Green Paths to Mental Health: Understanding How Neighbourhood Income Influences the Effects of Green Space on Mental Health

Nadha Hassen

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Wellesley Institute works in research and policy to improve health and health equity in the GTA through action on the social determinants of health.

Author
Nadha Hassen, Wellesley Junior Fellow 2015-2016

About This Report
This paper is a product of the Wellesley Junior Fellowship. It is part two in a three part series of papers within this fellowship project to understand how green spaces influence mental health and well-being. The series includes 1) a theoretical framework, based on a scoping review of reviews, 2) a discussion on how neighbourhood income moderates green space effects on mental health, based on quantitative analysis of existing data; and 3) a community consultations paper, based on a Walk Lab.

About the Wellesley Junior Fellowship
The Wellesley Junior Fellowship is building the next generation of social policy researchers who will work to advance population health and reduce health inequities in the Greater Toronto Area.

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Introduction

Green space is one component of the built environment but it is one that is essential for our mental health and well-being (Haluza, Schönbauer, & Cervinka et al., 2014; Maller, Townsend, Pryor, Brown, & St. Leger, 2006; Shanahan, Fuller, Bush, Lin, & Gaston, 2015). Studies have shown that green spaces may reduce stress and promote relaxation thereby contributing to improved mental health (Bratman, Hamilton, & Daily, 2012; Di Nardo, Saulle, & La Torre, 2010; Gascon, Triguero-Mas, Martinez, & Nieuwenhuijsen, 2015; Lachowycz & Jones, 2013).

We conducted a scoping review of reviews to examine the mediating and moderating factors that influence the relationship between green space and mental health and well-being (Wellesley Institute, 2016a). These factors were then categorized into four dimensions based on a model presented in Shah, Mizrahi, and McKenzie (2011) and include: 1) individual-level factors, 2) ecological-level factors, 3) the interactions between individual and ecological levels, and 4) time (Wellesley Institute, 2016b).

This research indicated that user demographics (such as gender, age, and race) are individual-level factors that can impact the relationship between green space and mental health and well-being (Wellesley Institute, 2016b). In Toronto, an important demographic factor that influences health equity is income (Hulchanski, 2010). Income can be both an individual-level factor and an ecological-level factor. At an individual-level, income is a determinant of health and low-income groups often have poorer health outcomes resulting in health inequities (Toronto Public Health [TPH], 2015; Public Health Agency of Canada [PHAC], 2016). At an ecological-level, neighbourhood income comprises the average socio-economic status of residents in a neighbourhood (Hulchanski, 2010). There is evidence that low-income neighbourhoods have higher rates of crime and deprivation that may lead to poorer health outcomes, compared to high-income neighbourhoods (Brisson, Lopez, & Yoder, 2014; Fabio, Tu, Loeber, & Cohen, 2011). It is unclear what relationships exist between income and neighbourhood characteristics and green space in Toronto.

This paper explores whether neighbourhood income (an ecological-level factor) moderates the relationship between green space and mental health by examining neighbourhood-level data across the City of Toronto. Does green space in Toronto promote mental health in both low-income and high-income communities to the same extent? Our research looks to address the following questions:

- Is there a relationship between the amount of green space and self-reported mental health across neighbourhoods in Toronto?
- If so, how does this relationship manifest itself in symptomatic ways?
- And, finally, how is this relationship affected by neighbourhood income?

Our hypothesis is that neighbourhood income will influence the relationship between green spaces and mental health.

Background

In 2015, Toronto Public Health (TPH) published *Green City: Why Nature Matters to Heal*th, an evidence-based review on how nature and green spaces impact physical and mental health and well-being (2015). They found that not only is frequent access to green space essential for mental health, but nearby green space may provide additional benefits in the case of low-income neighbourhoods. Neighbourhoods in a city like Toronto can vary in terms of positive neighbourhood assets such as parks and ravines. More specifically, low-income neighbourhoods typically have less access to available parks and green spaces of good, usable quality (Floyd, Taylor, & Whitt-Glover, 2009; Francis, Wood, Knuiman, & Giles-Corti, 2012).

Toronto's communities are currently shifting according to income inequality. *The Three Cities Within Toronto* report (Hulchanski, 2010) found that Toronto's neighbourhoods are increasingly polarized by income and that this increasing disparity between high and low-income neighbourhoods is increasingly racialized,[1] with lower-income households composed of more newcomers and visible minority populations (Hulchanski, 2010). In the City of Toronto, 18 percent of the population has resided in Canada for ten years or less. About 49 percent of the population speaks a mother tongue that is neither English nor French (City of Toronto, 2013). The extremes in income trend is further compounded by the fact that newcomers and racialized populations in Toronto often face barriers to income security (TPH, 2011).

In recognition of these shifting economic conditions in urban centres, health researchers have sought to better document health inequalities. In 2010 the World Health Organization (WHO) led an international initiative called the Urban Health Equity Assessment and Response Tool (Urban HEART) to address urban inequities (2010). In response, the City of Toronto analyzed data on its 140 neighbourhoods using the same framework (Centre for Research on Inner City Health [CRICH], 2014). This information was then used to identify 31 Neighbourhood Improvement Areas (NIAs), which had the lowest Neighbourhood Equity Scores. The Neighbourhood Equity Score is a "single number designed to capture the total weight of unnecessary, unfair, and unjust differences faced by neighbourhood residents in five key areas: economic opportunities, social development, healthy lives, participation and decision-making and physical surroundings" (City of Toronto, 2014, p.1). Green space is a key factor in determining the neighbourhood equity score.

In Toronto, Urban HEART measures the quantity of green space as the average amount of green space per kilometre squared in a one-kilometre circular buffer from each residential block by neighbourhood (CRICH, 2014). The quantity of, access to, and quality of green space are factors must be considered when assessing mental health and well-being (Wellesley

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1   Racialized populations are defined as "Non-dominant ethnoracial communities who, through the process of racialization, experience race as a key factor in their identity" (Galabuzi, 2001). Racialization is defined as "Non-dominant ethnoracial communities who, through the process of racialization, experience race as a key factor in their identity" (Galabuzi, 2001).

Institute, 2016a). This paper presents a quantitative analysis of secondary data through the Urban HEART project to examine how green spaces can influence mental health and well-being outcomes. This analyses focuses on the quantity of green space in neighbourhoods across Toronto and their impact on self-reported mental health.

Methods

Secondary Data Source

The City of Toronto has 140 neighbourhoods that range in demographics, size, infrastructure, and health (CRICH, 2014). Urban HEART used five policy domains, one of which is "Physical Environment & Infrastructure" to measure of the quantity of green space in the city by neighbourhood. *Urban HEART @ Toronto* data is publicly available and was downloaded from the Toronto Community Health Profiles website[2]. This secondary data was cleaned and analyzed using the statistical package for social sciences (SPSS).

Green space was measured using the average amount of green space per kilometre squared in a one-kilometre circular buffer from each residential block in the neighbourhood (CRICH, 2014). The Urban HEART data for green space was categorized into quintiles representing five different levels, with 1 = lowest amount of green space and 5 = highest amount of green space.

The self-reported mental health variable was calculated by combining the percentage of those 20+ reporting very good or excellent mental health. This data was calculated from combining four different waves (2005-2011) of the Canadian Community Health Survey (CCHS) data (CRICH, 2014). This mental health variable was kept as a continuous data for the analyses. One neighbourhood (Willowdale West) did not have data for self-reported mental health and was removed from the data set.

The Urban HEART dataset uses a low-income variables at the neighbourhood level to measure income, meaning that a neighbourhood on the bottom levels of the low-income spectrum would, in fact, have more high income in the neighbourhood and vice versa. The low-income variable measured the percentage of persons living below the after-tax low-income measures (LIMs) established for the City of Toronto in 2010 (CRICH, 2014). The low-income data was categorized into three distinct groups, with 1 = low low-income (i.e. high-income), 2= medium low-income, and 3= high low-income (i.e. low-income). Group 2 for medium low-income was removed from the analysis to reduce the noise and so a total of 92 neighbourhoods were included in the analysis. The cut-offs for groups 1 and 3 were 16.6 percent and 28.2 percent of the neighbourhoods living in low income respectively. For simplicity, in the remainder of this paper low low-income will be referred to as high-income and high low-income will

be referred to as low-income neighbourhoods. The three Urban HEART colour categories (red, yellow, and green) were not used to create the tertiles as they did not contain equal data points in each group. Creating these three groups allowed for conducting a stratified analysis of neighbourhood income.

Data Analysis

To identify whether a correlation existed between the quantity of green space and mental health, a bivariate correlation analysis was run on the data to determine Spearman's rank correlation coefficient (rho) (Daniel & Cross, 2013). This correlation was then run for only high-income neighbourhoods and low-income neighbourhoods in Toronto. To examine the interactions between income and green space on mental health a two-way Analysis of Variance (ANOVA) [2(income) x 5 (green space)], without replication, was run on neighbourhood income, the amount of green space, and self-reported mental health data on 92 neighbourhoods in the City of Toronto. An ANOVA used as this method helps to examine how much a variable (in this case, neighbourhood income) contributes to variation in the dependent variable of interest, which in this case is self-reported mental health (Daniel & Cross, 2013).

The data was stratified for high-income neighbourhoods and low-income neighbourhoods. To explore interactions between income and green space on mental health in Downtown Toronto the same ANOVA analysis was run, but only for neighbourhoods that are in the Downtown Toronto core, with the boundaries of "Bathurst Street to the west, the midtown rail corridor and Rosedale Valley Road to the north, the Don River to the east, and the Lake Ontario shoreline to the south" (City of Toronto, 2016, p.2). This Downtown area comprises 16 neighbourhoods; however, they are not consistent with the geographical boundaries of Urban HEART's 140 census tract neighbourhoods (City of Toronto, 2016).

Only the neighbourhoods in the Urban HEART data set, which best matched the Downtown Toronto core definition neighbourhoods, were used in the analysis. The following 12 neighbourhoods are in the Downtown Toronto core: South Riverdale, Cabbagetown-South St. James Town, Regent Park, Moss Park, North St. James Town, Church-Yonge Corridor, Bay Street Corridor, Waterfront Communities-The Island, Kensington-Chinatown, University,

Annex, and Rosedale-Moore Park. Of these 12 neighbourhoods, only nine neighbourhoods were included in the analysis, due to missing data points.

Results

1) Correlations Between Green Space and Mental Health Across Neighbourhood Income Levels

All Neighbourhoods		High Income	Low Income
Correlation Coefficient	-.024	.024	-.215
Sig. (2-tailed)	.783	.876	.151
N	92	46	46

Table 1: Correlation Between Quantity of Green Space (average/km^2) and Self-Reported Very Good/Excellent Mental Health (percentage reporting very good/ excellent health) at the Neighbourhood Level

The correlation between quantity of green space and self-reported mental health is -0.024. However, the correlation for only high-income neighbourhoods is 0.024 (slightly positive) and the correlation for low-income neighbourhoods is -0.215. None of the correlations were statistically significant for p <0.05. However, the correlations for high-income and low-income appear to exhibit distinctive directional, suggesting that while mental health increases with increasing areas of green space in high-income neighbourhoods, it also suggests that it decreases with increasing green space for low-income neighbourhoods.

2) Interactions Between Neighbourhood Income and Green Space on Mental Health in the City of Toronto:

A 2-way [2 (income) x 5 (green space)] found that neighbourhoods with different amounts of green space were not statistically distinct from each other ($F_{(4, 82)}$ = .579, p = .679). Neighbourhoods with different income levels were statistically different from each other ($F_{(1, 82)}$ = 15.638, p = .000). The interaction of quantity of green space and neighbourhood income level was not statistically significant ($F_{(4, 82)}$ = .839, p = .504).

As Figure 1 shows, for high-income neighbourhoods, higher quantities of green space show a trend towards increasing mental health. However, for low-income neighbourhoods the trend is reversed. Low-income neighbourhoods with higher amounts of green space have lower self-reported mental health. These trends suggest that the direction of the relationship between the quantity of green space and self-reported mental health may depend on the neighbourhood income.
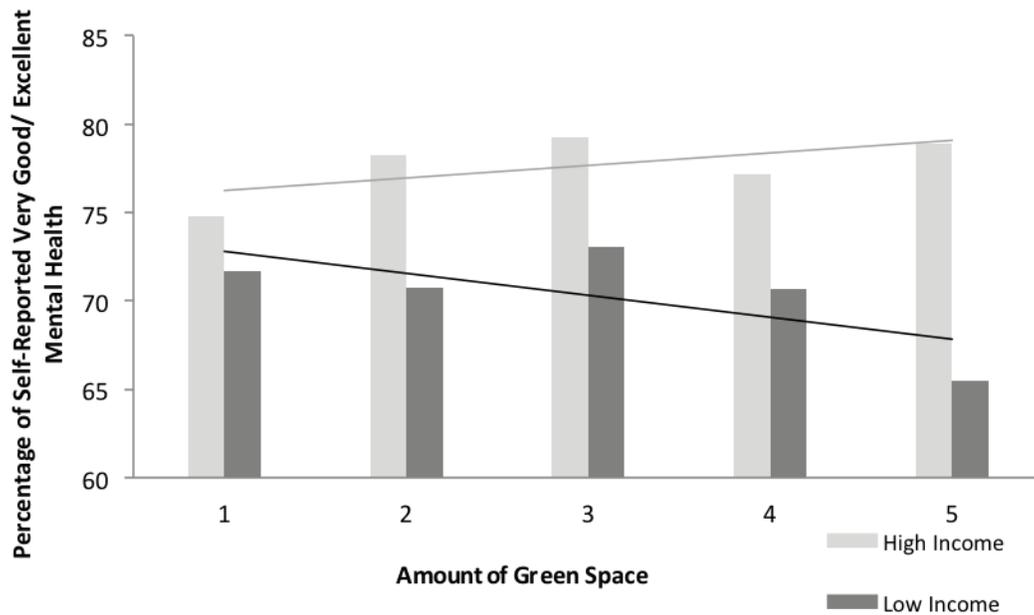
Figure 1: Differences in Self-Reported Mental Health Based on Amount of Green Space for Low and High-Income Neighbourhoods in City of Toronto

The figure shows a 2-way [2(income) x 5 (green space)] ANOVA (n=92). There was no statistically significant difference in mental health based on the amount of green space and no statistically significant interaction between the amount of green space and neighbourhood income. The figure shows a trend in opposite directions for the relationship between green space and mental health that depends on the neighbourhood's income level: positively for high-income neighbourhoods and negatively for low-income neighbourhoods. Note: The trend lines help to visualize the trends; however, neighbourhood income and amount of green space are categorical, not continuous variables.

3) Interactions Between Neighbourhood Income and Green Space on Mental Health in the Downtown Toronto Core:

Neighbourhoods with different amounts of green space were not statistically distinct from each other (F (3, 4) = .153, p = .923). Similarly, neighbourhoods with various income levels were also not statistically different from each other (F (1,4) = .142, p = .726). Therefore, it was not possible to calculate the interaction of quantity of green space and neighbourhood income level, due to missing data points.

As Figure 2 shows, for high-income neighbourhoods, those with the highest quantity of green space have the highest self-reported mental health. However, in low-income neighbourhoods the relationship is reversed. Low-income neighbourhoods with high quantities of green space have lower self-reported mental health than low-income neighbourhoods with low quantities of green space.

These trends suggest that the difference in the amount of green space may make a difference on self-reported mental health, depending on the income of the neighbourhood. By looking at just the neighbourhoods in the downtown Toronto core, the trend appears more pronounced.
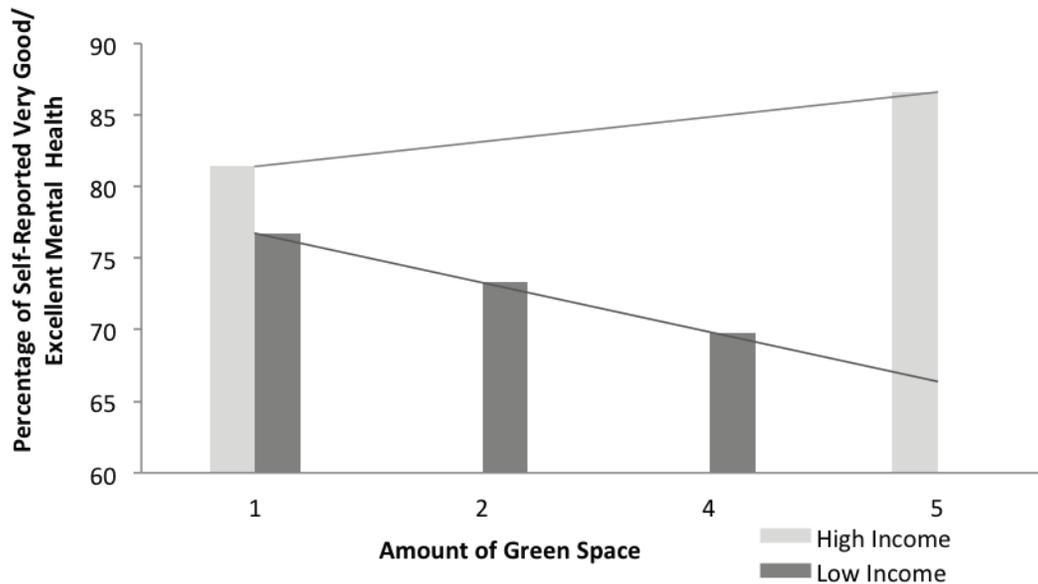
Figure 2: Differences in Self-Reported Mental Health Based on Amount of Green Space for Low and High-Income Neighbourhoods in Downtown Toronto

This figure shows a 2-way [2(income) x 5 (green space)] for Toronto core neighbourhoods (n=9). There was no statistically significant difference in mental health based on the amount of green space and no statistically significant interaction between the amount of green space and neighbourhood income. The figure shows a trend in opposite directions for the relationship between green space and mental health that depends on the neighbourhood's income level: positively for high-income neighbourhoods and negatively for low-income neighbourhoods. Note: The trend lines help to visualize the trends; however, neighbourhood income and amount of green space are categorical, not continuous variables.

There was no low-income neighbourhood in the downtown Toronto Core with the highest level of green space =5. In addition, there were no high-income neighbourhoods in the Toronto Core with the quantity of green space = 2 or 4. No neighbourhoods in the Toronto Core had amounts of green space = 3. These are not plotted on the graph.

Discussion and Next Steps

The correlation analysis found that overall the quantity of green space and self-reported positive mental health are not statistically correlated. Across all neighbourhoods in the City of Toronto, our results found (non-significant) trends towards an interaction between the

quantity of green space and neighbourhood income level. In high-income neighbourhoods, there was a trend showing that self-reported mental health may increase the amount of green space. Conversely, in low-income neighbourhoods self-reported mental health appeared to decrease with increasing quantities of green space. In high-income neighbourhoods, there was a slightly positive correlation of 0.024 and in low-income neighbourhoods there was a negative correlation of -0.215. These trends suggest that the impact of green space on mental health depends on whether an individual lives in a low-income or high-income neighbourhood. Across the nine neighbourhoods in the downtown Toronto core the same trends were observed as across all City of Toronto.

While these trends are interesting, none of the results in any of the correlation analyses or ANOVAs were statistically significant. These results may be due to the low variability in self-reported mental health across neighbourhoods. There are only 92 neighbourhoods in this analysis, resulting in a relatively small sample size. However, trends can point to curious relationships that may be happening, despite the fact they may not be statistically significant due to issues such as sample size. In this analysis, the variables are at an area-level or ecological-level, by neighbourhood. As such, these variables cannot be used to make inferences about individuals living in a specific neighbourhood, and can only tell us about what is happening at a population level (Pearce, 2000). It is possible that the area-level data may not be nuanced enough to capture the reality of what is happening.

Despite not reaching statistical significance, the relationship between the amount of green space and self-reported mental health for high-income neighbourhoods is the inverse of that in low-income neighbourhoods. This result indicates that, in low-income neighbourhoods, mental health appears to decrease with increasing quantities of green space—a surprising result that runs counter to the evidence that green space has a positive influence on mental health (Abraham, Sommerhalder, & Abel, 2010; Gascon et al., 2015).

Although there is evidence that the quality of green space is important for mental health (Wellesley Institute, 2016a; Dallimer et al., 2012; de Vries et al., 2013; Francis et al., 2012), the measurement of green space by Toronto Urban HEART is purely about quantity, not quality. It is possible that the quality of green space varies across neighbourhoods in Toronto based on income levels, and that this variable could explain the results found in this analysis (Lachowycz & Jones, 2013). For example, available facilities such as public toilets, benches, and playground equipment may differ between neighbourhoods. Parks may be maintained differently (e.g. extent of litter) or be perceived as safe or unsafe settings (Lachowycz & Jones, 2013). Green spaces in low-income neighbourhoods may be perceived as unsafe, or have high levels of crime and violence (Lorenc et al., 2012). These moderating factors may explain why there is poor mental health reported in areas with high amounts of green space in low-income neighbourhoods.

Suburban neighbourhoods tend to be areas with greater quantities of green space. However, due to the car-dependent design and sprawl of these areas, their green spaces are not always considered as accessible or within walking distance for residents. By only looking at the neighbourhoods in the downtown Toronto core, we were able to reduce this factor to a certain extent. Nonetheless, the trend remains pronounced for high-income and low-income neighbourhoods in the downtown Toronto core, suggesting that the quality of green space may be the missing factor to consider in the relationship between the amount of green space and self-reported mental health.

Urban HEART measures the quantity of green space and uses a WalkScore as a proxy measure for access at the neighbourhood level. Although these measures are valuable, our understanding of our city's green spaces would be improved if there were a way to assess the quality of green spaces across neighbourhoods in Toronto. Decisions about green space in Toronto, through policies and programs like Toronto Strong Neighbourhoods 2020, could more holistically assess our urban green spaces by including quality measures of green space.

Limitations

This analysis relied on the use of publicly available data. As a result, it is subject to the following limitations. Urban HEART's data is limited to the quantity of green space across neighbourhoods and, consequently, this variable was used in the analysis. In addition, their measure of mental health was based on self-reported data, which is a subjective measure and, therefore, subject to bias. Furthermore, to our knowledge, there is no available data that focuses specifically on access to green spaces. Urban HEART uses WalkScore, which is a numerical score assigned to each neighbourhood that represents how walkable it is. This WalkScore can be used as a proxy for access to green space. However, as a measure it does not apply specifically to accessing green spaces. If there was no green space in a neighbourhood, the walkability of the neighbourhood is a moot point. The available data was cross-sectional and represented a point in time. It is not possible to analyze the causal pathway in how green space influences mental health with this data, only to understand the correlations.

Conclusion

As cities grow and their density increases it is increasingly important to understand how we can integrate green spaces into our urban fabric to promote mental health for all. This paper presents a quantitative analysis of secondary data to start a discussion on why we should measure the quality of green spaces in a diverse city like Toronto.

The results of this analysis suggest that neighbourhood income may change the effect of the amount of green space on self-reported mental health. Our analysis identified some important trends to consider moving forward. Residents in high-income neighbourhoods

of Toronto with higher amounts of green space have better self-reported mental health while residents in low-income neighbourhoods with higher amounts of green space have lower self-reported mental health. This data set highlights the underlying complexities in the pathway of how green spaces promote mental health and points to differences between what is happening in high-income neighbourhoods in Toronto compared to those in low-income neighbourhoods. These trends suggest that quality of green space should be taken into account when assessing and planning green spaces in Toronto neighbourhoods. Further work is needed to understand how to measure and evaluate the quality of green spaces across Toronto's diverse neighbourhoods.

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