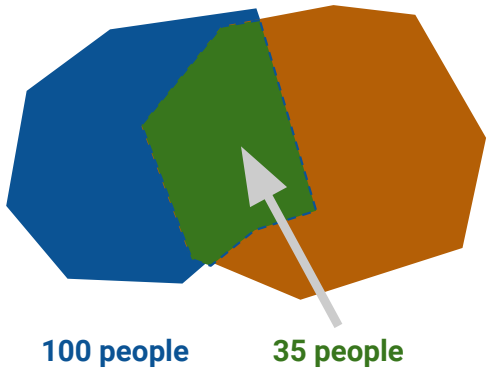

Figure A.2: Example of areal apportionment between two overlapping zones.

B. Community Consultation Summary

Memo

To: Nero Ibi, Network Planning, Metrolinx
From: Dr. Steven Farber and Dr. Willem Klumpenhouwer
CC: Eric Petersen, Network Planning, and Paul Semple, Regional Planning, Metrolinx
Date: December 8, 2023
Re: Community consultation session on transit equity for the RTP update

B.1 Background

Drs. Farber and Klumpenhouwer are conducting work for Metrolinx that will contribute to the transit equity section of the Regional Transportation Plan (RTP) update to 2051. On December 5th, 2023, we hosted a transit equity workshop with community members. The primary objective of the workshop was to present and seek feedback on our social equity analysis plans from a broad spectrum of voices representing marginalized populations and communities across the Greater Golden Horseshoe (GGH). We took the lead on the development of the workshop with support and collaboration from Metrolinx and in sync with the Ontario Ministry of Transportation (MTO) in light of their current consultation efforts for their own transportation equity framework. The workshop enabled community members to provide key feedback on our analysis plans, with a focus on how we are planning to conceptualize and measure transit equity, how we will define priority population groups, and which limitations to our current plans seem crucial to examine moving forward.

B.2 Workshop Overview

B.2.1 RECRUITMENT

Invitations were sent to a list of 66 individuals and organizations representing diverse populations, communities, and social and modal interests. We compiled this list from multiple sources including: a database personally maintained by Dr. Farber, the Mobilizing Justice Catalogue of Canadian Community Initiatives Addressing Transport Poverty, and a list of community contacts provided by Metrolinx.

The list was analyzed to ensure geographic and population-based representation. We then sent an email invitation (including using website contact forms) to the entire list soliciting expressions of interest in participating in our session by filling out a shared web form. We received 23 expressions of interest and all 23 were invited to join. An honorarium of $120 (based on a rate of $1 per minute) was provided to 7 members who indicated that they were coming as a personal volunteer and not as a paid employee of a community organization.

Note that MTO reviewed the list to identify whether any participants had recently engaged with them about their Transportation Equity Framework, so as not to overburden or confuse invitees. A separate process for four overlapping organizations was developed to invite these overlapping groups.

B.2.2 ATTENDEES

Nineteen community members joined our session (see Table B.1). Overall, representation from outside the GTA was lower than expected, considering how widely we reached out regionally. TTCRiders was unable to attend due to an existing commitment. When asked who was missing from the table, respondents said the following: TTCRiders; those needing to carry many things on transit such as artists and musicians; those with mobility devices; more cycling and walking advocacy groups; Social Planning Toronto; those suffering from mental health issues.

Joining the consultation were about a dozen observers from Metrolinx (including RTP consulting team member from HDR) and MTO. Appropriately, the observers remained to the sides (virtually), and did not occupy vital space. We would recommend better coordination in the future with clearer delineation of who was joining from the community, and who was joining to participate as an observer.

B.2.3 CONTENT

Following a thorough round of introductions, Dr. Farber, Metrolinx, and MTO provided the background context required to understand the basics of the RTP update project, transit equity work occurring at the province, and the specific scope of transit equity work we are performing on behalf of Metrolinx. Following this, Dr. Klumpenhouwer walked the participants through an equity analysis example using the Ontario Line as a case study. Participants then had an opportunity to provide feedback in three guided discussions using Mentimeter as a participation tool. The discussions surrounded around: 1) participant understanding of preferences for egalitarian vs. sufficientarian measures of transit equity;[1] 2) options for consolidating the number of population groups incorporated in our analysis; and 3) other factors that we could take under advisement as we perform this equity analysis or plan for future ones.

Table B.1: List of community participants in the workshop

Name	Organization
Doug Brown	Burlington for Accessible Sustainable Transit (BFAST)
Alison Baxter	Community Development Council Durham
Annette Salfarlie	Vulnerable people on transit (Toronto)
Cameron MacLeod	CodeRedTO
David Simor	The Centre for Active Transportation
Fran Quintero	Rawlings Method Collective
Haadhi Faizal	More Neighbours Toronto
Hafiz Khan	TNO-The Neighbourhood Organization
Ian DaSilva	Ontario PSW Association
Kristin Schwartz	CultureLink
Lanrick Bennett	Charlie's Freewheels/Bicycle Mayor for Toronto
Nicole Roach	Green Communities Canada
Tecla Namuson	Ontario Council of Agencies Serving Immigrants (OCASI)
Venesha Thomas	Toronto Community Housing (TCHC)
Neisha Mitchel	Canadian National Institute for the Blind (CNIB)
Louisa Mursell	Transportation Options Association of Ontario
Cindy Tse	Dixon Hall
Rose Butler	United Way Greater Toronto
Elise Antoniadis	Jane/Finch Centre

B.3 Consultation Findings

[1] Egalitarian measures quantify the extent to which transportation benefits accrue to different population groups while sufficientarian measures quantify the extent to which individuals in different population groups fall bellow a particular threshold of benefit.

B.3.1 COMMENTS ON ACCESS TO DESTINATIONS

Using Mentimeter, we asked participants what would be a reasonable transit travel time to the destinations we are planning to measure access to in our analysis. The results found in Table B.2 confirm that the thresholds we are intending to use are in line with acceptable levels provided by the participants.

Table B.2: Distribution of acceptable travel time thresholds

Destinations	Participant Responses			Intended Thresholds
	Mean	Median	Mode	
Employment	51	55	60	60
Post-Secondary Education	48	50	60	60
Primary Education	31	30	30	30
Hospitals	33	30	30	30
Shopping Centres	41	40	30	30

Next, we asked participants to rank the relative importance of including different destination types into our transit equity analysis. The distribution of ranks appearing in Table B.3 suggest a preference among community members to base our equity analysis on access to employment, followed by hospitals, then education, and finally shopping centres and other unmentioned destinations. In the conversation, one participant raised the importance of being able to connect from one community to another, without the need for going to downtown. This was raised within the specific context of personal support workers, who need to visit people in their homes, but seldom have the right transit connections between patients on their route. Another observed that regional transit really isn't used for elementary schools, but that such amenities as cultural destinations and natural spaces would be. One participant noted that fares were not included in the accessibility analysis, suggesting that they may not be reflective of the experience of riders for whom the high costs of regional transit are a barrier to travel. Finally, there was a brief discussion about inter-regional connectivity, suggesting that there is too much focus on getting to downtown Toronto.

B.3.2 COMMENTS ON MEASURING EQUITY

We wanted to know whether participants found the two different types of equity metrics we described, egalitarian ratios and transport poverty rates, to be compelling and useful. On both criteria, respondents preferred the transport poverty measures more than the egalitarian measures (as seen in Table B.4). Notably, two participants showed a clear preference for the egalitarian measures. Unfortunately, nobody provided further explanation orally, but based on written comments, we can surmise that this has to do with the seemingly arbitrary nature of setting the sufficiency threshold. Other comments included that

Table B.3: Ranking of destination importance

Destination	Count of Ranking						Mean Rank
	1st	2nd	3rd	4th	5th	6th	
Employment	8	3	0	0	1	0	1.58
Hospitals	1	4	2	1	2	0	2.90
Post-Secondary Education	0	3	0	5	2	0	3.60
Secondary Education	1	1	4	1	0	3	3.70
Shopping Centres	1	0	3	1	4	1	4.00
Other Destinations Not Considered	1	0	1	2	1	6	4.82

the concepts and measures seemed too academic, and wondered whether these were the equity concerns that communities would voice themselves, of if we are likely to gain an adequate understanding of community needs using these methods. Finally, participants noted that affordability was just as important as spatial accessibility in determining transit equity.

Table B.4: Degree of agreement with equity concepts and measures

Statement	Score					
	1	2	3	4	5	Mean
Egalitarianism is compelling	2	4	3	1	2	2.8
Sufficiency is compelling	2	0	2	5	3	3.6
Inequality ratios are useful	4	3	2	2	1	2.4
Transport poverty is useful	2	0	0	5	5	3.9

B.3.3 COMMENTS ON POPULATION GROUPS

We provided participants with 4 different options for achieving greater clarity in communicating results considering the large number of population groups under investigation. Participants agreed that some sort of data reduction or combining of population groups would be needed, and that the least desirable way of doing this would be to exclude groups from the analysis altogether (see Table B.5). There was a strong desire to combine results spatially so that priority neighbourhoods could be defined and visualized for planning purposes. It was mentioned that this approach aligned with other efforts in the region including work being undertaken at the City of Toronto in partnership with United Way. In the case of poverty reduction, research has found that poverty does concentrate spatially, and that people experiencing poverty tend to be co-located with other equity deserving groups. Participants were also supportive of combining outputs by different dimensions, e.g. material deprivation, gender, ability, etc., so long as this was combined with a check to see whether any of the constituent population groups within a dimension had equity results

that were very different to the dimension average. This is an important step to ensure that results don't get "averaged" out.

Table B.5: Ranking of options for combining population groups

Statement	Rank				Mean Rank
	1st	2nd	3rd	4th	
Create neighbourhoods	9	2	2	0	1.46
Combine groups by dimensions	3	5	1	1	2.00
Leave population groups as-is	1	3	5	0	2.44
Reduce the number of groups	0	0	1	7	3.88

B.3.4 ADDITIONAL COMMENTS

When asked to provide open-ended feedback, participants mentioned the importance of affordability, not just accessibility, in assessing equity. They also questioned what the different planning scenarios are and whether our equity analysis could consider scenarios that incorporated fare integration. A final comment was left to remind our team to not ignore pedestrian and cycling modes in our equity assessment, since all transit trips begin and end with an active mode being used.

Table B.6: Workshop attendees from Metrolinx, MTO, and HDR Inc.

Name	Organization
Lee Caragiale	HDR
Amy Peebles	Metrolinx
Christine Parris	Metrolinx
Eric Petersen	Metrolinx
Eugenia Ochoa Herrera	Metrolinx
Nero Ibis	Metrolinx
Paul Semple	Metrolinx
Pooja Ramaswamy	Metrolinx
Elnaz Yousefzadeh	MTO
Michael Brewer	MTO
Pricilla Ankomah-Hackman	MTO

B.4 Recommendations

Based on the feedback received, we make the following recommendations:

1. **Accessibility**. Our accessibility analysis aligns well with participant expectations and recommendations. We should continue to consider hospitals considering the high weight provided, and if we do remove opportunities from our list of destinations in the accessibility analysis, local schools, and shopping centres both received lower ranks and questionable applicability within a regional transit plan (for schools). We also noted that except for access to employment, reasonable travel times were closer to the 30-minute mark than to the 60-minute mark.

2. **Affordability**. We should consider whether and how affordability impacts of planning scenarios can be assessed. We should examine the planning scenarios to determine how/whether fare integration can be integrated into the plans, and if so, whether that can be reflected in our equity analysis. Currently, this falls outside the scope of our work.

3. **Equity Conceptualization**. We should prioritize transport poverty conceptualizations and metrics over egalitarian ones. They were better understood and more compelling among the participants. More work is needed to arrive at the thresholds used to delineate sufficiency.

4. **Populations**. We will work on combining results by dimension, while considering how to continue to spatialize the results using neighbourhood definitions.

C. Current State Analysis

C.1 Parameters and Assumptions

C.1.1 SPATIAL ACCESS MEASURES

The Spatial Access Measures use an inverse distance decay weighting function for opportunities for all three measures used in this study. Statistics Canada does not provide additional information on the shape or form of the smoothing function, nor the values of cumulative access in each Dissemination Block (DB). Their process is as follows:

> The gravity model is based on the principle that the likelihood of interaction between two locations is proportional to the attractiveness (mass) of the destination and inversely proportional to the distance or duration of travel between them. The distance or duration can be further transformed using an impedance or distance decay function to account for the variation in willingness to travel to different types of amenities and use different modes of transportation. Finally, the level values are rescaled into an index by min-max normalization; that is, the minimum value for all Canada is set to 0 and the maximum value for all of Canada is set to 1.

Spatial access measures for employment (`acs_idx_emp`), health care (`acs_idx_hf`), and post-secondary education (`acs_idx_psef`) at the DB level were used as the access component of the current state analysis. The 2021 Census provides demographic data at the DA level. This data was apportioned to the DB level using population weightings (e.g. if a DB contains 20% of a DA's population, 20% of the DA counts as area apportioned to that block).

The transport disadvantage line was determined as either:

- The total population-weighted 25th percentile of access to a given opportunity in a

given study region, or if that value is zero

- The smallest non-zero value of access to a given opportunity in a given study region.

This transport disadvantage line was used to compute severity as described in Appendix A.2.

C.2 Additional Results

This appendix contains detailed results using the Spatial Access Measures data and multiple opportunity locations. The charts in this section show individual demographic groups in addition to the dimension they are a part of. Demographics are abbreviated using the abbreviations in Table C.1.

Table C.1: Population group abbreviations used in the charts in this appendix.

Equity Dimension	Population, Household, or Trip Measure	Abbreviation
Language	Non-English speakers	NENG
Age	People under 15 years of age	U15
	People 65 years and older	65+
Means	Single-parent households	SPHH
	People considered low-income	LICO
	People unemployed	UNEM
Housing	Households living in homes in need of major repair	MAJR
	Households living in housing considered not suitable	NSUT
	Households who spend 30% or more of income on shelter	$30+
	Households living in rented subsidized housing	SUBS
Immigration	People who recently immigrated (2016-2021)	IREC
	Non-permanent residents	NPER
	People with refugee status	REFG
Race	People with Indigenous identity	INDG
	Racialized people	RCLD
	Black people	BLCK
Transportation	Journeys to work exceeding 60 minutes	LONG
	Households with zero car ownership	0CAR

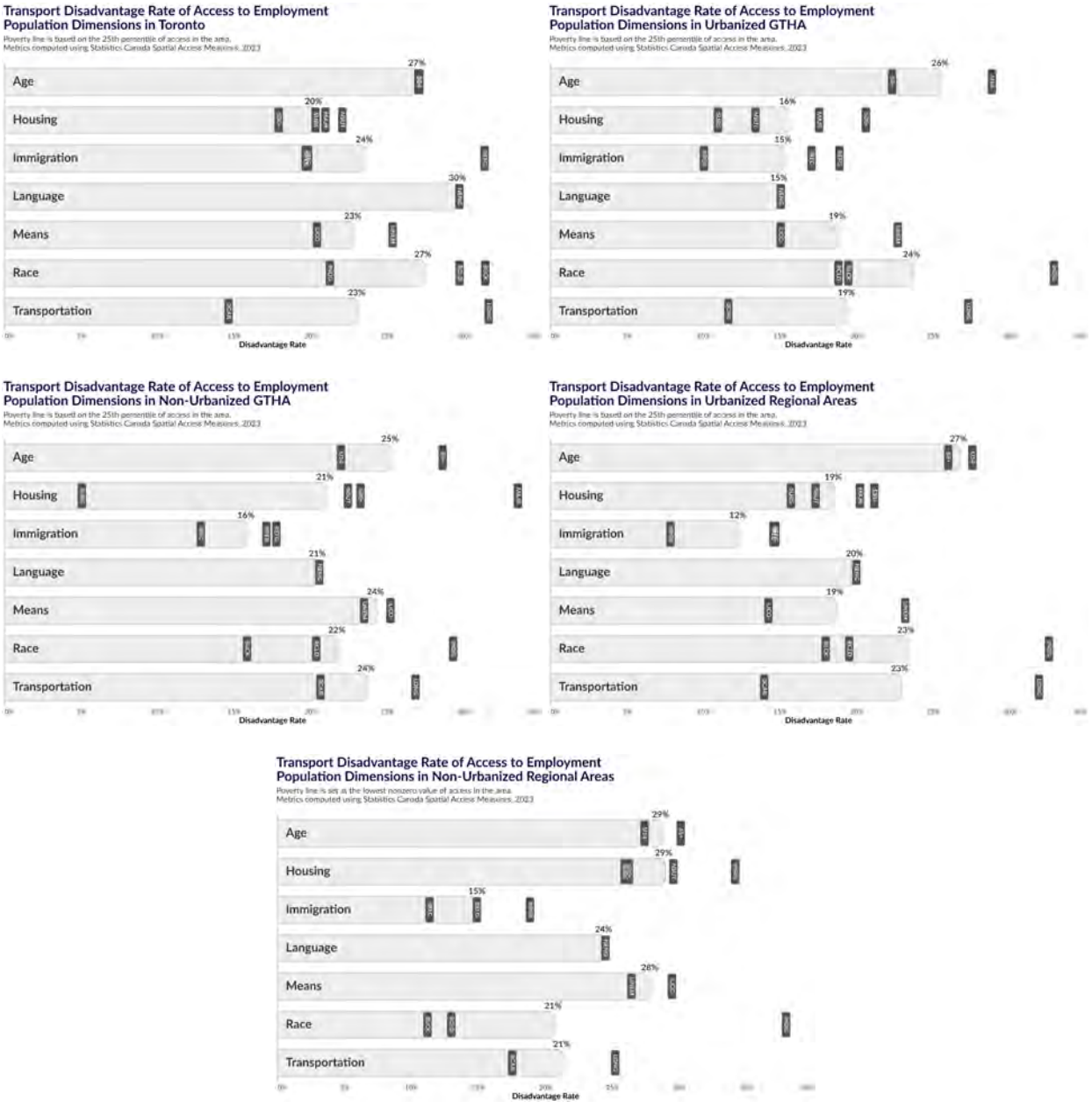

Figure C.1: Group and dimension level transport disadvantage rates of access to employment in all five study regions.

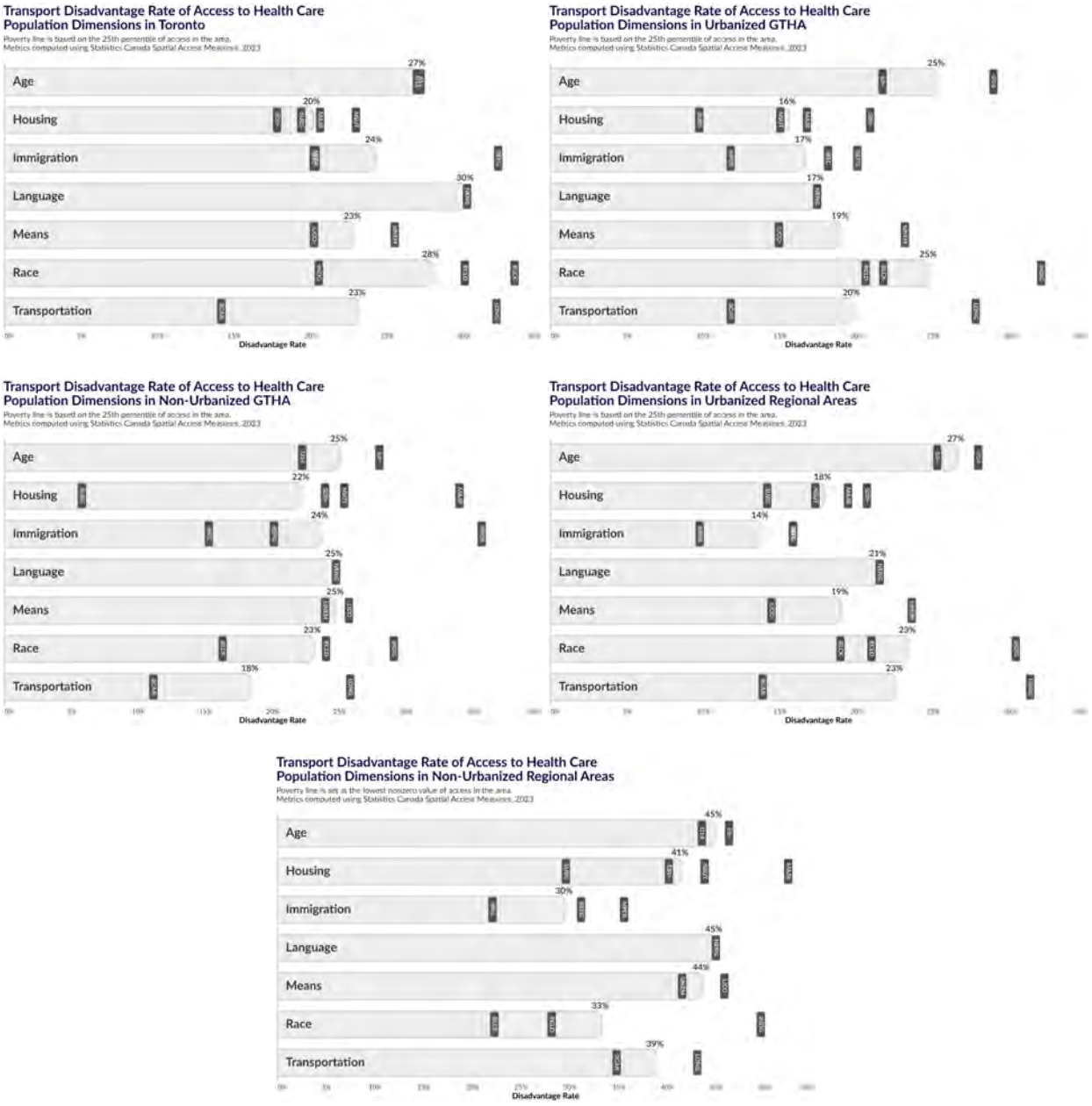

Figure C.2: Group and dimension level transport disadvantage rates of access to health care in all five study regions.

Figure C.3: Group and dimension level transport disadvantage rates of access to post-secondary education in all five study regions.

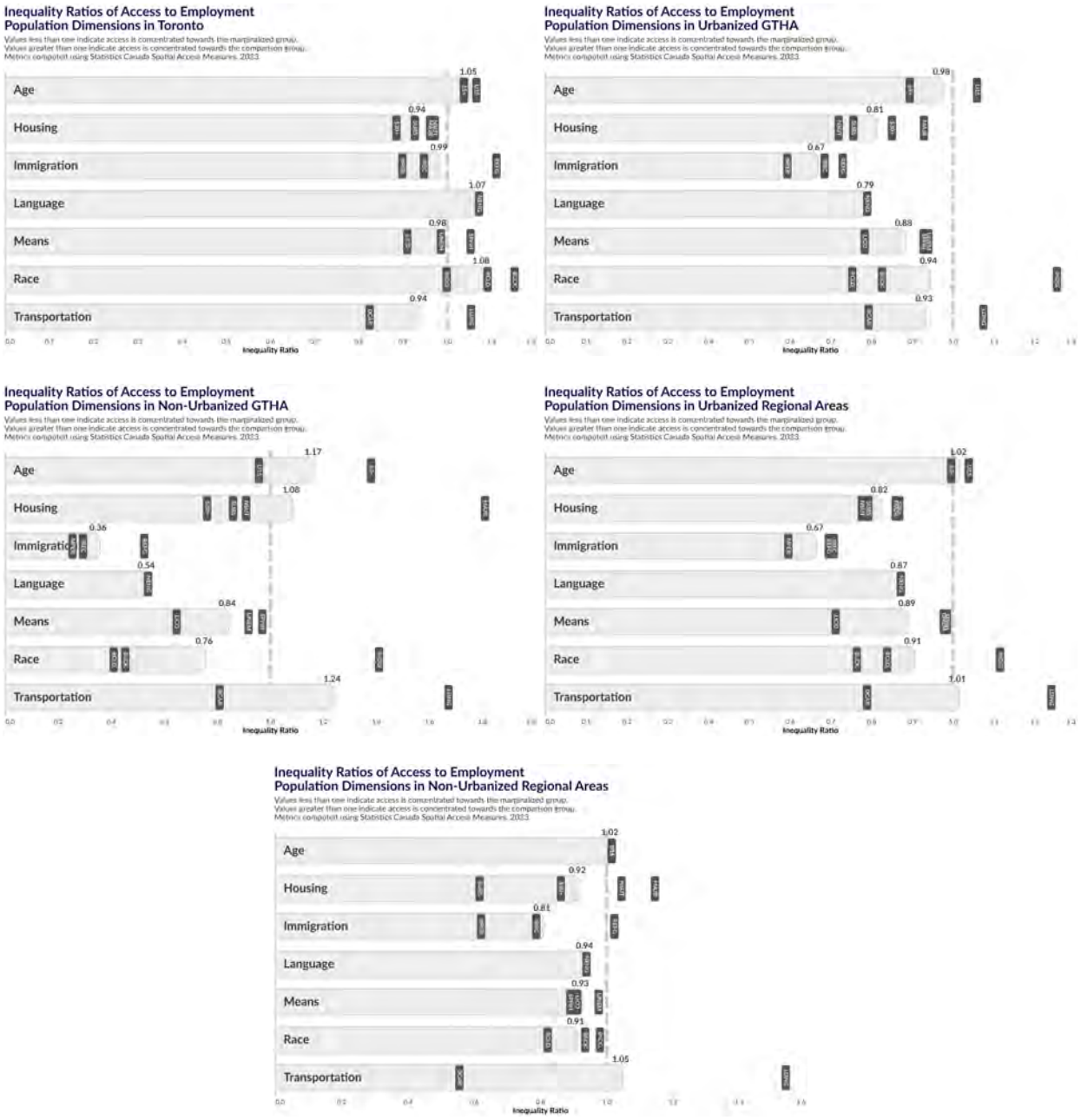

Figure C.4: Group and dimension level inequality ratios of access to employment in all five study regions.

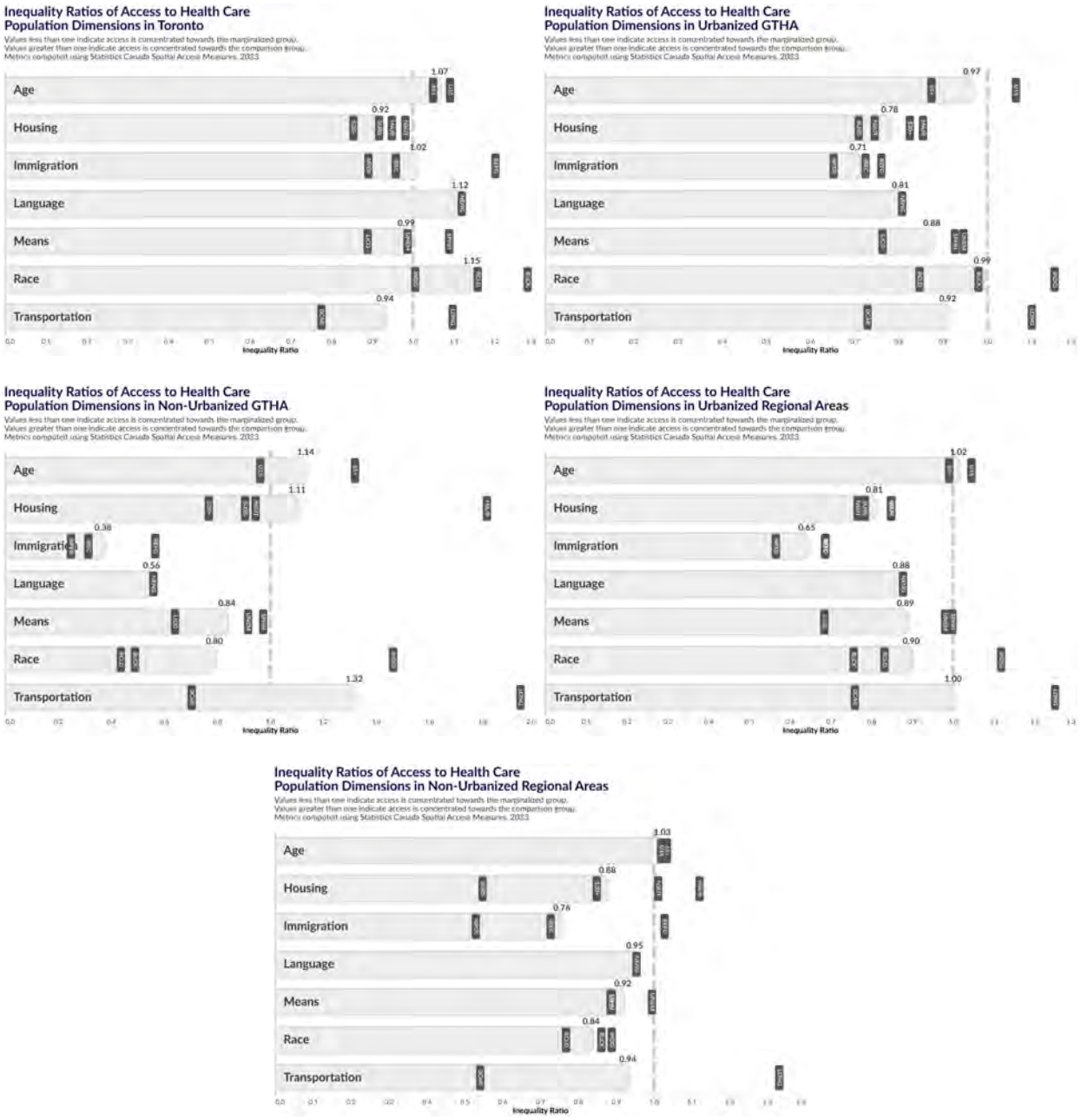

Figure C.5: Group and dimension level inequality ratios of access to health care in all five study regions.

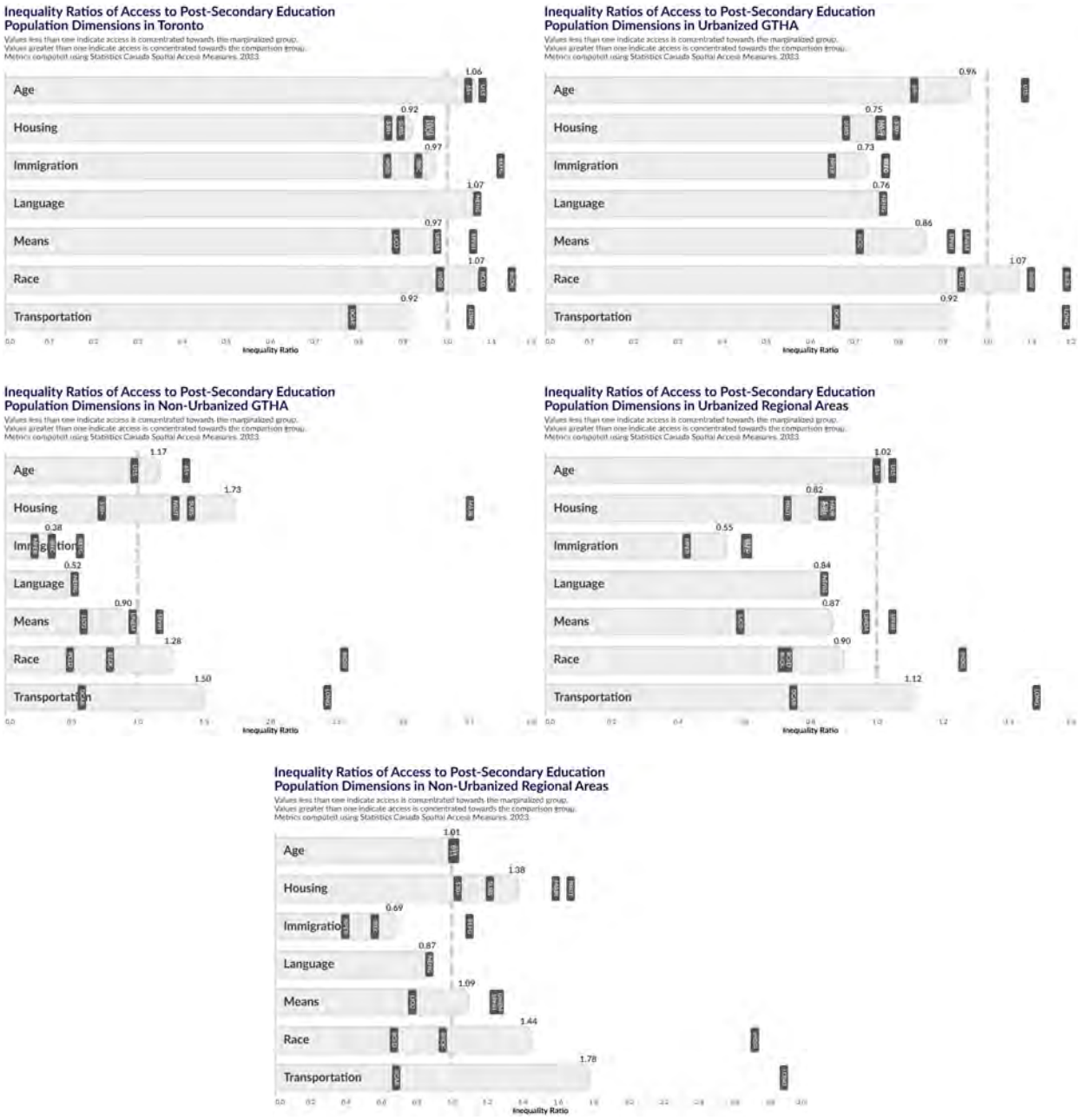

Figure C.6: Group and dimension level inequality ratios of access to post-secondary education in all five study regions.