CHAPTER 3:
BUILT ENVIRONMENT AND DIABETES

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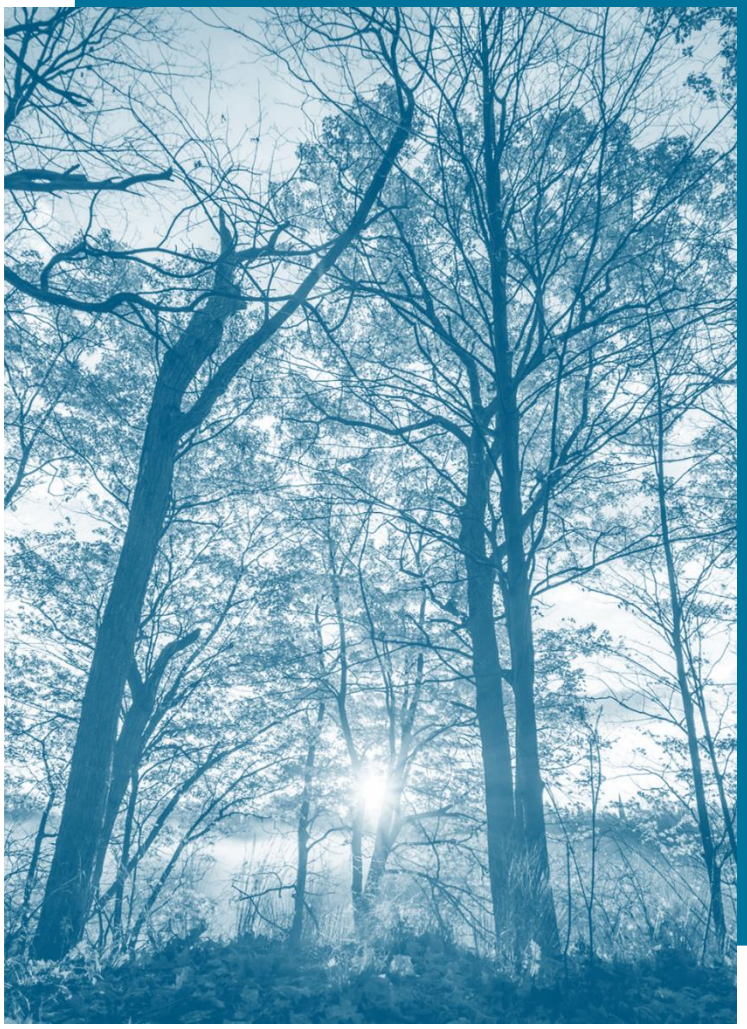
KEY FINDINGS

- **Walkability** is generally low in most communities in Peel; however, there is relatively good access to public parks and greenspace throughout the region. In addition, access to frequent transit is present only in certain regions (i.e. along the lakeshore and in central areas of Mississauga and Brampton) and completely absent in Caledon – creating a further barrier to active transportation as an alternative to car use.
- Other neighbourhood characteristics that influence the risk of diabetes, such as **fast-food access and core housing need**, are highly variable across the region, while poor air quality is highly concentrated in communities surrounding the airport and major transit routes.
- High diabetes prevalence neighbourhoods have one or more characteristics that make it challenging to adopt a healthy lifestyle. Policies to create healthier environments need to be multifaceted to address the diverse needs of each community.
- Some neighbourhoods have favourable characteristics that may compensate for less favourable aspects - for instance, the presence of a **transit network** may allow one to circumvent living in a less walkable neighbourhood.
- The spatial overlap between key environmental indicators and diabetes rates underscores the importance of assessing a range of social and environmental characteristics and their collective impacts on diabetes.



INTRODUCTION

In this chapter, we turn our attention toward the macro-level sector described in Chapter 2: understanding how neighbourhood features, including their infrastructure and amenities, can be targeted to prevent type 2 diabetes. By definition, the 'built' environment encompasses structures within communities that were made or modified by humans (e.g. buildings, roads, parks and transportation systems), and thus, it represents the physical environment in which we live, work, and play. The built environment impacts diabetes risk indirectly by creating opportunities for (or barriers to) healthy, active living. This includes whether neighbourhoods are conducive to walking and cycling; the presence of parks, natural environments, and recreational spaces; and access to frequent transit, healthy food, and safe, affordable housing. However, it may also affect diabetes risk directly through exposures such as air pollution or social stresses.

Research linking neighbourhood environments to health has grown substantially in recent decades.[1] Populations that use 'active' forms of transportation more often (i.e. walking, cycling, or public transit use) are more physically active, spend less time engaged in sedentary behaviour, and have better health outcomes than those who travel primarily by car .[2-4] Neighbourhoods that make it easier for residents to engage in active transportation are associated with higher rates of physical activity and lower rates of obesity, hypertension, type 2 diabetes incidence, and mortality, compared to car-oriented areas.[5-12] Highly walkable communities are more densely populated, compact, and oriented toward pedestrians than low walkability areas and have an abundance of service and shopping destinations within walking distance of people's homes, making it possible for people to carry out daily activities on foot or by cycling .[13] In contrast, sprawling, low-density neighbourhoods typically have few walkable destinations and infrequent transit, resulting in a greater dependency on car travel. Many other factors, such as housing prices and car ownership, can play a role by limiting one's options for where to live and the ability to live in a suitable, high-quality dwelling, underscoring the importance of how these relationships vary by socioeconomic status.

Built environment characteristics may have additive or synergistic effects. In an international study, residents living in communities that scored highly on multiple features (walkability, greenspace, and transit access) were far more likely to meet the target level of physical activity established by national guidelines than those living in areas where all three features were lacking.[14] Neighbourhood greenspace has been linked to a range of health benefits, including increased physical activity, social connectedness, mood and well-being, and reduced levels of obesity-related diseases.[1,15] Greenspace offers a central location for residents to engage in social and physical activities[16,17] and has the added benefit of reducing air pollution levels and urban heat and mitigating their downstream health impacts.[18,19] High concentrations of traffic-air pollution from idling cars may reduce the benefits of living in a highly walkable neighbourhood.[9] The retail food environment is another factor that can influence diabetes risk by altering one's ability to make healthy food choices.[20] Although research in this area is still growing, a Canadian systematic review showed an association between the food environment and body mass index,[20] while

a recent international study showed an association between access to unhealthy food outlets and both prevalence and incidence of type 2 diabetes.[21] While the relationship is complex, the proportion of nearby restaurants that serve fast food appears to be most consistently related to the risk of obesity and diabetes, particularly in neighbourhoods that have a high restaurant volume.[22-23]

To address the growing burden of type 2 diabetes, the Region of Peel has acknowledged the role of neighbourhoods in enabling healthy lifestyles in their ongoing initiatives . This includes innovative Region of Peel Official Plan (OP) Health and the Built Environment policies. These policies support the creation of healthy built environments by requiring a Health Assessment on all applicable development applications. The assessment involves reviewing and providing comments on the design details of the applications from a public health perspective to foster the development of healthy, complete, and compact communities that support active transportation.

As part of this program, a key innovation included the implementation of the Healthy Development Framework,[24] a collection of tools and indicators tailored to planners and developers in the Region of Peel for assessing the health-promoting potential of neighbourhoods and new policies to better meet the needs of a diverse population. Further, these Official Plan policies also require Peel's local municipalities to integrate the core elements of the Healthy Development Framework (HDF) into their land use development policies, including the requirement for a Health Assessment. Consequently, these Region of Peel policies support the creation of more walkable, healthier built environments throughout Peel to meet the needs of a diverse population.

The objective of this chapter is to build upon previous initiatives from the Region of Peel and its partners, such as the Healthy Development Mapping and Monitoring Project[25] and the Peel Diabetes Atlas[26], to characterize the built environment characteristics of the region and their spatial relationships to diabetes rates in Peel using recent data and novel measures.

METHODOLOGICAL APPROACH

This report investigates the spatial distribution of key built environmental characteristics and their association with diabetes prevalence in Peel. For this chapter, we chose six environmental aspects as our focus, based on previous frameworks for understanding the relationship between the built environment and health[27,28] , expert knowledge from members of the Novo Nordisk Network for Health Population Built Environment Baseline Data Strategy Working Group, as well as preliminary public consultations conducted by the Network (*Chapter 2)*.

Key indicators that reflect these environmental aspects are summarized in Table 2.1. Where possible, indicators were selected based on their broader availability (to enable comparisons to other regions), validity (their ability to capture specific features), and relevancy (completeness and degree to which data sources are current). We took a spatial descriptive approach[26] by mapping these indicators alongside diabetes prevalence rates at three different geographies (from smallest to largest): the dissemination area (DA), the census tract (CT), and the Peel Health Data Zone (PHDZ). A full description of the measures and methods used for this chapter is available in the Technical Appendix.

Table 2.1 Summary of Indicators

Environmental characteristic	Indicator	Data	Source	Year	Original geography
Neighbourhood Design	Clustered Active Living Environment class; Canadian Active Living Environments Database (Can-ALE)	Canadian Census OpenStreetMap	Canadian Urban Environmental Health Research Consortium (CANUE)	2016	DA
Natural environments/ Parks	Proximity to Parks and Green Space	Municipal parks/conservation area data	Region of Peel	2018	DA
Transportation	Proximity to Frequent Transit	General Transit Feed Specification (GTFS) Data	Region of Peel	2016	DA
Food Environment	Fast-food restaurant mix (R_{mix}); Canadian Food Environments Database (Can-FED)	Statistics Canada Business Register	Statistics Canada	2018	DA
Housing	Core Housing Need	Canadian Census Canadian Income Survey Canadian Housing Survey	Canadian Mortgage and Housing Corporation (CMHC)	2021	DA
Air Quality	Nitrogen dioxide (NO2)	National NO2 (ppb) land use regression model	CANUE	2016	Postal code

FINDINGS

Neighbourhood design plays an essential role in promoting an active lifestyle. Here, neighbourhood design is described using the Active Living Environment (ALE) class measure, which reflects whether or not neighbourhoods are conducive to active living (e.g. walking, cycling or public transit use). ALE is based on the following factors: residential density, street connectivity, and the number of walkable destinations[29] in each neighbourhood. This measure is similar in its construction to other walkability indices[5,13]. Neighbourhoods are assigned into five categories ranging from very unconducive (ALE class 1) to very conducive to active living (ALE class 5).

As depicted in *Exhibit 3.1,* most areas of Peel are classified as having low levels of conduciveness to active living. M ississauga's City Centre and its surrounding areas are the most active living-friendly areas in Peel, while most other urban areas within the region, including downtown Brampton, are far less favourable for active-living (*Exhibit 3.1, Appendix 3.1*). In addition, most areas within Caledon are categorized as being in the least favourable active living class regardless of which geographic unit was used (*Exhibit 3.1*), in keeping with the largely rural nature of this community. When the spatial relationship between ALE and diabetes is visualized at the level of PHDZs, it can be noted that several areas in Brampton have both unfavourable active living scores and high rates of diabetes. In contrast, central and eastern areas of Mississauga that are favourable for active living have low rates of diabetes *(Exhibit 3.2)*.

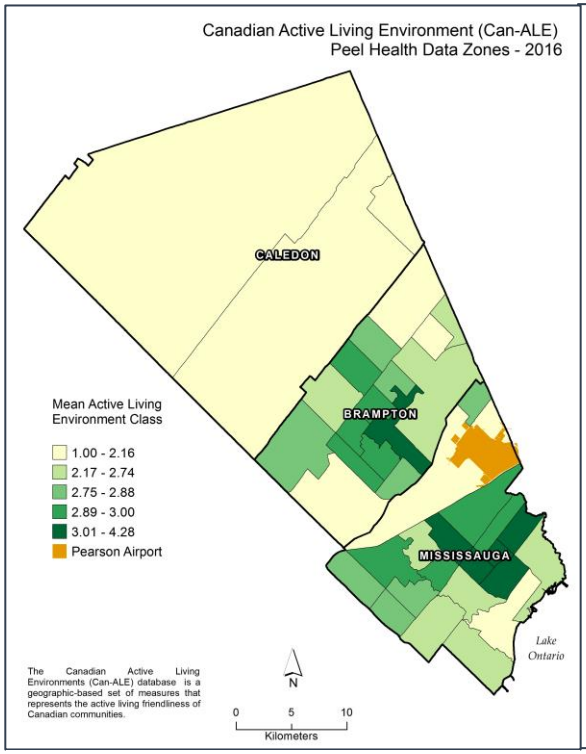


Exhibit 3.1 Active living environments [2016] as the mean Can-ALE class (class 1 to 5) grouped by quintile, by Peel Health Data Zone [2021].

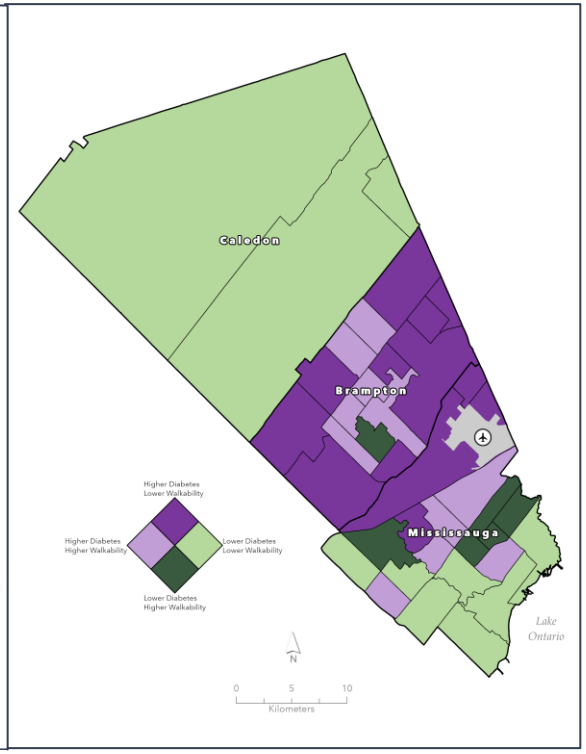


Exhibit 3.2 Spatial relationship between active living environments [2016] and age-standardized prevalence rate ratios of diabetes [2020], by Peel Health Data Zone [2021]. The top two quintiles were considered areas of *higher walkability,* and the bottom three quintiles areas of *lower walkability.*

Proximity to parks and green space describes the percentage of residents that live within a 5-minute walk (400-meters) to a park or conservation area that contains an active recreation feature (e.g. playground, baseball diamond, or tennis or basketball court) or pedestrian infrastructure such as walking paths or trails[25]. According to this proximity measure, over three-quarters of residents live within walking distance of a park or conservation area in Peel overall, and much of Mississauga and Brampton have areas with very good access to these amenities. Most of Caledon and the western areas of Brampton are measured as having lower access to public parks and green space (*Exhibit 3.3)*, although it is important to note that this does not include green areas that could be used recreationally but are not considered municipal public areas. The southern regions of Mississauga contain more parks and green space than surrounding areas. This was more pronounced when assessed at the DA- and CT-level than at the PDHZ-level (*Appendix 3.2)*. As noted for ALE, the northeast and southwest regions of Brampton have both lower access to parks and green space and higher rates of diabetes, while the western areas of Mississauga that have higher access to parks and green space have lower rates of diabetes *(Exhibit 3.4)*.

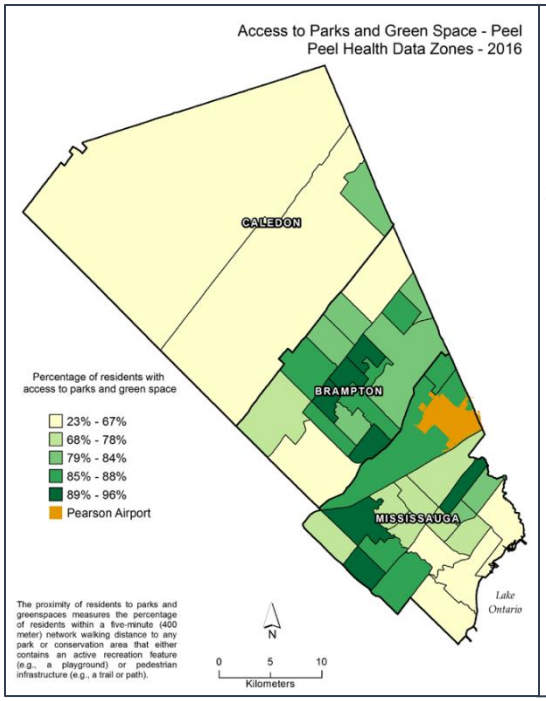


Exhibit 3.5 Access to parks and green space [2016] as the percentage of residents grouped by quintile, by Peel Health Data Zone [2021].

Exhibit 3.4 Spatial relationship between access to parks and green space [2016] as the percentage of residents grouped by quintile and age-standardized prevalence rate ratios of diabetes [2020], by Peel Health Data Zone [2021]. The top two quintiles were considered areas of *higher access to green space,* and the bottom three quintiles areas of *lower access.*

Proximity to frequent transit describes the percentage of the population that lives within a five-minute walking distance (400 meters) of a municipal transit stop and/or a 10-minute walking distance (800 meters) of a GO bus or rail stop with frequent service (see Technical Appendix for definition). Public transit systems are recognized as a key aspect of supporting active transportation and achieving physical activity guidelines.[30] Based on this measure, most Peel residents (59%) have no or low levels of access to frequent transit.[25] The highest percentage of residents with frequent transit access are found in areas of Central Mississauga, the Lakeshore, and central Brampton (*Exhibit 3.5*). No areas of Caledon were identified as having frequent transit access, owing to the absence of a transit network for the town. Areas in southeast and eastern Brampton had both a high prevalence of diabetes and low access to frequent transit (*Exhibit 3.6*).

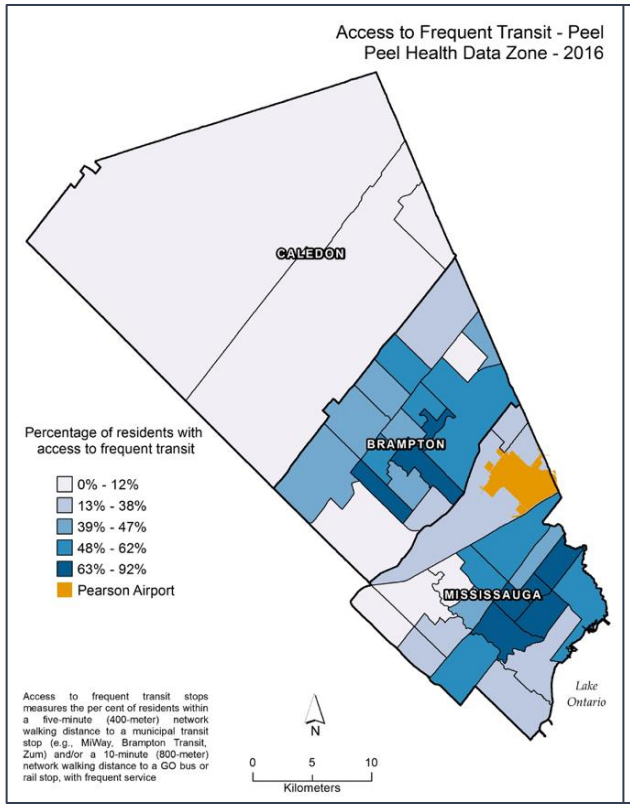


Exhibit 3.6 Access to frequent transit [2016] as the percentage of residents grouped by quintile, by Peel Health Data Zone [2021].

Exhibit 3.7 Spatial relationship between access to frequent transit [2016] as the percentage of residents grouped by quintile and age-standardized prevalence rate ratios of diabetes [2020], by Peel Health Data Zone [2021]. The top two quintiles were considered areas of *higher access to frequent transit,* and the bottom three quintiles areas of *lower access.*

The food environment generally refers how locally accessible different types of food sources, including restaurants and food stores, are in a given area. The Canadian Food Environment Database (Can-FED)[31,32] contains a measure of the proportion of all restaurants that serve fast-food. The measure clusters neighbourhoods into four categories, ranging from those with the lowest density of fast-food places (Can-FED class 1) to those with the highest (Can-FED class 4). Neighbourhoods that have no fast-food outlets or no food outlets of any kind are assigned a class of 0.

In Peel, about one-third of neighbourhoods are classified as having a very high proportion of fast-food outlets, while only 4% are classified as having a very low proportion of fast-food outlets. Many neighbourhoods (27%) do not have fast-food outlets or any food outlets at all. Looking at larger geographies (at PDHZs), regions with higher proportions of fast-food outlets overlap with areas with high diabetes prevalence, while those with low proportions of fast-food outlets have lower diabetes prevalence. However, mapping food environments in smaller areas (such as the CT or DA) within these larger regions reveals a more heterogeneous pattern to the food environment than mapping at larger regions seems to suggest (Appendix 3.4). As an example, many neighbourhoods in Brampton do not contain any fast-food or food establishments. However, when we evaluate these same areas at the larger PHDZ regional level, some are characterized as having a very high proportion of fast-food outlets – a discrepancy that likely arises from a few specific zones within the PHDZs that have high concentrations of fast-food establishments.

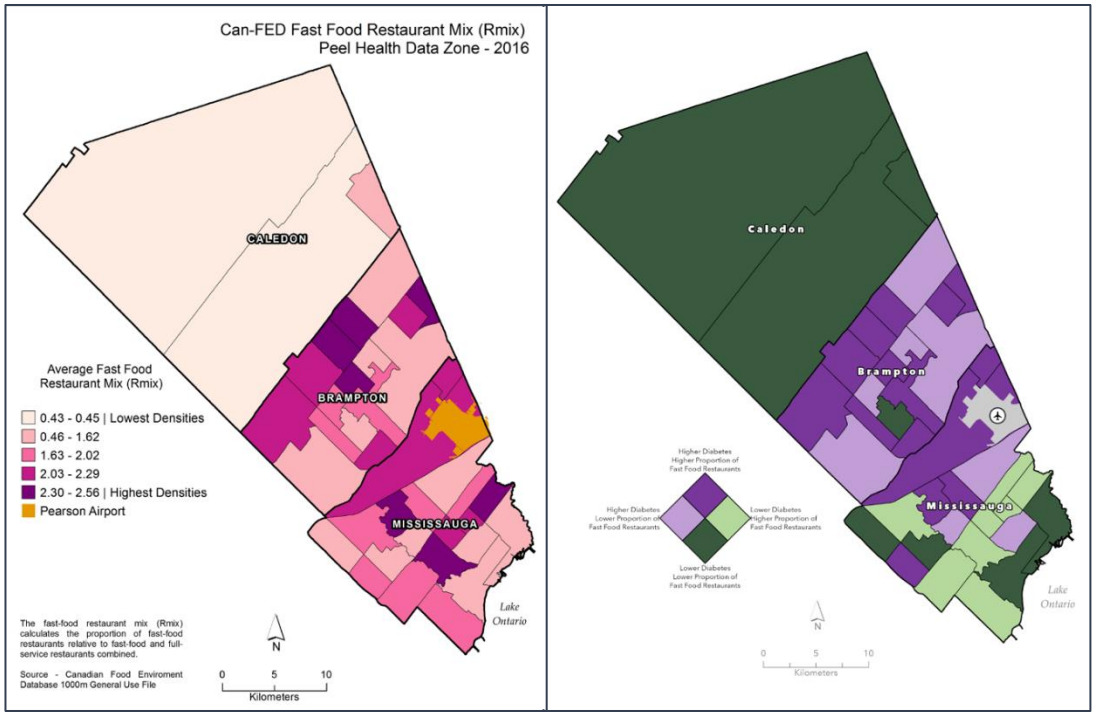


Exhibit 3.9 Food environments [2016] as the mean fast food restaurant mix R_{mix} (scores ranging from class 0 to 4) grouped by quintile, by Peel Health Data Zone [2021].

Exhibit 3.8 Spatial relationship between food environments [2016] and age-standardized prevalence rate ratios of diabetes [2020], by Peel Health Data Zone [2021]. The bottom two quintiles were considered areas with *lower proportions of fast food,* and the top three quintiles areas of *higher proportions.*

Core Housing Need is a key indicator for housing that is inversely related to socioeconomic status and also captures aspects of one's sustained, material living conditions. This measure is defined as the proportion of households living in an unsuitable, inadequate, or unaffordable dwelling and not able to afford alternative housing in their community. Prior reports suggest that rates of core housing need have fallen across Canada by ~20% in recent years.[33] Similar findings were noted for Peel and Ontario as a whole; however, the rate of core housing need remains consistently higher in Peel than Ontario (16.9% versus 15.3% in 2016 and 13.7% versus 12.1% in 2021, respectively). As shown in *Exhibit 3.9* and *Appendix 3.5,* rates of high core housing need are dispersed across Mississauga and Brampton based on DA-level maps, which is less apparent in maps at the levels of census tract and Peel Health Data Zones (PHDZ). No DAs in Caledon fall into the highest core housing need category. The bivariate map in *Exhibit 3.10*, which displays 2 variables, reveals overlap between high core housing need and high diabetes prevalence in four Peel Health Data Zones (PHDZs in Mississauga and several PHDZs in Brampton. Overall, Caledon PHDZs exhibit low rates of core housing need and low diabetes prevalence.

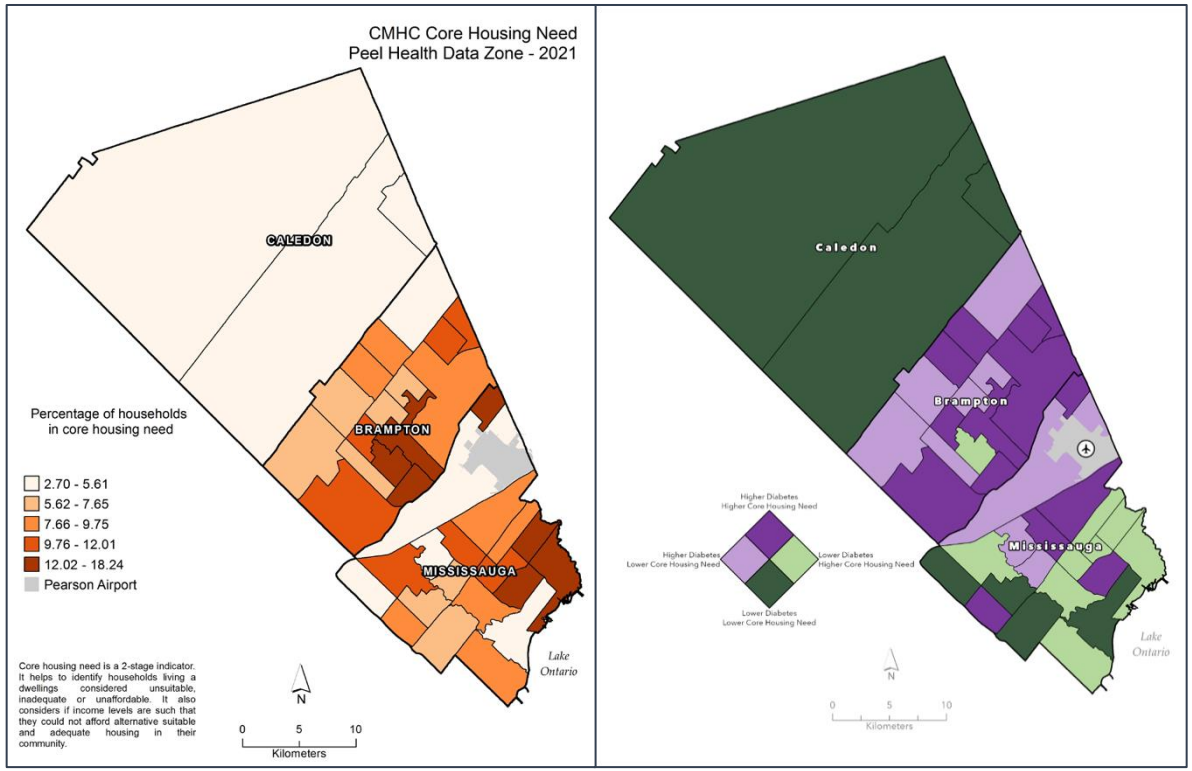


Exhibit 3.10 Core housing need [2021] as the mean percentage of households in core housing need grouped by quintile, by Peel Health Data Zone [2021].

Exhibit 3.11 Spatial relationship between core housing need [2021] and age-standardized prevalence rate ratios of diabetes [2020], by Peel Health Data Zone [2021]. The bottom two quintiles were considered areas of *lower core housing need,* and the top three quintiles areas of *higher need.*

Poor air quality has been identified as a major public health concern, owing to its ubiquity and growing prevalence as an urban environmental exposure. Air pollution has been associated with higher odds of developing diabetes and related outcomes,[34] through what is thought to be direct effects on insulin resistance.[35]

Nitrogen dioxide (NO_2) is one of the most common outdoor air pollutants, a major source of which is motor vehicle emissions. Although somewhat paradoxical, some highly walkable areas can have increased concentrations of NO_2 due to traffic congestion and idling cars, which can offset the benefits of living in a highly walkable neighbourhood.[36] In Peel Region, areas with the highest measured concentrations of NO_2 are in the eastern regions of Brampton and Mississauga, which overlap with the airport and major highways (*Exhibit 3.11, Appendix 3.6*). Such regions appear to have intermediate diabetes prevalence but do not otherwise correspond with areas of high diabetes prevalence, as seen in the northern regions of Brampton (*Exhibit 3.12*).

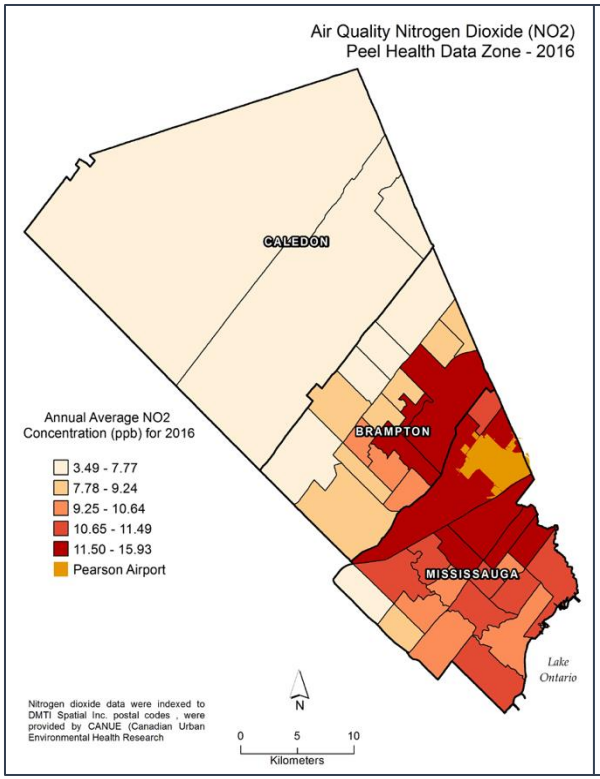


Exhibit 3.12 Air quality [2016] as the mean annual average concentration (parts per billion, ppb) of nitrogen dioxide (NO_2) grouped by quintile, by Peel Health Data Zone [2021].

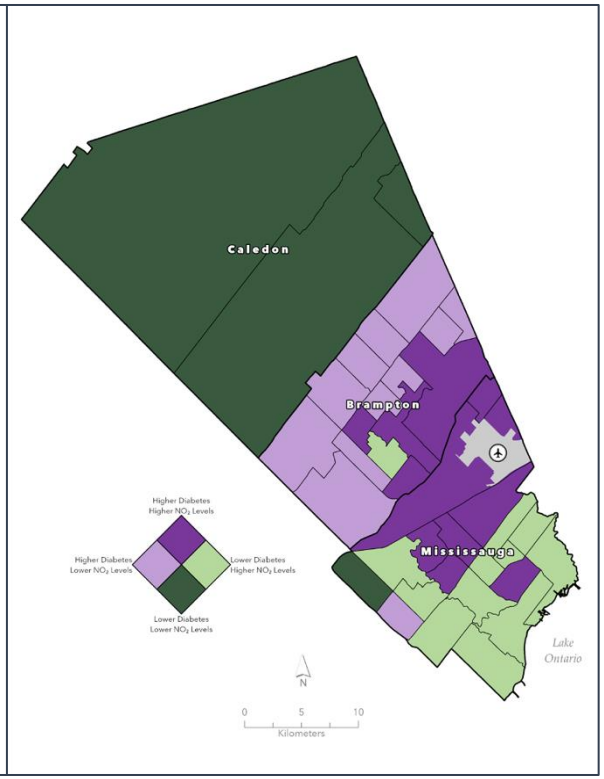


Exhibit 3.13 Spatial relationship between air quality [2016] and age-standardized prevalence rate ratios of diabetes [2020], by Peel Health Data Zone [2021]. The bottom two quintiles were considered areas of *higher air quality* (lower NO_2 levels), and the top three quintiles areas of *lower air quality* (higher NO_2 levels).

INTERPRETATION

Summary of Findings:

Our findings demonstrate considerable variation in neighbourhood characteristics across Peel. Overall, the Region of Peel has an abundance of unfavourable active living environments. In contrast, green space is broadly accessible in most communities but appeared more heavily concentrated toward the western areas of Mississauga and central Brampton. Access to frequent transit is present throughout much of Mississauga and Brampton, but many neighbourhoods lack frequent transit altogether, including all areas in Caledon. Access to fast-food outlets is quite variable throughout Mississauga and in central Brampton when assessed at the level of dissemination areas, as is the core housing need for all three municipalities. This highlights how heterogeneous neighbourhoods in the region are with respect to some aspects of the built environment. For example, many residents in Peel live near retail areas that have a high concentration of fast food outlets, with few non-fast food alternatives, while others do not. Poor air quality affects neighbourhoods close to the airport and major transit routes in Mississauga and Brampton.

Numerous adverse built environment indicators appear to correlate with high diabetes prevalence across Peel, particularly in areas of Brampton. While causal relationships between these indicators and risk of diabetes cannot be established, these findings underscore the need to prioritize the living conditions of areas that are most affected by diabetes. Disentangling the mechanisms that lead to these outcomes is also increasingly important. For example, there is an abundance of low-density neighbourhoods in regions with few walkable destinations, and while these areas may lead to fewer opportunities for walking, cycling and other forms of active transit, the presence of a transit network may allow one to circumvent low walkability.

Strengths and Limitations

These findings provide a glimpse into the built environment features of Peel Region and their spatial relationships with diabetes prevalence. Our report focuses on six factors covering six different aspects of the built environment that are strongly linked to diabetes-related health behaviours.[27,28] We used comprehensive, validated data sources and summary metrics. However, our findings have limitations that warrant consideration. First, Peel Health Data Zones (PHDZs) were the only units available for the spatial assessment of environmental characteristics and diabetes prevalence, and they are relatively large geographic units. PDHZs have a mean population size of 37,000 and range from approximately 23,000 to 103,000. Caledon is composed of only three PHDZs. Such large areas mask important variations across smaller areas for both environmental features (as apparent in *Appendices 3.1-3.6*) and diabetes prevalence (*Exhibit 2.1*).

Second, the results presented here are descriptive in nature, and caution should be taken when interpreting these findings. Although the literature that connects the built environment to health is extensive, we did not test whether residential areas that have unfavourable features are a direct risk factor for the development of diabetes. There are several known confounders in the relationship between the built environment and diabetes other than age that we did not explore or account for in this analysis, such as car ownership, socioeconomic status, the race/ethnic of residents, and other socio-cultural characteristics. It is possible that these factors contributed to the associations we observed.

Third, we chose six key indicators to study in this report. There are other potentially

important measures of the built environment that can influence health and health behaviours. For example, access to frequent transit does not capture travel behaviours nor travel purpose (i.e. transit for commuting to work or school versus transit to other locations). In addition, each measure we used has its strengths and limitations. As an example, we measured proximity to parks and green space based on walking distance to municipal parks that have recreational or pedestrian infrastructure. Much of Caledon appeared inaccessible to parks and green space with these features despite appearing relatively "green" based on other measures, such as the normalized difference vegetation index (NDVI). Given the abundance of green space in rural settings like Caledon, these populations may be less reliant on municipal parks for recreational physical activity. Lastly, our report did not assess for potential interplay between built environment indicators (e.g., walkability and access to fast food or traffic-related air pollution) or between the built environment and socioeconomic variables (e.g., access to green space and income). Such an analysis was beyond the reach and scope of this descriptive report.

Implications and Future Directions

Examining the spatial overlap between key environmental indicators and diabetes rates is a first step toward identifying the most important environmental characteristics to inform and tailor neighbourhood-level interventions to reduce the burden of diabetes in Peel. We found that neighbourhoods with high diabetes prevalence have one or more of the six environmental characteristics that make it challenging to adopt healthy lifestyles. Our findings reinforce the need for policies and interventions to be multifaceted in their approach in order to address the diverse needs of each community in Peel.[26]

This report also offers insight into the potential for favourable neighbourhood characteristics to compensate for less favourable aspects. For instance, the presence of a transit network may allow one to engage in active transportation, thereby circumventing the level of car dependency that is common in less walkable neighbourhoods. There remains a need for studies that examine the impact of a broader range of social and environmental characteristics on diabetes risk beyond those explored in this brief study, as well as a need for data available at smaller geographic scales.

Diabetes is a complex disease that is profoundly affected by our behaviours. Understanding the needs of local residents and their perceptions of their neighbourhood environment is essential for identifying interventions that will meaningfully promote physical activity and healthy eating. A full picture of how neighbourhood environments shape our behaviours and, in turn, our diabetes risk will be integral to the success of diabetes prevention strategies at the level of populations, communities and individuals.[26]

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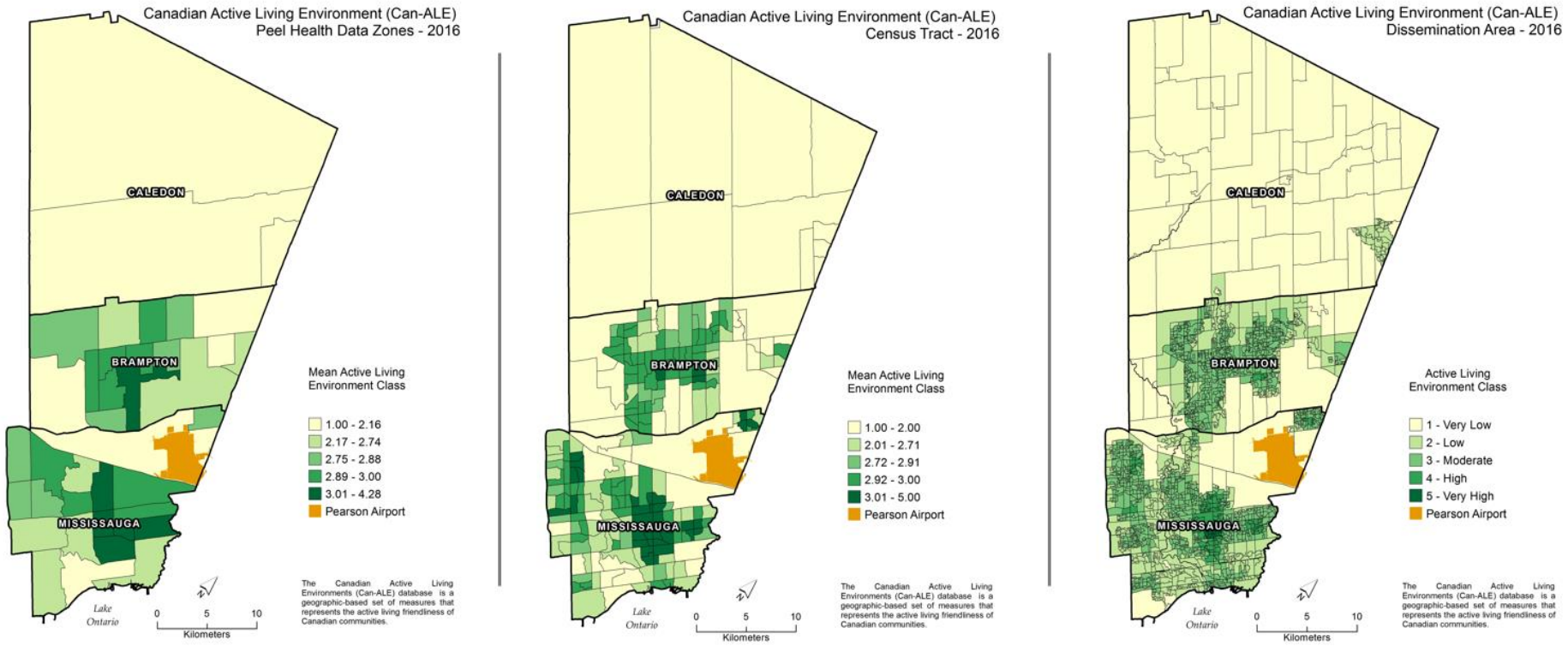
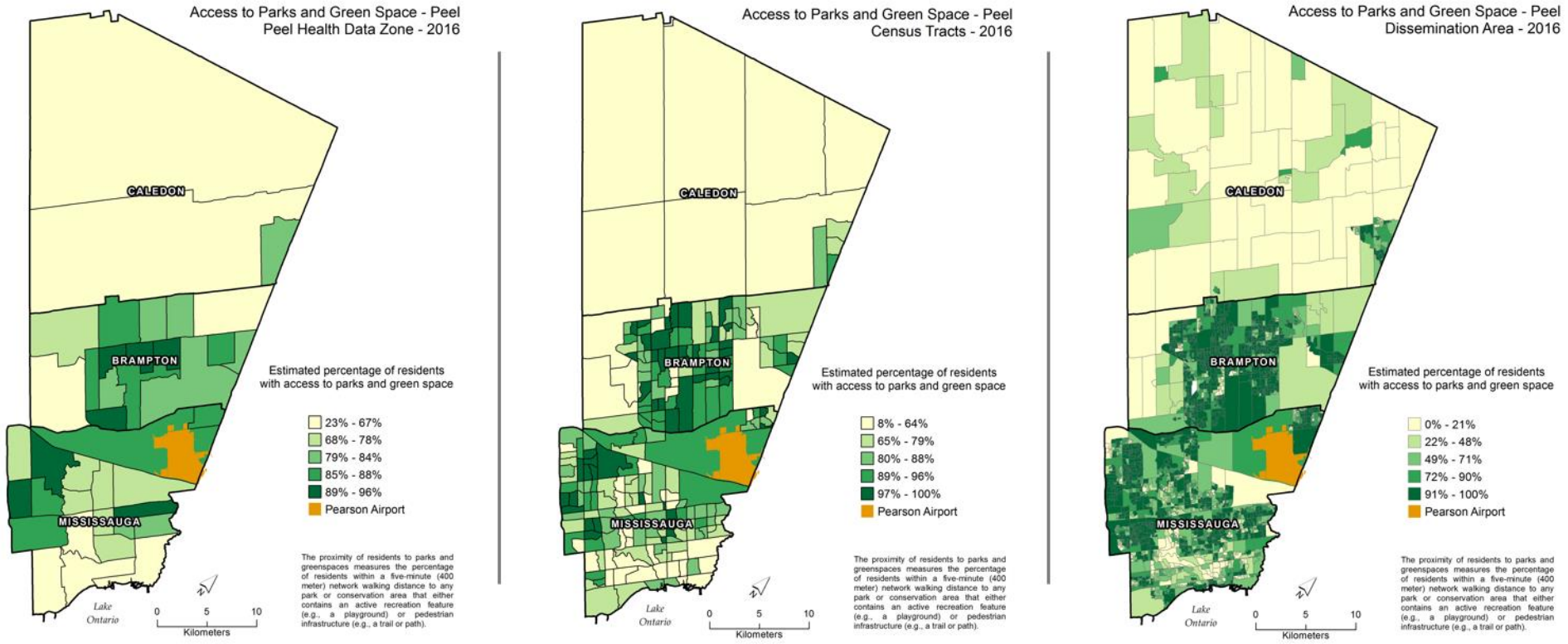
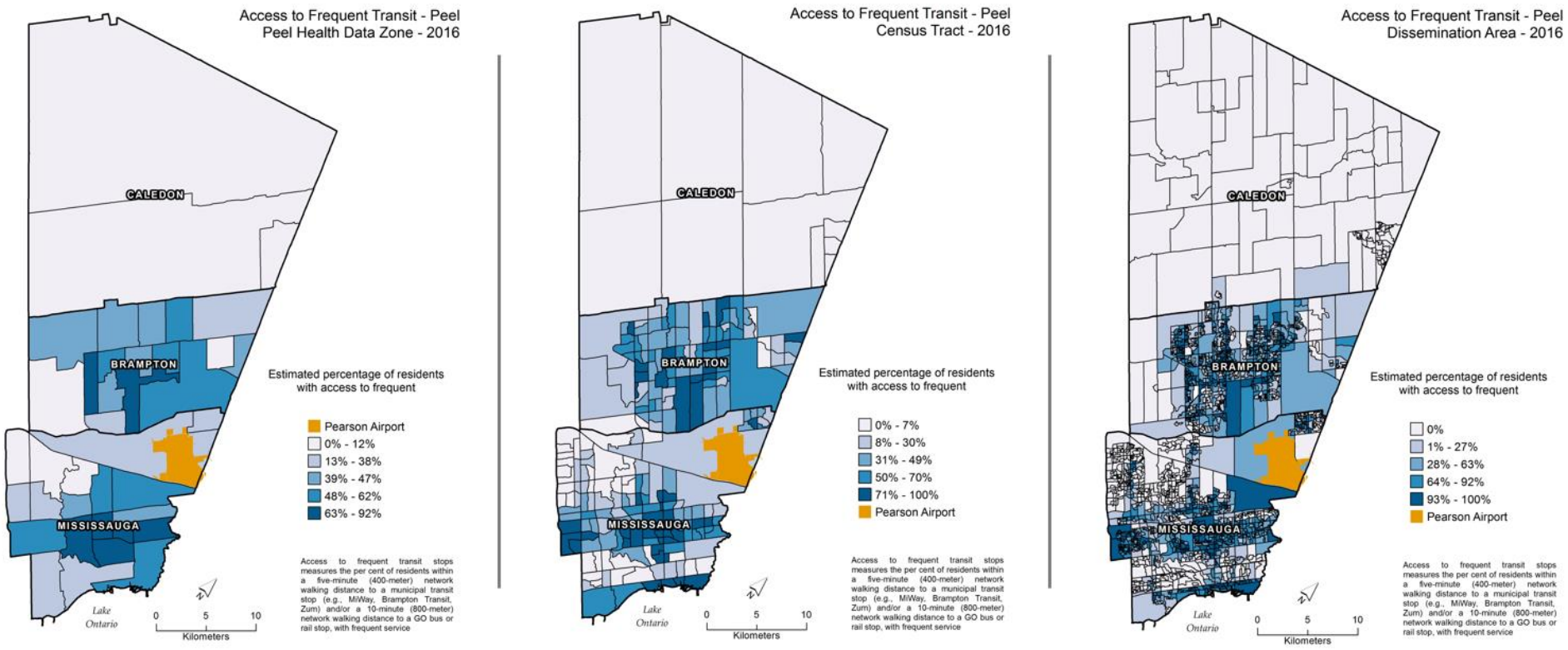
APPENDIX



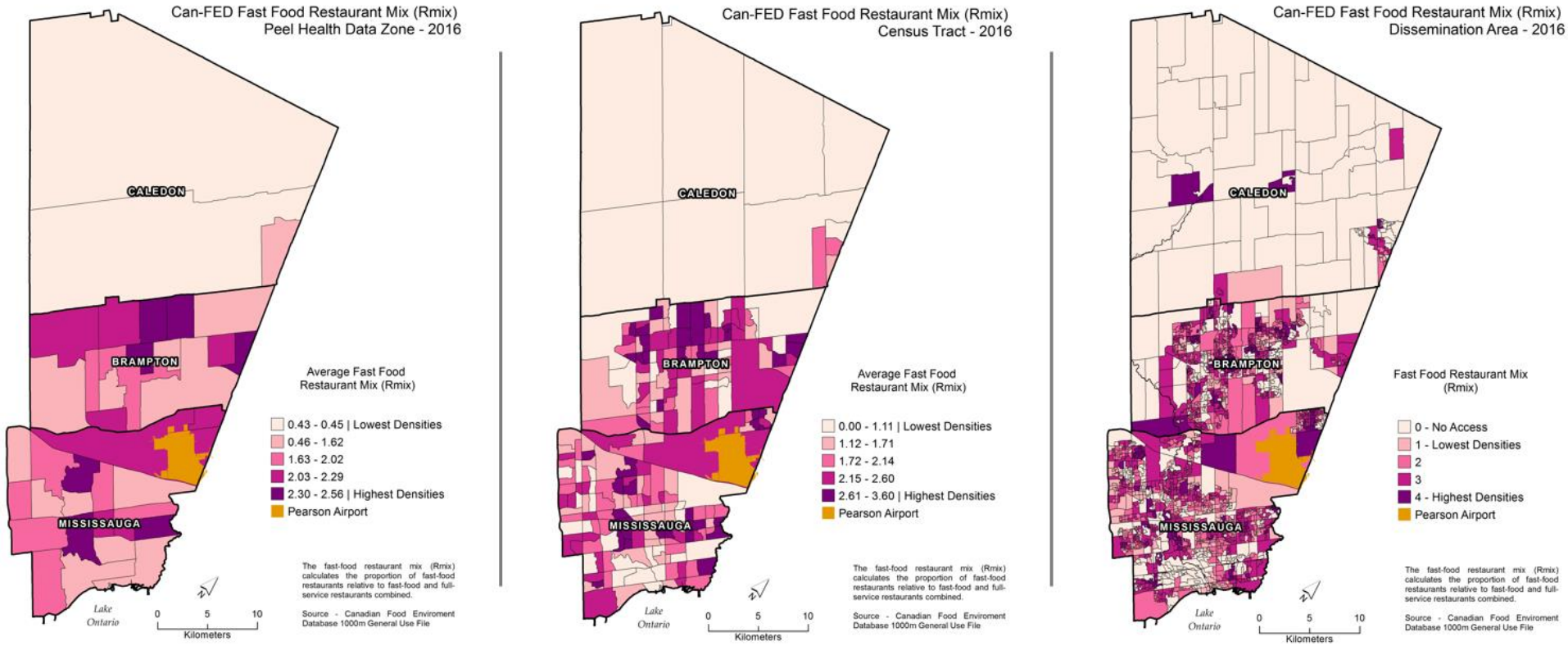
Appendix 3.1 Active living environments [2016] as the mean Can-ALE class (class 1 to 5) grouped by quintile for Peel Health Data Zones [2021] and census tracts [2021], and by Can-ALE class for dissemination areas [2021].



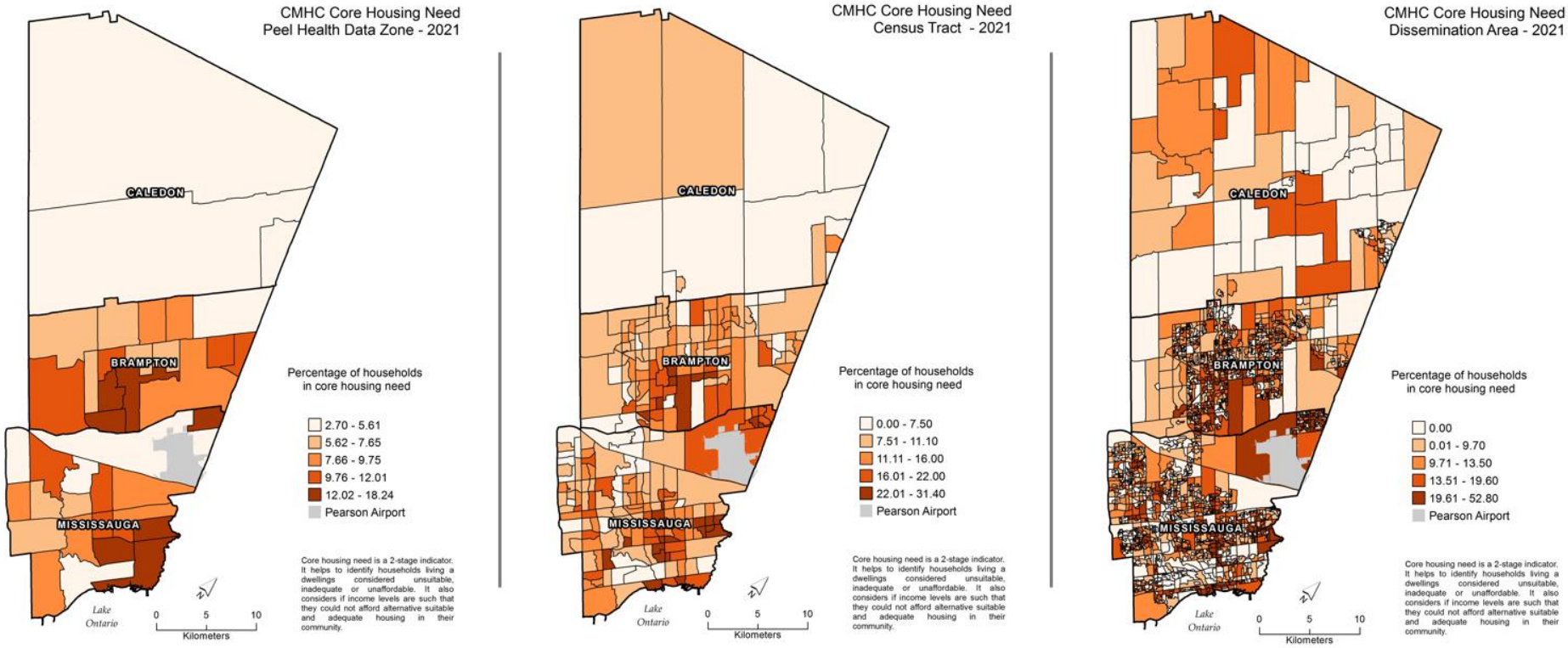
Appendix 3.2 Access to parks and green space [2016] as the percentage of residents grouped by quintile, by Peel Health Data Zone [2021], census tracts [2021], and dissemination areas [2021].



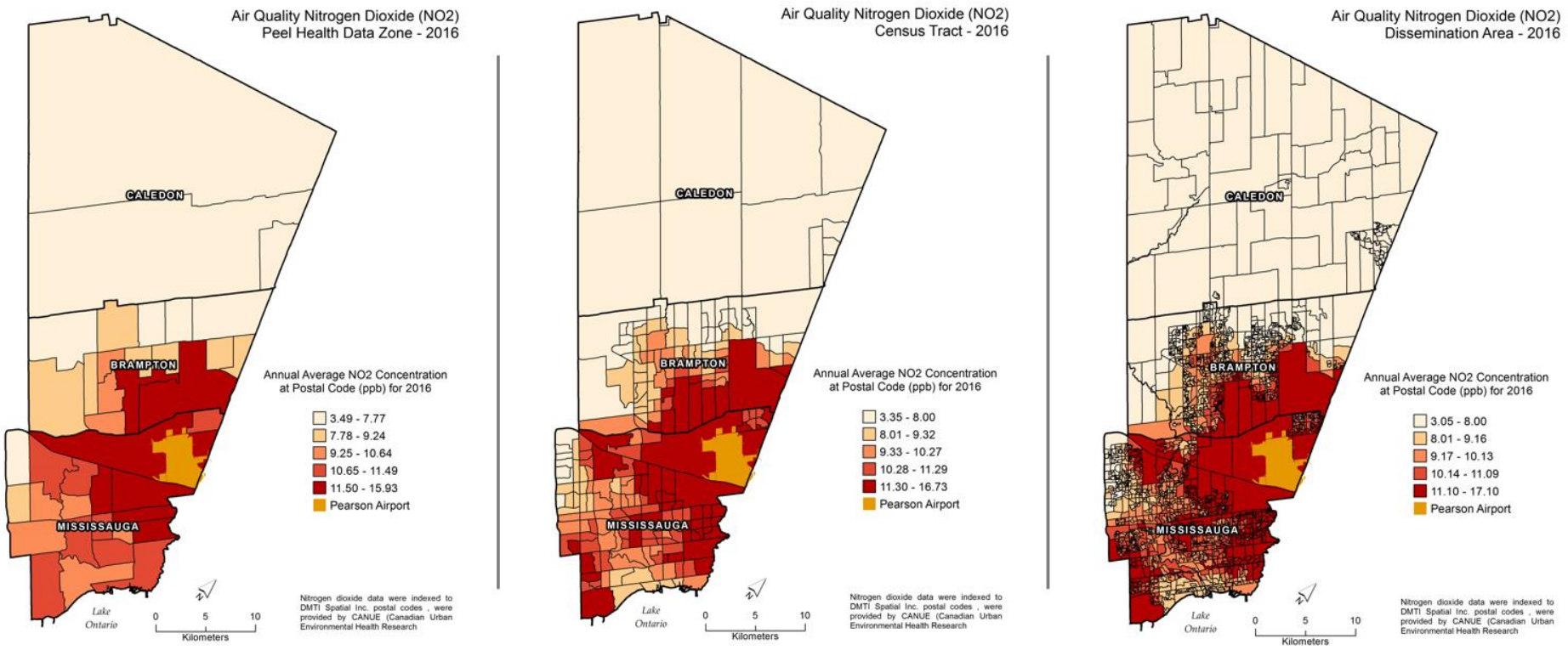
Appendix 3.3 Access to frequent transit [2016] as the percentage of residents grouped by quintile, by Peel Health Data Zone [2021], census tracts [2021], and dissemination areas [2021].



Appendix 3.4 Food environments [2016] as the mean fast food restaurant mix R_{mix} (scores ranging from class 0 to 4) grouped by quintile for Peel Health Data Zone [2021] and census tracts [2021], and by R_{mix} for dissemination areas [2021].



Appendix 3.5 Core housing need [2021] as the mean percentage of households in core housing need grouped by quintile for Peel Health Data Zone [2021], census tracts [2021] and dissemination areas [2021].



Appendix 3.6 Air quality [2016] as the mean annual average concentration (parts per billion, ppb) of nitrogen dioxide (NO_2) grouped by quintile for Peel Health Data Zone [2021], census tracts [2021] and dissemination areas [2021].

Current State of Type 2 Diabetes in the Peel Region