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Lindsey G. Smith
Department of Geography and Planning, University of Toronto-St. George, Canada

Michael J. Widener
Department of Geography and Planning, University of Toronto-St. George, Canada

Bochu Liu
Department of Geography and Planning, University of Toronto-St. George, Canada

Steven Farber
Department of Geography and Planning, University of Toronto-Scarborough, Canada

Leia M. Minaker
School of Planning, University of Waterloo, Canada

See next page for additional authors

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Comparing Household and Individual Measures of Access through a Food Environment Lens: What Household Food Opportunities Are Missed When Measuring Access to Food Retail at the Individual Level?

Lindsey G. Smith,[*] Michael J. Widener,[*] Bochu Liu,[*] Steven Farber,[†] Leia M. Minaker,[‡] Zachary Patterson,[§] Kristian Larsen,[‖] and Jason Gilliland[#]

[*]*Department of Geography and Planning, University of Toronto–St. George, Canada*
[†]*Department of Human Geography, University of Toronto–Scarborough, Canada*
[‡]*School of Planning, University of Waterloo, Canada*
[§]*Concordia Institute of Information Systems Engineering, Concordia University, Canada*
[‖]*Department of Geography and Planning, University of Toronto–St. George, and CAREX Canada, Faculty of Health Sciences, Simon Fraser University, Canada*
[#]*Department of Geography and Environment, Western University, Canada*

Geographers and public health researchers have long been interested in social, spatial, and economic factors that drive access and exposure to food retail. A growing body of evidence draws on mobility data to capture locations accessed by individuals beyond the home address. Given that food-related activities are shared by household members and often gendered, taking an individual-level approach might limit researchers' ability to accurately describe access to food retail. Using data that includes Global Positioning System trajectories of forty-six adults from twenty-one households in Toronto, this study compares access to food retailers at the individual and household levels and evaluates measurement issues that arise when relying on one household member. Spatial and spatiotemporal measures of access were derived from individual and total household activity spaces. Differences in access were tested for men and women and moderating effects of neighborhood, shopping responsibility, car access, and employment status were investigated. Supermarket density was greater for women when compared with men in the household, as well as their total household measure. Additionally, within-household differences in counts of supermarkets were moderated by neighborhood. Future research should consider the role of place and the contributions of household members when measuring access to food at the individual level. *Key Words: activity space, food access, food environment, gender, spatiotemporal.*

The relationships between diet and chronic disease, including cardiovascular diseases, diabetes, and some cancers, have been well established (Micha et al. 2017; World Cancer Research Fund 2018). Dietary risks are a leading contributor to the global burden of morbidity and mortality, with a suboptimal diet responsible for more deaths than any other risk factor (Afshin et al. 2019). Understanding the determinants of dietary behaviors, including purchasing and consumption patterns, has therefore become a public health priority.

Socioecological theories posit that dietary behaviors result from the interplay of individual, social, and physical environments (Sallis, Owen, and Fisher 2008; Lang and Rayner 2012). The physical food environment comprises a range of food retailers, including supermarkets, fast food outlets, and restaurants (Minaker, Shuh, et al. 2016). The geographic configuration of the food environment shapes the context in which people make their food decisions and could engender or restrict healthy dietary choices. Consequently, environmental interventions provide an attractive option for population-level change (Story et al. 2008) and understanding spatial access to food as a determinant of dietary behavior and health has received increased attention from

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researchers and policymakers (Charreire et al. 2010; Caspi, Sorensen, et al. 2012; Mah and Thang 2013; Lytle and Sokol 2017).

The physical food environment provides wide-reaching, potentially modifiable options to foster change. Interventions to improve geographic access to food have had mixed results, however, and the pathway and relationship between the food environment, food purchasing, and dietary intake remain unclear (Cummins, Flint, and Matthews 2014; Dubowitz et al. 2015; Ghosh-Dastidar et al. 2017; Gittelsohn and Trude 2017). One reason might be the simplistic conceptualizations of access that have been employed. Studies have commonly measured the food environment using geographic analysis, but access to food retailers is not a solely spatial concept (Charreire et al. 2010; Lytle and Sokol 2017). Individuals' travel and time limitations influence access and are connected with socioeconomic status and social structures. Socioecological perspectives and systems theories recognize that individuals do not operate in isolation but through interactions with their physical and social environments (Wright 2015). Researchers have long recognized that members within a household might influence each other's behavior, making it inappropriate to consider household members only as individuals (Kerr and Bowen 1989). For example, in multiple-adult households, the ability to procure food and the time and money available for, or attributed to, food shopping might be influenced by other household members. Whether individuals experience support, shared tasks, or dependencies with regard to food shopping might relate to their role and responsibility in the household, which has been shown to be gendered, a term we use in this article to describe the unequal distribution of time spent on tasks between men and women within households (Guppy, Sakumoto, and Wilkes 2019).

Considering the role of multiple actors, evidence should account for connections between people and their environments to inform and coordinate concurrent strategies (Rutter et al. 2017; Bagnall et al. 2019). In the context of the food environment, this requires a more holistic definition of food access that accounts for both spatial and social factors that influence shopping patterns, as well as the development of better measures and study designs that look beyond a narrow focus on environmental determinants at the individual level.

In this study, we aimed to illustrate how the exclusion of household responsibilities and shopping roles might obscure measures of access for men and women. To achieve this aim, we used data from multiple-adult households collected in Toronto, Canada, as a part of the Food Activities, Socioeconomics, Time, and Transportation (FASTT) Study, to examine the methodological implications of using individual measures of spatial access to food.

Households, Gender, and Food Activities

Household composition is associated with time pressure and dietary behaviors (Welch et al. 2009; Bauer et al. 2012; Rodrigues et al. 2020). Having children, and in particular being a single parent, is associated with more rigid time constraints (Farber et al. 2011; Strazdins et al. 2016; Venn et al. 2018), whereas support from coresiding partners, older children, or extended family with housework might alleviate time scarcity (Jabs et al. 2007; Ta, Liu, and Chai 2019). Time and convenience have been reported as important aspects of health and food behaviors (Strazdins and Loughrey 2007; Astbury et al. 2020), with more time spent on food shopping and preparation shown to positively impact diet (Connors et al. 2001; Monsivais, Aggarwal, and Drewnowski 2014). In high-income countries, however, housework and food responsibilities appear to remain gendered (Lake et al. 2006; Kan, Sullivan, and Gershuny 2011; Bianchi et al. 2012). This finding persists despite an increase in time spent on food shopping and preparation by men over the past twenty years (Marshall 2006; Taillie 2018), suggesting that increased support from household members might not have translated to equal access to food and improved dietary health for population subgroups.

The extent of spatial mobility and size of individual activity spaces of men and women have been shown to differ (Kwan and Kotsev 2015; Sanchez et al. 2017; Lo and Houston 2018), with some evidence for variation in access to healthy foods (Dai and Wang 2011; Li and Kim 2018). Using a space–time model, Kwan (1999) demonstrated that women have more rigid time constraints and access to fewer urban opportunities than men; however, constraints were reduced when receiving support with housework from a partner. Findings persisted regardless of socioeconomic status (which relates to job flexibility, access to convenient transport, and child care), affecting the resources available to purchase and prepare healthy food (Inglis, Ball, and Crawford 2005; Jabs and Devine 2006). A more equal division of household labor might help to reduce barriers to healthy dietary behaviors for individuals but also for their partners and household members (Blake et al. 2009; Fan et al. 2015).

Measures of Spatial Access to Food

Studies that measure spatial access to food have typically focused on the home environment, measuring densities or counts of outlets within administrative boundaries or within a specified proximity to the home address (Charreire et al. 2010; Caspi, Sorensen, et al. 2012; Lytle and Sokol 2017). These place-based approaches are limited by the uncertain geographic context problem (Kwan 2012) whereby the extent of the environment that an individual is exposed to, and interacts with, might not be captured. Emphasis on the home location assumes that the home has the greatest influence on behavior and access is equal for all individuals living close to one another. There is evidence to suggest, however, that environments around the home compared with those around locations used for work, school, shopping, and travel are markedly different for certain people and can exert differential influences on behaviors. For example, studies have identified differences between foodscapes around individuals' home and work locations that might be affected by socioeconomic and marital status, as well as associations between access to fast food outlets beyond the residential neighborhood and dietary intake (Zenk et al. 2011; Gilliland et al. 2012; Burgoine and Monsivais 2013; Howell et al. 2017; Maguire et al. 2017). Research on children's food environments in London, Ontario, has also shown that the presence of fast food outlets and convenience stores near schools is linked to increased junk food purchasing (He, Tucker, Gilliland, et al. 2012), poorer diets (He, Tucker, Irwin, et al. 2012), and higher body mass index *z* scores (Gilliland et al. 2012), whereas the food environment around the home had no significant effects. Misclassifying food accessibility and exposure for particular groups based on metrics used might therefore lead to inferential errors and affect the understanding of which environments are important for whom.

In line with theoretical and methodological advances, there has been a shift in research to the use of person-based measures that address previous limitations (Cummins 2007; Kwan 2009). Studies increasingly use geolocated mobility data to reflect the unique environments experienced by individuals and the multiple contexts in which activities occur (Cetateanu and Jones 2016). For example, data collected from Global Positioning System (GPS) sensors over a number of days are used to derive activity spaces within which retail outlets are quantified (Zenk et al. 2011; Perchoux et al. 2013; Sadler et al. 2016; Li and Kim 2018). Commuter flows from travel surveys are also used to show how daily mobility patterns change access to food retail (Widener et al. 2015). Person-based measures have largely been spatial, delineating path area boundaries of mobility data, although emerging approaches incorporate temporal dimensions of exposure. Kernel density estimation has been applied to identify "dwell points" (Chaix et al. 2017; Widener 2018) or to weight exposure by time spent nearby (Scully et al. 2019; Liu et al. 2020), and space–time prisms have been used to measure potentially accessible outlets between trip origin and destinations given a specified time budget (Horner and Wood 2014; Widener et al. 2015).

Whereas person-based measures provide an important advance in measuring the environment with which one interacts, the application of spatiotemporal methods to understand exposure remains in its infancy and not without limitations. Defining spaces visited as those potentially accessible could lead to selective daily mobility bias. The observation of a health-related outcome (e.g., food purchase) linked to a particular environmental feature (e.g., food outlet) could reflect people's choices to visit them more frequently rather than having better access to these features (Chaix et al. 2013). An additional limitation, which to this point has received little attention, relates to the unit of measurement (e.g., individuals vs. households) for whom activity spaces have been derived. Measures have predominantly focused on the individual with the role of other household members in providing access to food rarely considered. In contrast, some place-based approaches partially account for household roles by using a higher level of abstraction around the home address to investigate household-level outcomes or by focusing on the primary shopper (Kirkpatrick and

Tarasuk 2010; Gustafson 2017; Peng and Kaza 2019). Reviews, however, show that place-based measures of access have been used interchangeably for both households and individuals, with individual measures sometimes adjusting for household composition as a covariate in analyses (Caspi, Sorensen, et al. 2012; Carter, Dubois, and Tremblay 2014; Cobb et al. 2015; Bivoltsis et al. 2018). The coordination of food-related activities across household members remains an area of paucity in studies of food accessibility. To understand the food environment as a potential determinant of dietary behaviors more clearly, there is a need to combine methods that draw on spatial, temporal, and household measures of food access.

Given changes in roles in household labor since Kwan's (1999) publication investigating access to urban opportunities for men and women (Moyser and Burlock 2018), we seek to build on the previously described body of work by contributing a novel focus on within-household differences and how the role of support mighy distort the use of individual-level measures of access to food retail. The following two questions are answered. First, how do individual and household measures of spatial access to food retailers compare? Second, how do measures compare for men and women in the same household? Because access and spatial behaviors are linked closely to urban form, transport opportunities, and socioeconomic factors, we explore how these differences play out over different urban contexts. Understanding how roles within households contribute to food retail access is important for more accurately measuring access to food in future studies and ultimately improving equitable access to healthy and affordable retailers.

Materials and Methods

Data Source

We used data from the FASTT Study, collected in Toronto, Ontario, Canada. Toronto is Canada's largest city, with nearly 6 million inhabitants and a large immigrant population (46.1 percent), making it one of the most multicultural cities in the world (Statistics Canada 2017).

Individuals were recruited through face-to-face intercept interviews in three study neighborhoods on the street, in community centers, and in apartment lobbies. Recruitment took place in February through March 2019 by university and community-based research assistants (RAs) who were hired and trained for the study. Intercepted individuals completed a brief eligibility questionnaire to determine whether RAs would attempt to recruit them. Eligible participants were between eighteen and sixty-five years of age; were a parent of a child at home; owned a smartphone; and lived in Parkdale, Rexdale, or Scarborough. Although the study aimed to recruit an approximately equivalent number of participants from the three neighborhoods, recruiting was most successful in Parkdale and Rexdale, with forty-five and seventy-six eligible participants, respectively, attending orientations. Only four respondents attended orientation sessions in Scarborough and so were not taken forward for analysis in this study.

Parkdale and Rexdale have varying levels of retail and transport opportunities (Figure 1). Parkdale is adjacent to downtown Toronto and has a high population and retail density, along with relatively high levels of transit service. The Greater Rexdale neighborhood, which we term Rexdale, is an inner suburb that includes the adjoining official neighborhoods named Thistletown–Beaumond Heights and Rexdale–Kipling. Compared with Parkdale, levels of population and retail density are lower and the transport environment is more car-oriented. For example, based on access to employment scores (a common proxy for general access) that we generated based on participant home addresses, the mean number of employment opportunities within a thirty-minute transit ride was 4.4 times greater for Parkdale residents compared with Rexdale residents. In contrast, opportunities within a thirty-minute car ride were only 0.12 times greater for Parkdale residents (for data and code used, see https://github.com/SAUSy-Lab/canada-transit-access).

If interested in the study, eligible participants were invited to one of a number of orientation sessions held in their neighborhood in March and were asked to bring all adults (older than eighteen years old) residing in their household (e.g., a spouse or grandparent) who would also qualify as participants. At the orientation sessions, the project was described to eligible participants and written consent was sought for those who wanted to proceed. Once consent was acquired, participants completed a questionnaire that captured socioeconomic characteristics, food purchasing practices, self-reported health status, and anchor location information including home, work, and primary supermarket(s) usually visited.

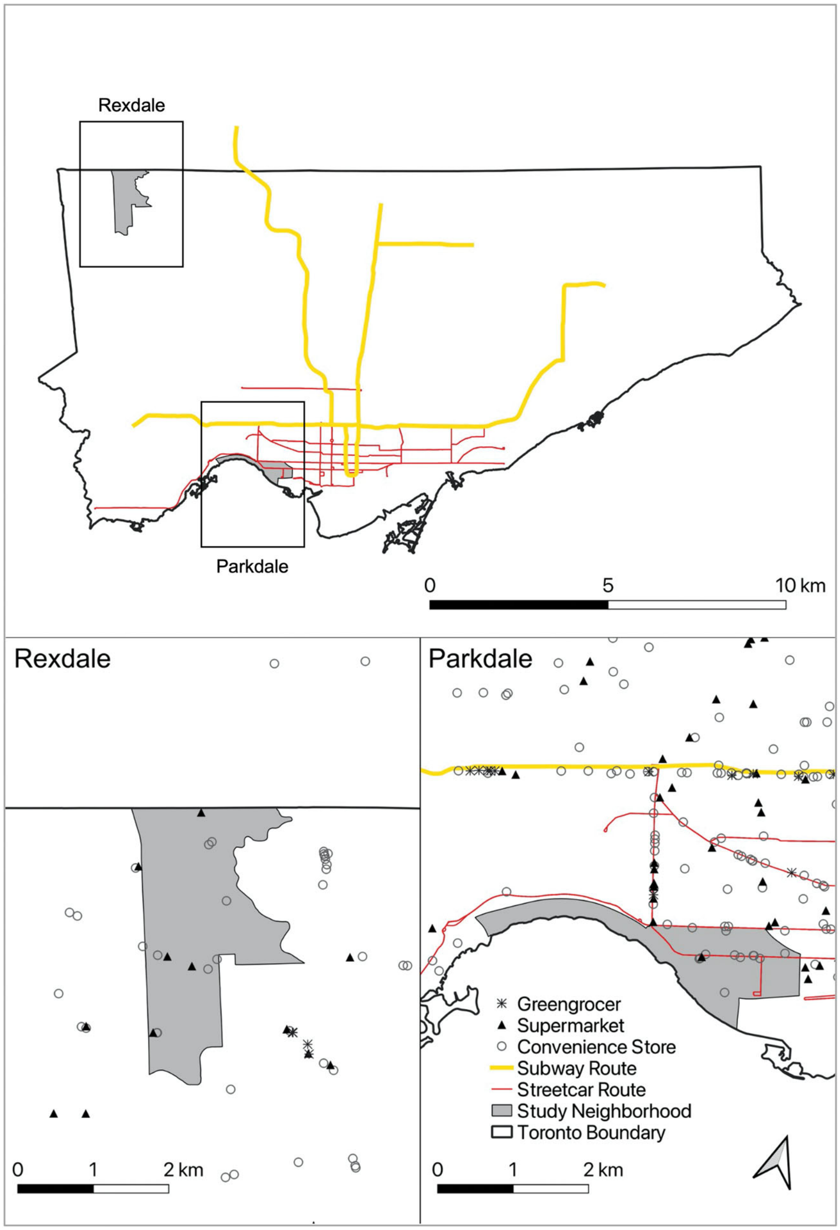


Figure 1. Map of Greater Toronto Area comprising public transport routes and food retail outlet locations for neighborhoods included for study. The study neighborhoods are represented by City of Toronto neighborhood boundaries in which recruitment for the Food Activities, Socioeconomics, Time, and Transportation Study occurred. Rexdale's boundary corresponds to the Mount Olive–Silverstone–Jamestown neighborhood and Parkdale corresponds to the South Parkdale neighborhood. Map contains data from © OpenStreetMap contributors.

Following orientation, participants were provided with the FASTT time use diary, based on the Harmonized European Time Use Survey and specialized for Canadian and food research contexts. Diaries were divided into ten-minute time intervals in which participants reported primary and secondary activities, their location or transport mode, and whether they were with anyone else (e.g., a child or friend). Diaries were completed for seven consecutive days, beginning the day following the orientation. After diaries were returned via postage-paid envelope to the research team, participant responses were coded into standardized primary and secondary activities by RAs, using the General Social Survey of Canada Time Use Cycle activity categories as a guide (Statistics Canada 2019a).

The final activity at the orientation involved assisting participants with downloading the FASTT smartphone application (an instance of Itinerum; Patterson et al. 2019) and requesting that they proceed as they normally would for the next eight-day period, inclusive of the orientation day, so that a total of seven days of time use diary and GPS data would be collected concurrently. The epoch at which GPS fixes were collected was dependent on the user's phone model but based on uninterrupted data averaged seven seconds (modal value = two seconds). A seven-day period was used to capture a variety of behaviors over the course of a week while limiting participant burden (Krenn et al. 2011; Zenk et al. 2018). Participants were offered 10 CAD in compensation at orientation once they completed the survey and were mailed a 50 CAD gift card after providing GPS and time use data.

The University of Toronto Research Ethics Board approved the study protocol (No. 35783).

Sample and Inclusion Criteria

A total of 121 Parkdale and Rexdale participants completed the paper questionnaire and 102 completed the GPS data collection in addition to the questionnaire (the potential sample). We included participants in this analysis if questionnaire and GPS data were available for at least two members of the same household, regardless of partner status. We therefore excluded multiple-adult households with only one data point from the study ($n = 39$). To capture a range of activities and locations visited over the course of the study period, participants were required to have at least three days of a minimum of eight hours' total time of data recorded by the FASTT app and reported in the time use diary. These thresholds align with other studies that use multiple-day activity spaces and objective measures of health behavior (Howie and Straker 2016; Kwon et al. 2019; L. Smith, Foley, and Panter 2019). The final analytic sample included forty-six participants from twenty-one households (seventeen households with two participants and four households with three participants). All households included at least one man and one woman. Details about the analytic sample are further explained in the Results section.

Deriving Activity Spaces

We used GPS data to derive three different and complementary activity space metrics that were designed to capture all spaces visited, including travel routes taken and key activity locations where most time was spent (Figure 2). Prior to the derivation of activity spaces, we identified erroneous GPS data points based on a measure of GPS accuracy (the horizontal dilution of precision) and their positioning in relation to neighboring points and removed them from the data set (Spatial Analysis of Urban Systems Lab 2019). Using GeoPandas 0.7.0 for Python (GeoPandas Developers 2019), we generated path areas by joining consecutive GPS points into polylines. To account for potential signal loss and signal stray (Auld et al. 2009; Duncan, Badland, and Mummery 2009), spatial and temporal differences between each point were calculated. Where differences of greater than 200 m or five minutes were identified, based on a two-second temporal epoch and distance that could feasibly be traveled, a break in each polyline was created. To check the suitability of line breaks and the location of route networks in relation to food retail outlets, we inspected GPS polylines using geographic information systems software (QGIS 3.14). We chose a network buffer of 100 m to create polygons around each polyline to capture relevant spaces individuals passed and to be sensitive enough to detect differences between household members. The buffer size was kept relatively small compared with other path area measures used in previous activity space research, which range from 50 m to 800 m (Sadler et al. 2016; L. Smith, Foley, and Panter 2019), but was wide enough to capture the space from the street centerline to building center points, including supermarkets located behind parking lots.

In contrast to the path area measure, which captures all locations an individual passes through, irrespective of time spent there, activity locations (and weighted activity locations) were defined as spaces individuals visited for a minimum of ten minutes and aimed to capture locations where potential exposure to food retail outlets was greatest. In line with a study by Liu et al. (2020), a ten-minute threshold accounted for the majority of total recorded GPS time (88 percent), removing locations where trips were made or short activities undertaken. An algorithm was used to extract activity locations from cleaned GPS points for each participant (Spatial Analysis of Urban Systems Lab 2019). In brief, the algorithm generated a kernel density estimation surface and where peaks in clustered points

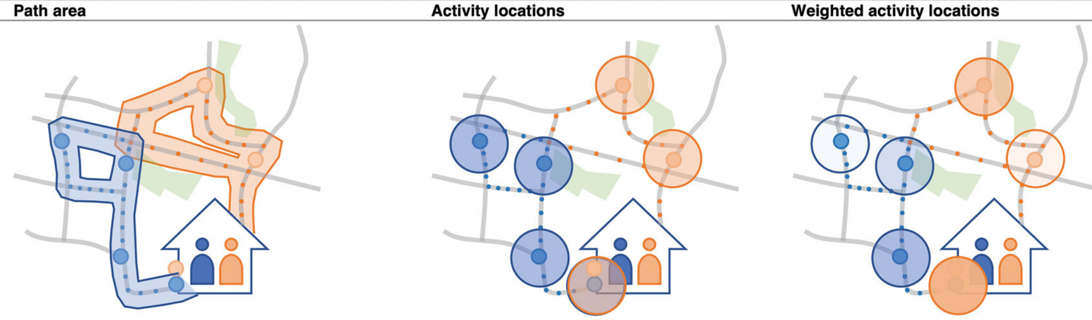
Metric	Path area	Activity locations	Weighted activity locations
			
Definition	Captures all mobility and spaces visited, including routes travelled	Captures key locations where activity takes place	Weights key locations by time spent there Greater transparency in diagram indicates less time spent at the activity location
Individual measure	100-m buffer polygon of individual's GPS traces Traces are derived from joining consecutive GPS points into polylines Overlapping buffer polygons are merged into a single polygon	500-m buffer polygon of each location where individual spends ten minutes or more Overlapping buffer polygons are merged into a single polygon	500-m buffer polygon of each location where individual spends ten minutes or more, weighted by total time spent at activity location Overlapping buffer polygons are merged into a single polygon and total time spent at activity location attributed
Household measure[a]	100-m buffer polygon of all household members' GPS traces Overlapping buffer polygons are merged into a single polygon	500-m buffer polygon of each location where any household member spends ten minutes or more Overlapping buffer polygons are merged into a single polygon	500-m buffer polygon of each location where any household member spends ten minutes or more, weighted by total time spent at activity location Overlapping buffer polygons are merged into a single polygon and total time spent by all household members in location attributed
Quantification of outlets for individuals[b]	$PAArea_i = \text{area}\left(\bigcup_j PA_{ij}\right)$ $R_i = \left\lvert\left\{r_k \in \bigcup_j PA_{ij}\right\}\right\rvert$ $PADensity_i = \frac{R_i}{PAArea_i}$	$ALArea_i = \text{area}\left(\bigcup_j AL_{ij}\right)$ $R_i = \left\lvert\left\{r_k \in \bigcup_j AL_{ij}\right\}\right\rvert$ $ALDensity_i = \frac{R_i}{ALArea_i}$	Let X_i be the set of all AL_{ij} for person i. Define a partition of X_i such that each subset $Q = \{AL_{ij} \mid \cap_j AL_{ij} \neq 0\}$ $AL_{iq} = \bigcup_{AL_{ij} \in Q} AL_{ij}$ $R_{iq} = \lvert\{r_k \in AL_{iq}\}\rvert$ $WeightedDensity_i = \frac{\sum_q \left(\frac{T_{iq} R_{iq}}{T_i}\right)}{\sum_j \text{area}(AL_{iq})}$

Figure 2. Activity space metrics used to quantify spatial access to food retail. GPS = Global Positioning System. [a]Full definitions for household measures of access to retail outlets are provided in the Appendix (Table A.1). [b]Where PA_{ij} is the jth path buffer polygon of person i; area(Z) is a function returning the area of polygon Z; r_k is the kth retail outlet; AL_{ij} is the jth activity location buffer polygon of person i; T_{ij} = time spent at jth activity location by person i; and $T_i = \sum_j T_{ij}$ is the time spent at all activity locations by person i.

exceeded a ten-minute dwell time, a coordinate with the total time spent there was exported. For weighted activity locations, we retained the total time spent at each dwell point. Compared with measures of areas around routes and path areas, buffer sizes of anchor locations such as workplaces are typically larger to capture accessibility (Williams et al. 2014; Perchoux et al. 2015) and so we created a 500-m radial buffer around each coordinate to delineate activity spaces. A 500-m buffer was considered in line with existing studies and the reporting of consistent findings, compared with larger buffer sizes (Gilliland et al. 2012; Perchoux et al. 2016; Liu et al. 2020). Because the focus of this study was to identify differences between household members and individual and household measures of spatial access, the size of the buffer used should have few implications for results.

For each activity space metric, we merged resultant overlapping polygons in QGIS for (1) each individual and (2) each set of household members and used the activity space area for nonweighted metrics (Figure 2). For weighted activity locations we summed the total time spent in overlapping polygons by either the individual or the grouped household members and attributed it to the merged polygon. Time spent at each activity location was presented as a proportion by dividing it by the total time spent at all activity locations, which we then used to weight the total area.

Measuring the Food Environment

We used OpenStreetMap (OSM) data to identify locations of food retail outlets (OpenStreetMap contributors 2015). OSM contributors populate and verify geographic information within an open-source platform, linking "OSM tags" with the North American Industry Classification System. OSM tags for "supermarket," "convenience," and "green_grocer" relate to North American Industry Classification System codes for Supermarkets and Other Grocery (except Convenience) Stores, Convenience Stores, and Fruit and Vegetable Markets, respectively (Statistics Canada 2019b). These were queried and downloaded for urban regions in Canada in March 2019, the same month for which FASTT survey data were collected. Where point data were unavailable, we converted the centroids of polygons of outlets into coordinates. OSM retail outlet data have been used by other studies of the built environment and shown to have reasonable validity with government data sets in Canada (>81 percent; Open Street Map Wiki: Toronto Statistics 2019) and other high-income countries (Bright et al. 2018; Herrmann et al. 2019; Präger et al. 2019).

Within QGIS, we plotted retail outlets and activity spaces in a common projection. The total number of supermarkets, convenience stores, and greengrocers within each activity space type were summed for each participant and household. In addition to total count, we derived a density measure dividing the sum of outlets by total activity space area in square kilometers for nonweighted metrics (Figure 2). For weighted activity locations, we multiplied the proportion of time spent at each activity location by the corresponding count and then summed for all activity locations. We then divided the final weighted count by the total area for each individual and household to create a weighted density.

We chose the retail outlet types to reflect potential locations to purchase food that is likely to be prepared at home and made accessible to other household members. A relative score assessing the ratio of healthy and unhealthy outlets was therefore not investigated in this study.

Covariates

Participants self-reported personal and lifestyle characteristics via a questionnaire, including their gender identity, shopping responsibilities, whether they currently work, how often they have access to a car, and their home address. Response options of covariates used for analysis are provided in the Appendix (Table A.2). Addresses were used to assign individuals to a residential neighborhood. To test for multicollinearity, correlations between potentially connected covariates were tested using Pearson and Spearman correlation formulas. Strong correlations were shown between neighborhood and transit score.

To compare with self-reported shopping responsibilities in the questionnaire, we used time spent coded as "offline grocery shopping" in time use diary entries. All included participants with time use diary data completed entries for the entire seven-day period. We summed the total time reported for each household and calculated the proportion of time spent grocery shopping by each individual within the household. If an individual's proportion was within 20 percent of another household member's, that person was categorized as a shared shopper. For example, for households with two respondents, individuals responsible for 40 to 60 percent of household shopping time were identified as shared shoppers, those who recorded more than 60 percent as primary shoppers, and those with less than 40 percent as secondary shoppers. Interestingly, only 50 percent of individuals who identified as primary or secondary shoppers in the questionnaire were categorized in the corresponding category based on time use data. Given this, we primarily relied on the categorization from the time use data as it demonstrates observed food shopping behavior, rather than a participant's perceived food shopping role. Where time use diary data were not available ($n = 6$), we used answers from the paper questionnaire as a proxy for shopping role to maintain the highest possible sample size (Kitterød and Lyngstad 2005).

Analysis

We described sample characteristics for the potential sample, the excluded sample, and the analytic sample.

We used independent *t* tests to assess differences in sample means across binary categorical variables of gender, employment status, car access, and neighborhood. For shopping status, we performed analysis of variance (ANOVA) and Tukey's tests to compare means of all possible pairs of strata within the category and used chi-square tests to compare gender and both questionnaire and time use derived shopping variables. To identify potential retail opportunities added or missed by adults living in the same household, we used paired *t* tests to first compare individual measures of exposure with combined household measures for men and women. Second, we compared measures for men and women living within the same household.

Finally, we used two-way ANOVA tests to investigate whether moderating factors affected within-household gender differences in exposure. A two-way ANOVA was considered appropriate over regression analyses due to the small sample size and the study's aim to test for differences in measures, rather than effect sizes. Given the study's attempt to highlight methodological implications of individual-level approaches, we selected factors based on the available data, their ability to be analyzed meaningfully, and their influence on the extent of mobility and shopping habits. We included interaction terms for neighborhood, shopping status, employment status, and car access in separate models but acknowledge that the small sample size did not allow for additional confounding factors, notably ethnicity and income, to be controlled for. Because supermarkets were identified as primary food shopping locations by respondents, outcomes focused on measures of supermarket counts and densities. If there was evidence of an interaction, we investigated variables further by stratifying within-household differences between men and women by levels of the moderator.

We checked model assumptions of normality for tests using Shapiro-Wilk tests and analytic plots of residuals.

Sensitivity Analysis

The analytic sample included adults living in multiple-adult households, irrespective of the relationship between household members, because it is plausible that cohabiting adults could share shopping responsibilities. Because the literature has largely focused on households with two adults (e.g., coupled parents) rather than households with more than two adults (e.g., a couple and a grandparent), we performed a sensitivity analysis for participants who reported living with a partner ($n = 42$). The direction, magnitude, and size of differences remained consistent with primary findings, justifying the inclusion of all cohabiting adults in the analytic sample.

Results

Sample Characteristics

Valid GPS data from multiple-adult households were available for eighty-five participants (83.3 percent of potential sample) nested within sixty-two households. Just over half ($n = 46$, 54.1 percent) were from twenty-one households with data from more than one individual, with eleven participants residing in the urban neighborhood of Parkdale and thirty-five in the suburban neighborhood of Rexdale (Table 1).

The mean age for participants was forty years (with a range of eighteen to sixty-four) with a relatively even distribution of men and women in both neighborhoods, contrasting with the potential and excluded samples, which were composed of a majority of women. Most participants identified as South Asian, which was consistent for all samples in Rexdale (74.3 percent of analytic sample), and the proportion of participants identifying as White in the Parkdale analytic sample was lower than that in the potential and excluded samples. Most participants in the analytic sample were employed, although a greater proportion of participants in Parkdale were in full-time employment (63.6 percent) than were those in Rexdale (45.7 percent). Similarly, the Parkdale sample reported higher income, distributions that were unique to the analytic sample.

Sample Measures of Food Retail Access

Sample means of food retail access for subgroups and differences in access by characteristics are detailed in the Appendix (Table A.3). In brief, there were no conclusive differences shown between genders in exposure to different retail outlets across all three measures, except for weak evidence of a greater density of greengrocers for women (path area: men = 0.14 per square kilometer; women = 0.38 per square kilometer). Based on all activity space metrics, there was no indication that supermarket access varied by shopping status. Activity space areas were greater for employed participants (path area: employed = 25.21 km^2; not employed = 10.64 km^2; activity locations: employed = 6.38 km^2; not employed = 4.33 km^2), as were counts of retailers. Car owners also had larger activity spaces and lower densities of outlets.

Counts and densities of supermarkets and convenience stores were consistently higher in Parkdale than Rexdale for all activity space metrics, which aligns with the denser characteristics of urban form associated with the Parkdale neighborhood (Figure 1).

Table 1. Sample characteristics

	Participants with GPS data ($n = 102$)				Participants from multiple-adult households with valid GPS data ($n = 85$)[a]							
	Potential sample				Excluded sample ($n = 39$)[b]				Final analytic sample ($n = 46$)			
	Parkdale		Rexdale		Parkdale		Rexdale		Parkdale		Rexdale	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Individuals	38	100	64	100	18	100	21	100	11	100	35	100
Age M (*SD*)	41.0 (9.50)		39.1 (10.50)		41.19 (7.20)		36.14 (9.60)		40.82 (10.34)		40.83 (11.28)	
Gender[d]												
Man	11	28.9	25	39.1	1	5.6	4	19.0	6	54.5	18	51.4
Woman	27	71.1	39	60.9	17	94.4	17	81.0	5	45.5	17	48.6
Ethnicity												
Black	7	18.4	7	10.9	4	22.2	1	4.8	0	0.0	4	11.4
South Asian	6	15.8	49	76.6	1	5.6	18	85.7	5	45.5	26	74.3
White	15	39.5	1	1.6	8	44.4	0	0.0	2	18.2	0	0.0
Multiple identities	4	10.5	1	1.6	3	16.7	1	4.8	1	9.1	0	0.0
Other identities	6	15.8	4	6.3	2	11.1	0	0.0	3	27.3	4	11.4
No answer	0	0.0	2	3.1	0	0.0	1	4.8	0	0.0	1	2.9
Household composition												
1 adult	4	10.5	1	1.6	*N/A*		*N/A*		*N/A*		*N/A*	
2 adults	0	0.0	4	6.3	0	0.0	2	9.5	0	0.0	2	5.7
3+ adults	2	5.3	7	10.9	2	11.1	1	4.8	0	0.0	5	14.3
1 adult + children	4	10.5	3	4.7	*N/A*		*N/A*		*N/A*		*N/A*	
2 adults + children	22	57.9	33	51.6	13	72.2	12	57.1	8	72.7	18	51.4
3+ adults + children	6	15.8	16	25.0	3	16.7	6	28.6	3	27.3	10	28.6
Total no. households	32		44		18		21		5		16	
Job												
Full-time	19	50.0	26	40.6	5	27.8	7	33.3	7	63.6	16	45.7
Part-time	4	10.5	10	15.6	1	5.6	3	14.3	2	18.2	5	14.3
Not employed	14	36.9	26	40.7	11	61.1	11	52.3	2	18.2	14	40
Other	1	2.6	2	3.1	1	5.6	0	0.0	0	0.0	0	0.0
Income (Canadian dollars)												
<30,000	8	21.1	19	29.7	6	33.3	3	14.3	0	0.0	12	34.3
30,000–60,000	12	31.6	18	28.1	5	27.8	8	38.1	3	27.3	8	22.9
60,000–90,000	2	5.3	15	23.4	0	0.0	4	19.0	1	9.1	10	28.6
90,000–120,000	5	13.2	4	6.3	2	11.1	2	9.5	2	18.2	2	5.7
120,000+	6	15.8	0	0.0	4	22.2	0	0.0	2	18.2	0	0.0
No answer	5	13.2	8	12.5	1	5.6	4	19.0	3	27.3	3	8.6

Note: Percentages shown are of neighborhood subgroups for each sample. Some categories have been collapsed to maintain anonymity where numbers of participants in subgroups are low. GPS = Global Positioning System.
[a]Twelve participants from single-adult households and five participants with invalid GPS data from the potential sample were excluded.
[b]Data from one participant in household.
[c]Data from two or more participants in household.
[d]None of the sample self-identified as anything but woman or man.

Within-Household Differences in Food Retail Access

Mean differences between individual measures of access and their household measures of access are reported for men and women throughout this section. For example, in Figure 3, path area activity spaces for men are 10.43 km^2 smaller on average than their merged household area, whereas path area activity spaces for women are 23.33 km^2 smaller.

Significant differences between individual's and their household's measure of activity space area were shown for nonweighted metrics (path area: men = −10.43, 95 percent confidence interval [CI] [−15.72, −5.14 km^2]; women = −23.33, 95 percent CI [−37.26, −9.41 km^2]; activity locations: men = −3.41, 95 percent CI [−4.42, −2.40 km^2]; women = −4.78, 95 percent CI [−6.16, −3.41 km^2]), with greater differences between individual and household measures shown for women (Figure 3). Taken

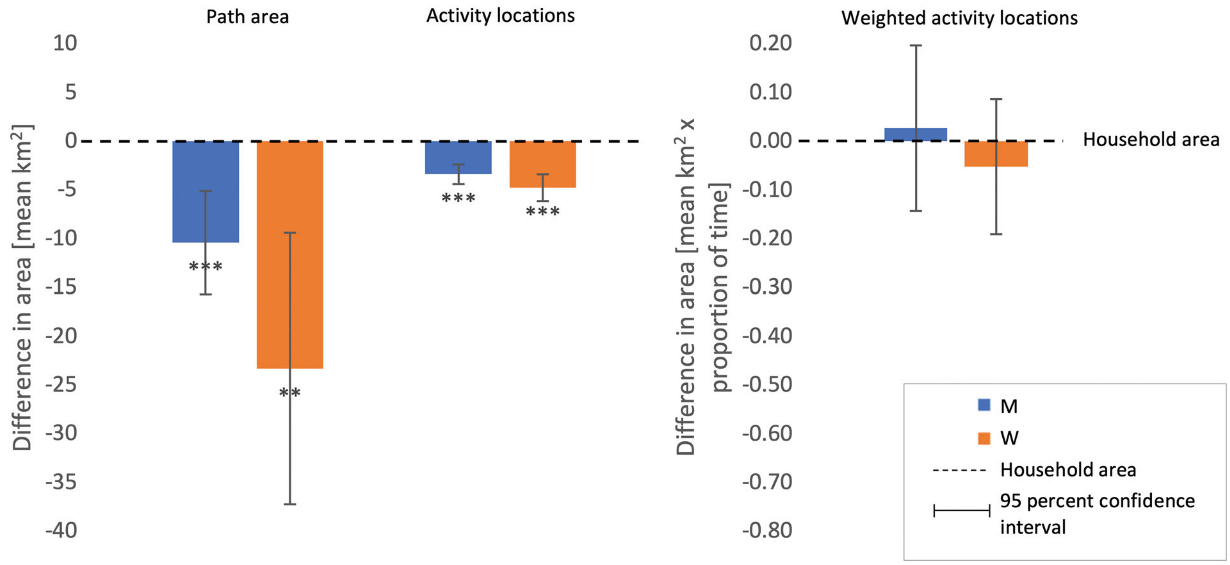


Figure 3. Mean within-household differences between individual and household measures of activity space area for men and women. Results of paired *t* tests comparing individual measure and the corresponding household measure: $^{*}p < 0.05$. $^{**}p < 0.01$. $^{***}p < 0.001$. M = men; W = women.

alongside results from within-household comparisons of individual measures (Table 2), these findings suggest that men typically have larger activity spaces than women in the same household and men appear to make up most of the area covered by household members for merged activity spaces. When area was weighted by time spent at activity locations, men seemed to spend proportionally more time across a greater area, but findings were nonsignificant (men: $p = 0.7605$; women: $p = 0.4417$).

Counts of retail outlets were consistently greater for household than individual measures (Figure 4A), as expected given the greater area of the merged activity space polygons for households. For path areas, the greatest differences between individual and household counts were shown for women (–13.32, 95 percent CI [–20.07, –6.57] supermarkets; –33.59, 95 percent CI [–50.61, –16.57] convenience stores), although this was less clear for activity locations. When counts were time-weighted, supermarket access was greater for women than for men in the household, as well as the total household measure (Figure 4A and Table 2). A comparable pattern reflecting the greater magnitude of differences was shown when assessing food retail outlet density across all three activity space measures (Figure 4B and Table 2). Supermarket density was consistently higher for women across all three metrics and greengrocer density was higher based on path area and weighted activity locations.

In contrast to the comparisons of sample means (Appendix, Table A.3) where no clear differences in access to retail outlets were apparent by gender, a pattern of greater retail outlet density emerged for women when comparing access with total household measures and access with men in the same household. The results from nonweighted activity space measures might be a product of women having smaller activity space areas than men in the household, whereas the time-weighted findings potentially owe to more time spent in or near supermarkets and greengrocers. The latter findings were corroborated by data on time spent shopping from questionnaires and time use diaries. Independence tests indicated that shopping status was dependent on gender, with a greater proportion of women identified as primary shoppers and men as shared or secondary shoppers (Appendix, Table A.4).

The results of the investigation of moderating effects of key variables on gender and supermarket access are included in the Appendix (Table A.5). There was no evidence of an interaction with shopping status, employment status, or car access for any measures of access to supermarkets. Differences in activity location areas and supermarket counts, however, appeared to be modified by neighborhood. Differences in access between men and women in the same household stratified by neighborhood are illustrated in Figure 5. A positive difference indicated that access was greater for men than for

Table 2. Within-household comparisons of access to food retail outlets between men and women

	Area (km^2)		Count						Density per square kilometer					
			Supermarkets		Greengrocers		Convenience stores		Supermarkets		Greengrocers		Convenience stores	
	M	95% CI	M	95% CI	M	95% CI	M	95% CI	M	95% CI	M	95% CI	M	95% CI
Mean difference between men and women in same household														
Path area	13.75	[0.28, 27.21]*	2.48	[−6.60, 11.56]	−0.24	[−2.32, 1.84]	7.20	[−14.13, 28.53]	−0.33	[−0.66, 0.00]*	−0.25	[−0.45, −0.05]*	−0.46	[−1.13, 0.21]
Activity locations	1.67	[0.08, 3.26]*	−0.48	[−2.82, 1.86]	0.24	[−0.91, 1.39]	0.64	[−5.17, 6.45]	−0.41	[−0.80, −0.01]*	−0.07	[−0.28, 0.15]	−0.02	[−0.86, 0.82]
Weighted activity locations	0.15	[−0.13, 0.43]	−0.66	[−1.17, −0.15]*	−0.10	[−0.24, 0.03]	−0.38	[−1.72, 0.95]	−0.33	[−0.63, −0.04]*	−0.02	[−0.04, 0.00]*	−0.08	[−0.83, 0.66]

Note: Positive difference indicates access is greater for men than women, and negative difference indicates access is greater for women than men.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

women and a negative difference indicated the reverse.

Based on spatial activity space measures, men residing in Rexdale had larger activity location areas and counts of supermarkets than women in their household. The opposite was shown for Parkdale residents, with women having larger activity location areas and counts of supermarkets. When weighting supermarket counts by time spent at activity locations, within-house differences appear less clear for Rexdale households but greater supermarket access for women persists for Parkdale households (although confidence intervals are wide).

Discussion

This study showed that for the sample with a large South Asian population in Toronto, gendered differences in access to food retail outlets were not identified when comparing sample means but spatial and spatiotemporal access was different for men and women within households. Household activity spaces were larger than individual activity spaces with greater counts of food retail outlets. When comparing within-household differences of individual activity spaces by gender, men had larger activity spaces than women in their household and typically accounted for the majority of area covered by household members. A consistent pattern was shown for supermarket density and, to a lesser extent, greengrocers across different activity space metrics. A higher number of supermarkets per square kilometer was shown for women than men in their household, as well as total household measures, with women potentially spending more time in or near supermarkets.

Findings appeared to be moderated by neighborhood. At the sample level, supermarket access was greater for residents in the more urban neighborhood of Parkdale and within-household analysis demonstrated greater activity space areas and supermarket counts for women in Parkdale households and for men in Rexdale households. The built environment might therefore affect potential mobility and access to food retail for men and women differently, irrespective of car access or shopping status.

Situating Findings within the Literature

A lack of difference in access by gender across individuals in the sample suggests that there is

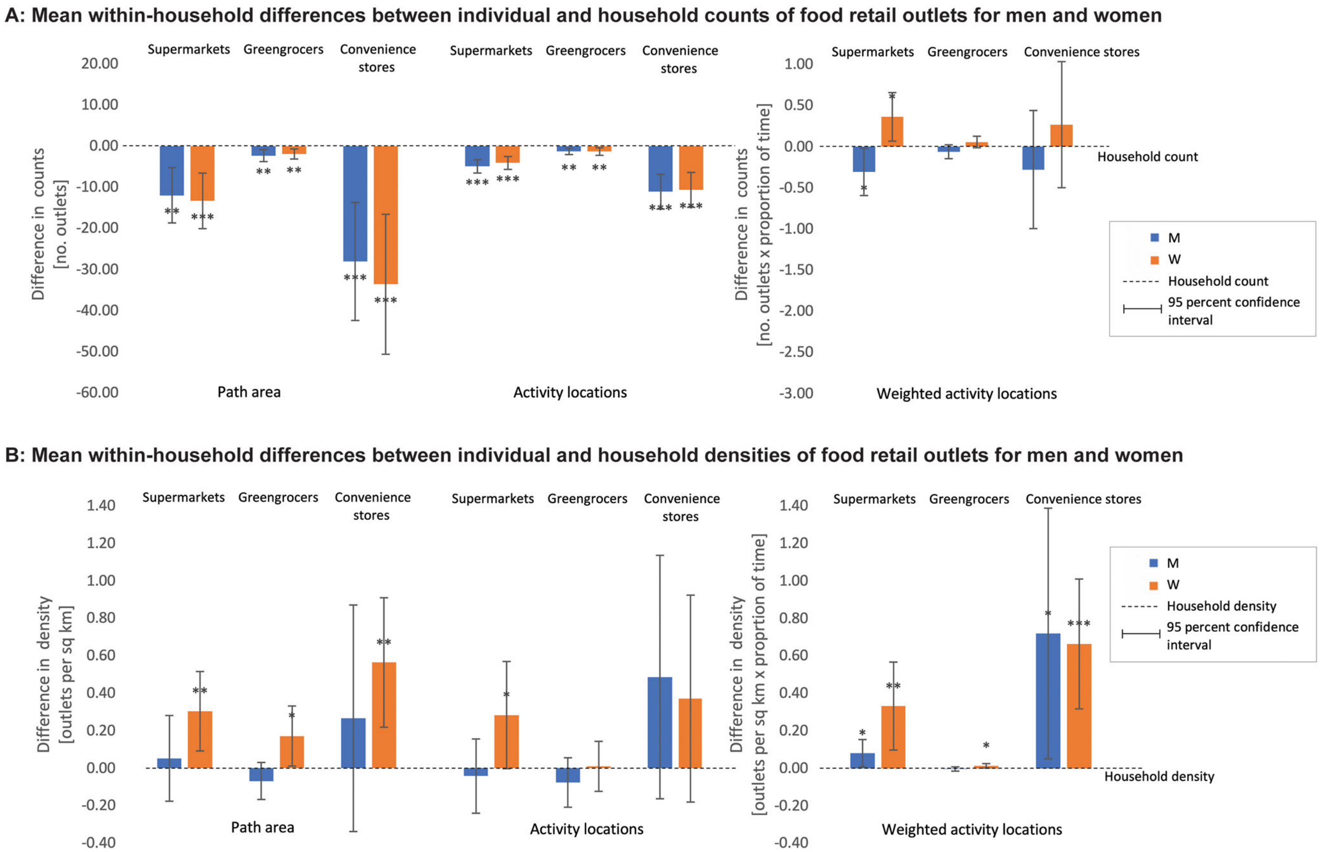


Figure 4. Mean within-household differences between individual and household measures of food retail outlets for men and women. Results of paired *t* tests comparing individual measure and the corresponding household measure: $^{*}p < 0.05$. $^{**}p < 0.01$. $^{***}p < 0.001$. M = men; W = women.

variation in mobility patterns and food environments experienced for both men and women. Between households, the extent of areas covered and outlets to which individuals are exposed diverge. More structured differences by gender seem to be present at the household level, however, when movement and access are assessed relative to other household members.

Literature that has considered variation in parameters of activity spaces and mobility has typically focused on individuals. Several studies have demonstrated differences in patterns of mobility between men and women. Smaller activity spaces have been identified for women (Kwan and Kotsev 2015; Sanchez et al. 2017; Lo and Houston 2018), in part due to travel modes taken, whereby women are more likely to use public and active modes of transport (Vance and Iovanna 2007; Mercado et al. 2012; Miralles-Guasch, Melo, and Marquet 2016). At the sample level, this study showed that those with regular access to a car typically had larger activity spaces than those who did not, and there was evidence for within-household differences in the size of activity space between men and women with men traveling further. Findings related to gendered sizes of activity spaces have not been consistently reported across studies and settings, however (G. C. Smith and Sylvestre 2001; Zenk et al. 2011), and in this study, women's activity locations were greater in area for residents in Parkdale. Car ownership did not moderate within-household differences in access in this study, possibly due to shared use of a car within a household, but the availability of public transport might explain some variations by neighborhood. Given the greater public transport opportunities and number of retail outlets in and around Parkdale than Rexdale (Figure 1), the extent of mobility might be increased for women who can use public transport. Traveling a smaller additional distance in a neighborhood of dense urban form allows for counts of supermarkets to increase, which might reflect the variations in access by gender for each neighborhood. Without transit ridership information from sample participants, however, conclusions around

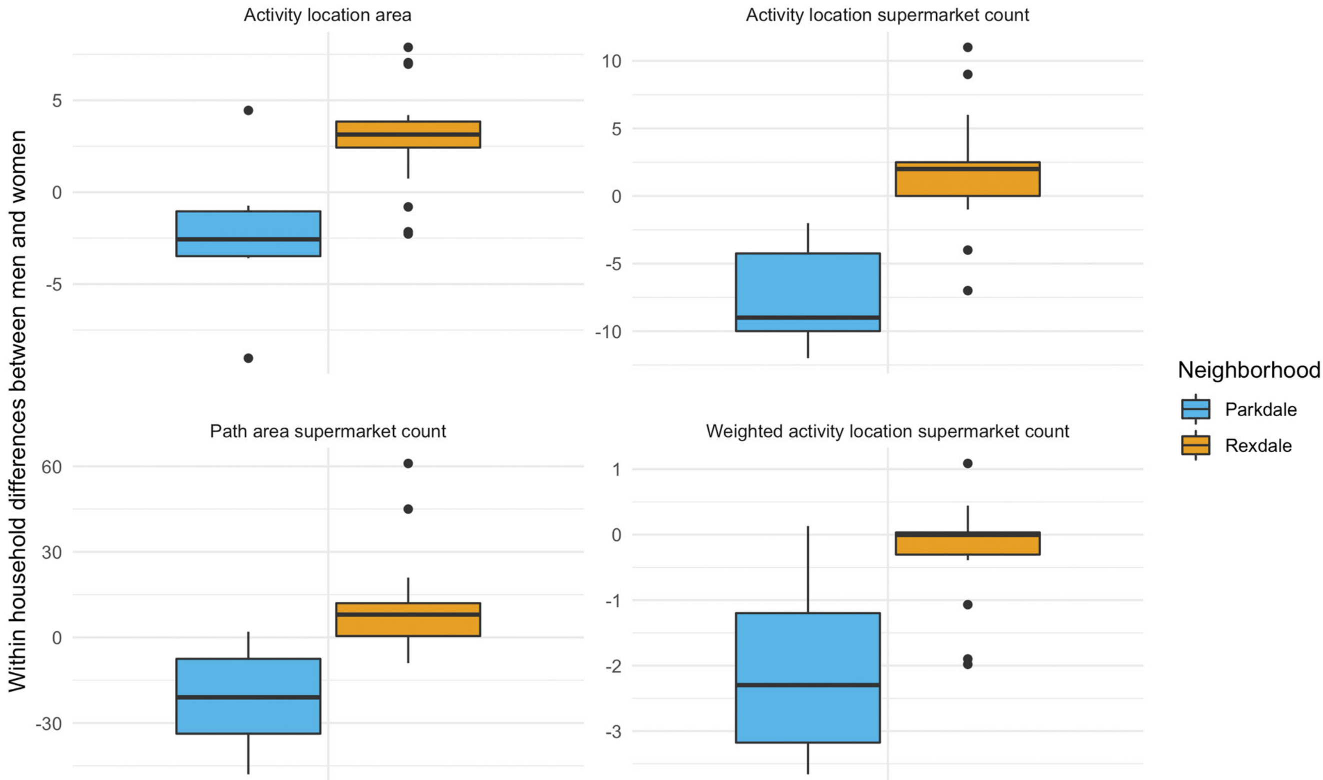


Figure 5. Within-household differences in measures of access for men and women by neighborhood. Positive difference indicates that access is greater for men than for women and negative difference indicates that access is greater for women than for men.

neighborhood transit as a potential modifying factor should be interpreted with caution.

Regardless of neighborhood or car access, the density of supermarkets remained highest for women in the household. More food retail opportunities might not always be an indication of a larger activity space size; instead, it might owe to gender roles and the types of spaces where women spend more time. In line with changes in employment, differences in gender-based patterns of mobility have been argued to be decreasing, with women replicating mobility patterns prevalent among men with longer, motorized trips (Dobbs 2005). Although this theory reflects the lack of findings across sample means from this study, the within-household differences in time spent in or near food retail outlets suggest that women's spatial and temporal fixity continues to be constrained relative to men in their households. The division of domestic labor has been shown to be gendered, with responsibilities relating to food work, chauffeuring, and child care disproportionately carried by women (Bianchi et al. 2012; Boarnet and Hsu 2015; Taillie 2018). Despite some convergence in employment and household responsibilities between men and women, within-household dependencies and consequent imbalances appear to have persisted (Kwan 1999; Marshall 2006). Findings from this study highlight the potential for built environments to offer greater travel and food retail opportunities, particularly for women, but also suggest that mobility patterns and spaces experienced might reflect gender roles, with women assuming responsibility for the majority of household food shopping. Women appear to spend more time in and near supermarkets compared to men in the household, a potential consequence of multiple tasks assumed by women in terms of both employment and household labor.

Finally, no significant differences between household members were shown for convenience store access, which has been associated with lower quality diets (He, Tucker, Irwin, et al. 2012; Lind et al. 2016; Kaji et al. 2019). In contrast, the greater access to supermarkets and greengrocers for women highlights their potential to positively contribute to their diet and the diet of their household members (Laraia 2004; Moore et al. 2008; Minaker, Olstad, et al. 2016), albeit at the cost of their time use. Findings related to supermarket access and diet have been mixed, however (Caspi, Kawachi, et al. 2012; Lear, Gasevic, and Schuurman 2013; Dubowitz et al. 2015; Vogel et al. 2016), which might in part be due to a focus on neighborhood measurements and a lack of understanding regarding who is shopping for what and for whom.

Methodological Implications

Attempts to understand mobility and the food environment are increasingly centered around the individual. In methodological terms, though, this causes important household dependencies and social connections to be missed. Seemingly, access to healthy food for an individual, particularly for men, could be increased by extension of another household member's activity space and food shopping activities. By virtue, using individual-level measures in studies assessing spatial access to food retailers could provide a poor representation of potential stores and food accessible through other household members.

This study uses a merged household measure as a way to test for variation in activity spaces and potential food access between household members. A merged measure is not necessarily advocated, however, as a replacement for individual measures because it assumes equal accessibility for all members of the same household. Further, it does not shed light on who contributes most to food shopping and whose access to food is benefited by the actions of another household member. Depending on assumed food purchasing responsibilities, the use of a merged measure could under- or overestimate exposure for household members and give rise to bias in results. Future studies of food access and exposure should incorporate some understanding of respondent responsibilities within the household and potential support received in relation to food purchasing. This could be achieved through time use diaries, using questionnaires, or framing research questions to move forward previous ideologies relating to household levels of consumption (which used static neighborhood measures) into a more dynamic context. When assessing outcomes such as food purchasing or dietary outcomes, this might require the use of variables relating to household composition, how food shopping is divided between members, and the potentially accessible spaces of the primary shopper.

In addition to household responsibilities, gender disparities in activity spaces have been related to urban form (Fagan and Trudeau 2014). Our study suggests that differences in within-household access between men and women might vary by urban setting. More thoughtful consideration is required for what is being measured, particularly in the context of urban settings, and how this might skew results. In the case of this data set, for example, controlling for gender at the sample level might not have accounted for within-household differences, and relying on measures of access to supermarkets for individuals might have caused access to be underrepresented for some, depending on the method used and neighborhood studied.

Improving studies of access to food could help to strengthen evidence for future policy and planning and ultimately lead to more equitable and healthy food environments for individuals and households. Drawing on more representative measures of access provides an opportunity to gain insight into what access means for whom and where and to identify mechanisms and stronger evidence on the pathways that act to shape purchasing habits and dietary behavior.

Strengths and Limitations

This is one of the first studies to consider within-household differences in spatial access to food retail and the implications of realizing high-resolution data at the individual level, at the cost of accounting for gendered roles and dependencies within households.

A key limitation of the study was the small sample size, particularly for the subsample residing in the Parkdale neighborhood. The data collected were rich in location information, however, and allowed for spatial and temporal patterns of mobility to be accurately mapped and quantified for multiple members of households. The aim of the study was not to quantify empirical differences between household members but rather to identify patterns in differences across measures and types of retail outlets. By using multiple activity space delineations, both total mobility and locations where the most time was spent were captured, allowing the potential contributions of shopping opportunities by different household members to be explored in line with the current literature on gendered differences in household labor. Despite the small sample size, observations could be drawn across the measures and limitations of using individual-level spatial measures of access could be qualitatively identified.

Due to the small sample size, it was not possible to perform multivariable analyses and to control for important factors, including ethnicity and income, which might play a role in the differentiation of food access and choice of retailers visited. Findings cannot therefore claim to be generalizable and patterns shown for gender might be biased by residual confounding. The sample was also limited by a lack of data for common household arrangements, including same-gender partners and cohabiting adults, such as older parents. The study, however, offers an important starting point for recognizing the importance of both spatial and social contributions to access, not just for partnered adults, and provides critical insights into a sample across different urban settings.

Finally, data were collected over a seven-day period that could not be validated against self-reported information to ascertain whether the data constituted a "typical" week for shopping. The data collection period might have obscured habitual patterns of behavior and might explain some variation between the time use and questionnaire responses surrounding shopping responsibilities. To address these limitations, we recommend that future studies adopt a sampling frame that captures diverse styles of household over multiple time points. Data should allow for a breadth of factors that influence food shopping behaviors to be controlled for, and consideration should be given to shared tasks and interdependencies, not only between household members but with actors outside of the household as well.

Conclusions

This study identified differences in measures of spatial access to food between household members and highlighted important methodological limitations of the increased collection and use of individual-level spatiotemporal data in studies of the food environment.

As studies of the food environment increasingly incorporate spatiotemporal detail at the individual level, future research should also consider the role of place, social connections, and the division of shopping responsibilities between household members. More representative measures of access to food might allow for improved understanding of relationships with dietary behavior and for more equitable design of urban environments that encourage an alleviation of time pressure and a more equal division of household labor by shifting food purchasing responsibilities.

Supplemental Material

Supplemental data for this article is available online at https://doi.org/10.1080/24694452.2021.1930513.

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ORCID

Lindsey G. Smith http://orcid.org/0000-0002-0932-4437
Michael J. Widener http://orcid.org/0000-0003-3312-6710
Bochu Liu http://orcid.org/0000-0002-0735-8000
Steven Farber http://orcid.org/0000-0002-3870-5984
Jason Gilliland http://orcid.org/0000-0002-2909-2178

References

Afshin, A., P. J. Sur, K. A. Fay, L. Cornaby, G. Ferrara, J. S. Salama, E. C. Mullany, K. H. Abate, C. Abbafati, Z. Abebe, et al. 2019. Health effects of dietary risks in 195 countries, 1990–2017: A systematic analysis for the Global Burden of Disease Study. *The*

Lancet 393 (10184):1958–72. doi: 10.1016/S0140-6736(19)30041-8.

Astbury, C. C., L. Foley, T. L. Penney, and J. Adams. 2020. How does time use differ between individuals who do more versus less foodwork? A compositional data analysis of time use in the United Kingdom time use survey 2014–2015. *Nutrients* 12 (8):2280. doi: 10.3390/nu12082280.

Auld, J., C. Williams, A. Mohammadian, and P. Nelson. 2009. An automated GPS-based prompted recall survey with learning algorithms. *Transportation Letters* 1 (1):59–79. doi: 10.3328/tl.2009.01.01.

Bagnall, A.-M., D. Radley, R. Jones, P. Gately, J. Nobles, M. Van Dijk, J. Blackshaw, S. Montel, and P. Sahota. 2019. Whole systems approaches to obesity and other complex public health challenges: A systematic review. *BMC Public Health* 19 (1):8. doi: 10.1186/s12889-018-6274-z.

Bauer, K. W., M. O. Hearst, K. Escoto, J. M. Berge, and D. Neumark-Sztainer. 2012. Parental employment and work-family stress: Associations with family food environments. *Social Science and Medicine* 75 (3):496–504. doi: 10.1016/j.socscimed.2012.03.026.

Bianchi, S. M., L. C. Sayer, M. A. Milkie, and J. P. Robinson. 2012. Housework: Who did, does or will do it, and how much does it matter? *Social Forces* 91 (1):55–63. doi: 10.1093/sf/sos120.

Bivoltsis, A., E. Cervigni, G. Trapp, M. Knuiman, P. Hooper, and G. L. Ambrosini. 2018. Food environments and dietary intakes among adults: Does the type of spatial exposure measurement matter? A systematic review. *International Journal of Health Geographics* 17 (1):19. doi: 10.1186/s12942-018-0139-7.

Blake, C. E., C. M. Devine, E. Wethington, M. Jastran, T. J. Farrell, and C. A. Bisogni. 2009. Employed parents' satisfaction with food-choice coping strategies: Influence of gender and structure. *Appetite* 52 (3):711–19. doi: 10.1016/j.appet.2009.03.011.

Boarnet, M. G., and H. P. Hsu. 2015. The gender gap in non-work travel: The relative roles of income earning potential and land use. *Journal of Urban Economics* 86:111–27. doi: 10.1016/j.jue.2015.01.005.

Bright, J., S. D. Sabbata, S. Lee, B. Ganesh, and D. K. Humphreys. 2018. OpenStreetMap data for alcohol research: Reliability assessment and quality indicators. *Health and Place* 50:130–36. doi: 10.1016/j.healthplace.2018.01.009.

Burgoine, T., and P. Monsivais. 2013. Characterising food environment exposure at home, at work, and along commuting journeys using data on adults in the UK. *The International Journal of Behavioral Nutrition and Physical Activity* 10 (1):85. doi: 10.1186/1479-5868-10-85.

Carter, M. A. N., L. Dubois, and M. S. Tremblay. 2014. Place and food insecurity: A critical review and synthesis of the literature. *Public Health Nutrition* 17 (1):94–112. doi: 10.10/S1368980013000633.

Caspi, C. E., I. Kawachi, S. V. Subramanian, G. Adamkiewicz, and G. Sorensen. 2012. The relationship between diet and perceived and objective access to supermarkets among low-income housing residents. *Social Science and Medicine* 75 (7):1254–62. doi: 10.1016/j.socscimed.2012.05.014.

Caspi, C. E., G. Sorensen, S. V. Subramanian, and I. Kawachi. 2012. The local food environment and diet: A systematic review. *Health and Place* 126:99–109. doi: 10.1016/j.healthplace.2012.05.006.

Cetateanu, A., and A. Jones. 2016. How can GPS technology help us better understand exposure to the food environment? A systematic review. *SSM - Population Health* 2:196–205. doi: 10.1016/j.ssmph.2016.04.001.

Chaix, B., D. Duncan, J. Vallée, A. Vernez-Moudon, T. Benmarhnia, and Y. Kestens. 2017. The "residential" effect fallacy in neighborhood and health studies formal definition, empirical identification, and correction. *Epidemiology* 28 (6):789–97. doi: 10.1097/EDE.0000000000000726.

Chaix, B., J. Méline, S. Duncan, C. Merrien, N. Karusisi, C. Perchoux, A. Lewin, K. Labadi, and Y. Kestens. 2013. GPS tracking in neighborhood and health studies: A step forward for environmental exposure assessment. A step backward for causal inference? *Health and Place* 21:46–51. doi: 10.1016/j.healthplace.2013.01.003.

Charreire, H., R. Casey, P. Salze, C. Simon, B. Chaix, A. Banos, D. Badariotti, C. Weber, and J.-M. Oppert. 2010. Measuring the food environment using geographical information systems: A methodological review. *Public Health Nutrition* 13 (11):1773–85. doi: 10.1017/S68980010000753.

Cobb, L. K., L. J. Appel, M. Franco, J. C. Jones-Smith, A. Nur, and C. A. M. Anderson. 2015. The relationship of the local food environment with obesity: A systematic review of methods, study quality, and results. *Obesity* 23 (7):1331–44. doi: 10.1002/oby.21118.

Connors, M., C. A. Bisogni, J. Sobal, and C. M. Devine. 2001. Managing values in personal food systems. *Appetite* 36 (3):189–200. doi: 10.1006/appe.2001.0400.

Cummins, S. 2007. Commentary: Investigating neighbourhood effects on health—Avoiding the "local trap." *International Journal of Epidemiology* 36 (2):355–57. doi: 10.1093/ije/dym033.

Cummins, S., E. Flint, and S. A. Matthews. 2014. New neighborhood grocery store increased awareness of food access but did not alter dietary habits or obesity. *Health Affairs* 33 (2):283–91. doi: 10.1377/hlthaff.2013.0512.

Dai, D., and F. Wang. 2011. Geographic disparities in accessibility to food stores in southwest Mississippi. *Environment and Planning B: Planning and Design* 38 (4):659–77. doi: 10.1068/b36149.

Dobbs, L. 2005. Wedded to the car: Women, employment and the importance of private transport. *Transport Policy* 12 (3):266–78. doi: 10.1016/j.tranpol.2005.02.004.

Dubowitz, T., M. Ghosh-Dastidar, D. A. Cohen, R. Beckman, E. D. Steiner, G. P. Hunter, K. R. Flórez, C. Huang, C. A. Vaughan, J. C. Sloan, et al. 2015. Diet and perceptions change with supermarket introduction in a food desert, but not because of supermarket use. *Health Affairs* 34 (11):1858–68. doi: 10.1377/hlthaff.2015.0667.

Duncan, M. J., H. M. Badland, and W. K. Mummery. 2009. Applying GPS to enhance understanding of transport-related physical activity. *Journal of Science and Medicine in Sport* 12 (5):549–56. doi: 10.1016/j.jsams.2008.10.010.

Fagan, C., and D. Trudeau. 2014. Empowerment by design? Women's use of new urbanist neighborhoods in suburbia. *Journal of Planning Education and Research* 34 (3):325–38. doi: 10.1177/0739456X14539353.

Fan, W., J. Lam, P. Moen, E. Kelly, R. King, and S. McHale. 2015. Constrained choices? Linking employees' and spouses' work time to health behaviors. *Social Science and Medicine* 126:99–109. doi: 10.1016/j.socscimed.2014.12.015.

Farber, S., A. Páez, R. G. Mercado, M. Roorda, and C. Morency. 2011. A time-use investigation of shopping participation in three Canadian cities: Is there evidence of social exclusion? *Transportation* 38 (1):17–44. doi: 10.1007/s11116-010-9282-0.

GeoPandas Developers. 2019. *GeoPandas 0.7.0*. Accessed June 2, 2020. https://geopandas.org/#.

Ghosh-Dastidar, M., G. Hunter, R. L. Collins, S. N. Zenk, S. Cummins, R. Beckman, A. K. Nugroho, J. C. Sloan, L. V. Wagner, and T. Dubowitz. 2017. Does opening a supermarket in a food desert change the food environment? *Health and Place* 46:246–56. doi: 10.1016/j.healthplace.2017.06.002.

Gilliland, J. A., C. Y. Rangel, M. A. Healy, P. Tucker, J. E. Loebach, P. M. Hess, M. He, J. D. Irwin, and P. Wilk. 2012. Linking childhood obesity to the built environment: A multi-level analysis of home and school neighbourhood factors associated with body mass index. *Canadian Journal of Public Health* 103 (Suppl. 3):S15–21. doi: 10.1007/BF03403830.

Gittelsohn, J., and A. Trude. 2017. Diabetes and obesity prevention: Changing the food environment in low-income settings. *Nutrition Reviews* 75 (Suppl. 1):62–69. doi: 10.1093/nutrit/nuw038.

Guppy, N., L. Sakumoto, and R. Wilkes. 2019. Social change and the gendered division of household labor in Canada. *Canadian Review of Sociology* 56 (2):178–203. doi: 10.1111/cars.12242.

Gustafson, A. 2017. Shopping pattern and food purchase differences among Supplemental Nutrition Assistance Program (SNAP) households and non-Supplemental Nutrition Assistance Program households in the United States. *Preventive Medicine Reports* 7:152–57. doi: 10.1016/j.pmedr.2017.06.005.

He, M., P. Tucker, J. Gilliland, J. D. Irwin, K. Larsen, and P. Hess. 2012. The influence of local food environments on adolescents' food purchasing behaviors. *International Journal of Environmental Research and Public Health* 9 (4):1458–71. doi: 10.3390/ijerph9041458.

He, M., P. Tucker, J. D. Irwin, J. Gilliland, K. Larsen, and P. Hess. 2012. Obesogenic neighbourhoods: The impact of neighbourhood restaurants and convenience stores on adolescents' food consumption behaviours. *Public Health Nutrition* 15 (12):2331–39. doi: 10.1017/S1368980012000584.

Herrmann, T., W. Gleckner, R. A. Wasfi, B. Thierry, Y. Kestens, and N. A. Ross. 2019. A pan-Canadian measure of active living environments using open data. *Health Reports* 30 (5):16–25. doi: 10.25318/82-003-x201900500002-eng.

Horner, M. W., and B. S. Wood. 2014. Capturing individuals' food environments using flexible space–time accessibility measures. *Applied Geography* 51:99–107. doi: 10.1016/j.apgeog.2014.03.007.

Howell, N. A., S. Farber, M. J. Widener, and G. L. Booth. 2017. Residential or activity space walkability: What drives transportation physical activity? *Journal of Transport and Health* 7:160–71. doi: 10.1016/j.jth.2017.08.011.

Howie, E. K., and L. M. Straker. 2016. Rates of attrition, non-compliance and missingness in randomized controlled trials of child physical activity interventions using accelerometers: A brief methodological review. *Journal of Science and Medicine in Sport* 19 (10):830–36. doi: 10.1016/j.jsams.2015.12.520.

Inglis, V., K. Ball, and D. Crawford. 2005. Why do women of low socioeconomic status have poorer dietary behaviours than women of higher socioeconomic status? A qualitative exploration. *Appetite* 45 (3):334–43. doi: 10.1016/j.appet.2005.05.003.

Jabs, J., and C. M. Devine. 2006. Time scarcity and food choices: An overview. *Appetite* 47 (2):196–204. doi: 10.1016/j.appet.2006.02.014.

Jabs, J., C. M. Devine, C. A. Bisogni, T. J. Farrell, M. Jastran, and E. Wethington. 2007. Trying to find the quickest way: Employed mothers' constructions of time for food. *Journal of Nutrition Education and Behavior* 39 (1):18–25. doi: 10.1016/j.jneb.2006.08.011.

Kaji, A., Y. Hashimoto, R. Sakai, H. Okada, M. Hamaguchi, E. Ushigome, S. Majima, M. Yamazaki, and M. Fukui. 2019. Frequent usage of convenience stores is associated with low diet quality. *Nutrients* 11 (6):1212. doi: 10.3390/nu11061212.

Kan, M. Y., O. Sullivan, and J. Gershuny. 2011. Gender convergence in domestic work: Discerning the effects of interactional and institutional barriers from large-scale data. *Sociology* 45 (2):234–51. doi: 10.1177/0038038510394014.

Kerr, M., and M. Bowen. 1989. *Family evaluation: An approach based on Bowen theory*. New York: Norton. doi: 10.1192/s0007125000177876.

Kirkpatrick, S. I., and V. Tarasuk. 2010. Assessing the relevance of neighbourhood characteristics to the household food security of low-income Toronto families. *Public Health Nutrition* 13 (7):1139–48. doi: 10.1017/S68980010000339.

Kitterød, R. H., and T. H. Lyngstad. 2005. Diary versus questionnaire information on time spent on housework—The case of Norway. *Electronic International Journal of Time Use Research* 2 (1):13–32. doi: 10.13085/eijtur.2.1.

Krenn, P. J., S. Titze, P. Oja, A. Jones, and D. Ogilvie. 2011. Use of global positioning systems to study physical activity and the environment: A systematic review. *American Journal of Preventive Medicine* 41 (5):508–15. doi: 10.1016/j.amepre.2011.06.046.

Kwan, M. P. 1999. Gender, the home–work link, and space–time patterns of nonemployment activities. *Economic Geography* 75 (4):370–94. doi: 10.2307/144477.

Kwan, M. P. 2009. From place-based to people-based exposure measures. *Social Science and Medicine* 69 (9):1311–13. doi: 10.1016/j.socscimed.2009.07.013.

Kwan, M. P. 2012. The uncertain geographic context problem. *Annals of the Association of American Geographers* 102 (5):958–68. doi: 10.1080/00045608.2012.687349.

Kwan, M. P., and A. Kotsev. 2015. Gender differences in commute time and accessibility in Sofia, Bulgaria: A study using 3D geovisualisation. *Geographical Journal* 181 (1):83–96. doi: 10.1111/geoj.12080.

Kwon, S., L. B. Andersen, A. Grøntved, E. Kolle, G. Cardon, R. Davey, S. Kriemler, K. Northstone, A. S. Page, J. J. Puder, on behalf of the ICAD Collaborators, et al. 2019. A closer look at the relationship among accelerometer-based physical activity metrics: ICAD pooled data. *International Journal of Behavioral Nutrition and Physical Activity* 16 (1):40. doi: 10.1186/s12966-019-0801-x.

Lake, A. A., R. M. Hyland, J. C. Mathers, A. J. Rugg-Gunn, C. E. Wood, and A. J. Adamson. 2006. Food shopping and preparation among the 30-somethings: Whose job is it? (The ASH30 study). *British Food Journal* 108 (6):475–86. doi: 10.1108/00070700610668441.

Lang, T., and G. Rayner. 2012. Ecological public health: The 21st century's big idea? An essay by Tim Lang and Geof Rayner. *BMJ* 345:e5466. doi: 10.1136/bmj.e5466.

Laraia, B. A. 2004. Proximity of supermarkets is positively associated with diet quality index for pregnancy. *Preventive Medicine* 39 (5):869–75. doi: 10.1016/j.ypmed.2004.03.018.

Lear, S. A., D. Gasevic, and N. Schuurman. 2013. Association of supermarket characteristics with the body mass index of their shoppers. *Nutrition Journal* 12 (1):117. doi: 10.1186/1475-2891-12-117.

Li, J., and C. Kim. 2018. Measuring individuals' spatial access to healthy foods by incorporating mobility, time, and mode: Activity space measures. *The Professional Geographer* 70 (2):198–208. doi: 10.1080/00330124.2017.1338591.

Lind, P. L., P. V. Jensen, G, Glümer, and U. Toft. 2016. The association between accessibility of local convenience stores and unhealthy diet. *European Journal of Public Health* 26 (4):634–39. doi: 10.1093/eurpub/ckv242.

Liu, B., M. Widener, T. Burgoine, and D. Hammond. 2020. Association between time-weighted activity space-based exposures to fast food outlets and fast food consumption among young adults in urban Canada. *International Journal of Behavioral Nutrition and Physical Activity* 17 (1):62. doi: 10.1186/s12966-020-00967-y.

Lo, A. W. T., and D. Houston. 2018. How do compact, accessible, and walkable communities promote gender equality in spatial behavior? *Journal of Transport Geography* 68:42–54. doi: 10.1016/j.jtrangeo.2018.02.009.

Lytle, L. A., and R. L. Sokol. 2017. Measures of the food environment: A systematic review of the field, 2007–2015. *Health and Place* 44:18–34. doi: 10.1016/j.healthplace.2016.12.007.

Maguire, E. R., T. Burgoine, T. L. Penney, N. G. Forouhi, and P. Monsivais. 2017. Does exposure to the food environment differ by socioeconomic position? Comparing area-based and person-centred metrics in the Fenland Study, UK. *International Journal of Health Geographics* 16 (1):33. doi: 10.1186/s12942-017-0106-8.

Mah, C. L., and H. Thang. 2013. Cultivating food connections: The Toronto food strategy and municipal deliberation on food. *International Planning Studies* 18 (1):96–110. doi: 10.1080/13563475.2013.750941.

Marshall, K. 2006. Converging gender roles. *Perspectives*, 7 (No. 75-001-XIE). Ottawa, ON: Statistics Canada. https://www150.statcan.gc.ca/n1/en/pub/75-001-x/10706/0009290-eng.pdf?st=OcYtEGeF

Mercado, R. G., A. Paez, S. Farber, M. J. Roorda, and C. Morency. 2012. Explaining transport mode use of low-income persons for journey to work in urban areas: A case study of Ontario and Quebec. *Transportmetrica* 8 (3):157–79. doi: 10.1080/18128602.2010.539413.

Micha, R., M. L. Shulkin, J. L. Peñalvo, S. Khatibzadeh, G. M. Singh, M. Rao, S. Fahimi, J. Powles, and D. Mozaffarian. 2017. Etiologic effects and optimal intakes of foods and nutrients for risk of cardiovascular diseases and diabetes: Systematic reviews and meta-analyses from the nutrition and chronic diseases expert group (NutriCoDE). *PLoS ONE* 12 (4):e0175149. doi: 10.1371/journal.pone.0175149.

Minaker, L. M., D. L. Olstad, M. E. Thompson, K. D. Raine, P. Fisher, and L. D. Frank. 2016. Associations between frequency of food shopping at different store types and diet and weight outcomes: Findings from the NEWPATH study. *Public Health Nutrition* 19 (12):2268–77. doi: 10.1017/S1368980016000355.

Minaker, L. M., A. Shuh, D. L Olstad, R. Engler-Stringer, J. L. Black, and C. L. Mah. 2016. Retail food environments research in Canada: A scoping review. *Canadian Journal of Public Health* 107:70. doi: 10.17269/CJPH5344.

Miralles-Guasch, C., M. M. Melo, and O. Marquet. 2016. A gender analysis of everyday mobility in urban and rural territories: From challenges to sustainability. *Gender, Place and Culture* 23 (3):398–417. doi: 10.1080/0966369X.2015.1013448.

Monsivais, P., A. Aggarwal, and A. Drewnowski. 2014. Time spent on home food preparation and indicators of healthy eating. *American Journal of Preventive Medicine* 47 (6):796–802. doi: 10.1016/j.amepre.2014.07.033.

Moore, L. V., A. V. Diez Roux, J. A. Nettleton, and D. R. Jacobs. 2008. Associations of the local food environment with diet quality—A comparison of assessments based on surveys and geographic information systems. *American Journal of Epidemiology* 167 (8):917–24. doi: 10.1093/aje/kwm394.

Moyser, M., and A. Burlock. 2018. *Time use: Total work burden, unpaid work, and leisure*. *Women in Canada: A gender-based statistical report*. (No. 89-503-X). Ottawa, ON: Statistics Canada. https://www150.statcan.gc.ca/n1/pub/89-503-x/2015001/article/54931-eng.pdf

OpenStreetMap contributors. 2015. *Planet OSM data dump*. Accessed March 25, 2019. https://planet.openstreetmap.org.

Open Street Map Wiki. 2019. Toronto statistics. Accessed February 4, 2021. https://wiki.openstreetmap.org/wiki/Toronto/Statistics.

Patterson, Z., K. Fitzsimmons, S. Jackson, and T. Mukai. 2019. Itinerum: The open smartphone travel survey platform. *SoftwareX* 10. doi: 10.0230.1016/j.softx.2019.04.002.

Peng, K., and N. Kaza. 2019. Availability of neighbourhood supermarkets and convenience stores, broader built environment context, and the purchase of fruits and vegetables in U.S. households. *Public Health Nutrition* 22 (13):2436–47. doi: 10.1017/S1368980019000910.

Perchoux, C., B. Chaix, R. Brondeel, and Y. Kestens. 2016. Residential buffer, perceived neighborhood, and individual activity space: New refinements in the definition of exposure areas—The RECORD Cohort Study. *Health & Place* 40:116–22. doi: 10.1016/j.healthplace.2016.05.004.

Perchoux, C., B. Chaix, S. Cummins, and Y. Kestensa. 2013. Conceptualization and measurement of environmental exposure in epidemiology: Accounting for activity space related to daily mobility. *Health and Place* 21:86–93. doi: 10.1016/j.healthplace.2013.01.005.

Perchoux, C., Y. Kestens, R. Brondeel, and B. Chaix. 2015. Accounting for the daily locations visited in the study of the built environment correlates of recreational walking (the RECORD Cohort Study). *Preventive Medicine* 81:142–49. doi: 10.1016/j.ypmed.2015.08.010.

Präger, M., C. Kurz, J. Böhm, M. Laxy, and W. Maier. 2019. Using data from online geocoding services for the assessment of environmental obesogenic factors: A feasibility study. *International Journal of Health Geographics* 18 (1):13. doi: 10.1186/s12942-019-0177-9.

Rodrigues, P. R. M., L. S. Monteiro, D. B. Cunha, R. Sichieri, and R. A. Pereira. 2020. Adult food consumption by household composition: An analysis of the first National Dietary Survey, Brazil, 2008. *Public Health Nutrition* 23 (2):193–201. doi: 10.1017/S1368980019002374.

Rutter, H., N. Savona, K. Glonti, J. Bibby, S. Cummins, D. T. Finegood, F. Greaves, L. Harper, P. Hawe, L. Moore, et al. 2017. The need for a complex systems model of evidence for public health. *The Lancet* 390 (10112):2602–4. doi: 10.1016/S0140-6736(17)31267-9.

Sadler, R. C., A. F. Clark, P. Wilk, C. O'Connor, and J. A. Gilliland. 2016. Using GPS and activity tracking to reveal the influence of adolescents' food environment exposure on junk food purchasing. *Canadian Journal of Public Health* 107 (Suppl. 1):eS14–20. doi: 10.17269/CJPH.107.5346.

Sallis, J. F., N. Owen, and E. B. Fisher. 2008. Ecological models of health behavior. In *Health behavior and health education: Theory, research, and practice*, 4th ed., ed. K. Glanz, B. K. Rimer, and K. Viswanath, 465–85. San Francisco: Jossey-Bass. doi: 10.7326/0003-4819-116-4-350_1.

Sanchez, M., A. Ambros, M. Salmon, S. Bhogadi, R. Wilson, S. Kinra, J. Marshall, and C. Tonne. 2017. Predictors of daily mobility of adults in peri-urban south India. *International Journal of Environmental Research and Public Health* 14 (7):783. doi: 10.3390/ijerph14070783.

Scully, J., A. Moudon, P. Hurvitz, A. Aggarwal, and A. Drewnowski. 2019. A time-based objective measure of exposure to the food environment. *International Journal of Environmental Research and Public Health* 16 (7):1180. doi: 10.3390/ijerph16071180.

Smith, G. C., and G. M. Sylvestre. 2001. Determinants of the travel behavior of the suburban elderly. *Growth and Change* 32 (3):395–412. doi: 10.1111/0017-4815.00165.

Smith, L., L. Foley, and J. Panter. 2019. Activity spaces in studies of the environment and physical activity: A review and synthesis of implications for causality. *Health & Place* 58:102113. doi: 10.1016/j.healthplace.2019.04.003.

Spatial Analysis of Urban Systems Lab. 2019. Itinerum-trip-breaker, GitHub repository. Accessed September 5, 2020. https://github.com/SAUSy-Lab/itinerum-trip-breaker.

Statistics Canada. 2017. Toronto [Census metropolitan area], Ontario and Ontario [Province] (table). Census Profile, 2016 Census. Ottawa, Canada, Statistics Canada, Catalogue No. 98-316-X2016001. Accessed November 16, 2020. https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CMACA&Code1=535&Geo2=PR&Code2=35&Data=Count&SearchText=Caledon%20East&SearchType=Begins&SearchPR=01&B1=All.

Statistics Canada. 2019a. General Social Survey—Time use (GSS). Accessed October 27, 2020. https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&Id=1268587.

Statistics Canada. 2019b. North American Industry Classification System (NAICS) Canada 2017 Version 3.0. Accessed March 25, 2019. https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=1181553&CVD=1181576&CPV=445&CST=01012017&CLV=2&MLV=5.

Story, M., K. M. Kaphingst, R. Robinson-O'Brien, and K. Glanz. 2008. Creating healthy food and eating environments: Policy and environmental approaches. *Annual Review of Public Health* 29 (1):253–72. doi: 10.1146/annurev.publhealth020907.090926.

Strazdins, L., J. Welsh, R. Korda, D. Broom, and F. Paolucci. 2016. Not all hours are equal: Could time be a social determinant of health? *Sociology of Health and Illness* 38 (1):21–42. doi: 10.1111/1467-9566.12300.

Strazdins, L., and B. Loughrey. 2007. Too busy: Why time is a health and environmental problem. *New South Wales Public Health Bulletin* 18 (12):219. doi: 10.1071/NB07029.

Ta, N., Z. Liu, and Y. Chai. 2019. Help whom and help what? Intergenerational co-residence and the gender differences in time use among dual-earner households in Beijing, China. *Urban Studies* 56 (10):2058–74. doi: 10.1177/0042098018787153.

Taillie, L. S. 2018. Who's cooking? Trends in U.S. home food preparation by gender, education, and race/ethnicity from 2003 to 2016. *Nutrition Journal* 17 (1):41. doi: 10.1186/s12937-018-0347-9.

Vance, C., and R. Iovanna. 2007. Gender and the automobile: Analysis of nonwork service trips. *Transportation Research Record: Journal of the Transportation Research Board* 2013 (1):54–61. doi: 10.3141/2013-08.
Venn, D., J. Dixon, C. Banwell, and L. Strazdins. 2018. Social determinants of household food expenditure in Australia: The role of education, income, geography and time. *Public Health Nutrition* 21 (5):902–11. doi: 10.1017/S1368980017003342.
Vogel, C., G. Ntani, H. Inskip, M. Barker, S. Cummins, C. Cooper, G. Moon, and J. Baird. 2016. Education and the relationship between supermarket environment and diet. *American Journal of Preventive Medicine* 51 (2):e27–34. doi: 10.1016/j.amepre.2016.02.030.
Welch, N., S. A. McNaughton, W. Hunter, C. Hume, and D. Crawford. 2009. Is the perception of time pressure a barrier to healthy eating and physical activity among women? *Public Health Nutrition* 12 (7):888–95. doi: 10.1017/S1368980008003066.
Widener, M. J. 2018. Activity space-based measures of the food environment and their relationships to food purchasing behaviours for young urban adults in Canada. *Public Health Nutrition* 21 (11):2103–16. doi: 10.1017/S1368980018000435.
Widener, M. J., S. Farber, T. Neutens, and M. Horner. 2015. Spatiotemporal accessibility to supermarkets using public transit: An interaction potential approach in Cincinnati, Ohio. *Journal of Transport Geography* 42:72–83. doi: 10.1016/j.jtrangeo.2014.11.004.
Williams, J., P. Scarborough, A. Matthews, G. Cowburn, C. Foster, N. Roberts, and M. Rayner. 2014. A systematic review of the influence of the retail food environment around schools on obesity-related outcomes. *Obesity Review* 15 (5):359–74. doi: 10.1111/obr.12142.
World Cancer Research Fund. 2018. *Diet, nutrition, physical activity and cancer: A global perspective*. Continuous Update Project Expert Report. https://www.wcrf.org/wp-content/uploads/2021/02/Summary-of-Third-Expert-Report-2018.pdf
Wright, J. D. 2015. *International encyclopedia of the social & behavioral sciences*. 2nd ed. Amsterdam: Elsevier.
Zenk, S. N., S. A. Matthews, A. N. Kraft, and K. K. Jones. 2018. How many days of Global Positioning System (GPS) monitoring do you need to measure activity space environments in health research? *Health and Place* 51:52–60. doi: 10.1016/j.healthplace.2018.02.004.
Zenk, S. N., A. J. Schulz, S. A. Matthews, A. Odoms-Young, J. Wilbur, L. Wegrzyn, K. Gibbs, C. Braunschweig, and C. Stokes. 2011. Activity space environment and dietary and physical activity behaviors: A pilot study. *Health & Place* 17 (5):1150–61. doi: 10.1016/j.healthplace.2011.05.001.

LINDSEY G. SMITH is a Postdoctoral Fellow in the Department of Geography and Planning at the University of Toronto–St. George, Toronto, ON M5S 3G3, Canada. E-mail: lindsey.smith@utoronto.ca. Her research focuses on food and physical activity environments and their relationships with health behaviors.

MICHAEL J. WIDENER is an Associate Professor and Canada Research Chair in Transportation and Health at the University of Toronto–St. George, Toronto, ON M5S 3G3, Canada. E-mail: michael.widener@utoronto.ca. His research interests include food environments, health geography, transportation, and cities.

BOCHU LIU is a PhD Candidate in the Department of Geography and Planning at the University of Toronto–St. George, Toronto, ON M5S 3G3, Canada. E-mail: bochu.liu@mail.utoronto.ca. His research interests include time geography and health geography.

STEVEN FARBER is an Associate Professor in the Department of Human Geography at the University of Toronto–Scarborough, Toronto, ON M1C 1A4, Canada. E-mail: steven.farber@utoronto.ca. His research interests include transportation and spatial analysis.

LEIA M. MINAKER is an Assistant Professor in the School of Planning at the University of Waterloo, Waterloo, ON N2L 2T1, Canada. E-mail: lminaker@uwaterloo.ca. Her research interests include environmental determinants of health, and public health and planning, in particular as they relate to food access and health behavior.

ZACHARY PATTERSON is Associate Professor at the Concordia Institute of Information Systems Engineering at Concordia University, Montreal, QC H3G 1M8, Canada. E-mail: zachary.patterson@concordia.ca. His research focuses on the use of emerging technologies in transportation data collection, GIS, artificial intelligence, and statistical analysis.

KRISTIAN LARSEN is a Research Scientist at CAREX Canada, Faculty of Health Sciences, Simon Fraser University, Vancouver, BC V6B 5K3, Canada and Sessional Lecturer in the Department of Geography and Planning, University of Toronto, Toronto, ON M5S 3G3, Canada. E-mail: kristian.larsen@utoronto.ca or kristian@carexcanada.ca. His research examines relationships between the environment and health with a focus on chronic disease prevention.

JASON GILLILAND is a Professor in the Department of Geography and Environment and Director of the Urban Development Program at Western University, London, ON N6A 5K6, Canada. E-mail: jgillila@uwo.ca. His research interests include children's geographies, food environments, and healthy cities.