Perceived Walkability, Social Support, Age, Native Language, and Vehicle Access as Correlates of Physical Activity: A Cross-Sectional Study of Low-Socioeconomic Status, Ethnic, Minority Women

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Background: The role of social-environmental factors in physical activity (PA) within lower income and ethnic minority populations is understudied. This study explored correlates of age-related PA and perceived walkability (PW).

Methods: Cross-sectional data (N = 401 women; ≥18 y) were collected within the Jane-Finch community in Toronto, Ontario using questionnaires. Generalized additive models, an extension to multiple regression, were used to estimate effect sizes and standard errors.

Results: Significant interactions between native language and car access (CA) were observed in PA variation across the lifespan. Individuals were evenly distributed across 4 comparison groups: 29.2% English-NoCA, 24.1% English-CA, 20.7% Non-English-NoCA, and 26.0% Non-English-CA. Risk of sedentariness increased with age for native English speakers > 50 years, but appears unaffected by age for other groups. English speakers without CA < 60 years appear least likely to be sedentary, followed by English speakers with CA. In general, an active individual at the 75th percentile of social support for exercise would have 1.62 (CI: 1.22–2.17) times the MET-Hours of PA than an active individual at the 25th percentile of SSE.

Conclusions: English language facility and car access moderate relationships of social-environmental factors and PA. Further investigation is required to better understand correlates of PA for women in this demographic.

Keywords: survey, neighborhood, exercise, epidemiology

Better understanding of physical activity in at-risk groups such as racialized, low-socioeconomic status (SES), new-immigrant populations is an important topic of current research. Increasing evidence indicates that the built environment (BE) influences ambulation and physical activity (PA).1–4 Highly ‘walkable’ neighborhoods have been shown to be supportive of decreased motor vehicle (MV) use and increased PA.5 However, it is unlikely that improvements in walkability alone will increase PA without some form of direct social support for exercise to encourage use of improved resources. Walkable environments and social support for exercise (SSE) are particularly relevant to those ethnic minority and newer immigrant groups observed to have a prevalence of PA lower than that of the general population.5,50 While lower PA prevalence may be offset by lower levels of obesity in newer immigrants on arrival in North America, as time passes, PA and obesity patterns shift until immigrant health behavior profiles approximate those of nonimmigrants.7,8 The consequent increase in health risk is important, given that inadequate chronic disease screening is more likely in immigrant and ethnic minority populations.9

While the benefits of at least moderate-intensity PA and the costs of inactivity have been intensively researched,10–14 major improvements in PA levels in North America have not occurred.15,16 Physical inactivity is of particular concern for Canadian women, as the most recent Canadian Community Health Survey (2008) revealed only 46.8% achieved moderate-to-high levels of leisure time PA (versus 54.5% of males). To better understand what factors contribute to an active lifestyle in women, multiple dimensions of community living in relation to PA must be analyzed. As Canada, like other developed nations, has a population that grows largely via immigration,17 immigrant females have progressively become a larger proportion of the total population. The need for research focused on the unique circumstances of urban low SES immigrants is highlighted by findings18 that revealed a 3-fold variation in lifestyle risk factors such as low PA across urban statistical areas, representing important deviations from broader state-level estimates. Given the associations between PA, obesity, type-2 diabetes, and other chronic diseases,16,19 the geographic and
demographic determinants of PA warrant investigation in demographically diverse populations.

Specifically, many PA and obesity-related risk factors and outcomes demonstrate spatial and socio-economic clustering. In high-immigrant, multiethnic, and low-SES population these factors coincide and represent an increased risk of physical inactivity, creating an excess but likely preventable disease burden that may in part relate to factors like built environment features and social support for exercise. To better understand the factors responsible for this clustering, this study examined variation in social-environmental correlates of PA in a low-socioeconomic status, high-immigrant female population in Toronto, Ontario.

**Methods**

**Participants**

This study focused on correlates of total PA in a multi-ethnic community with high proportions of recent immigrants, low-SES residents, and crime. The Jane-Finch community of Toronto has a population of ~52,000 in the Ward 8 area, over 36,000 of whom are above 18 years of age. The sampling goal of N = 360 represented ~2% of eligible women with English proficiency. The sample was stratified to reflect the proportional division of the community into high-rise residences (building > 5 stories) within a 1 km radius of the primary intersection (30%) vs. beyond (30%) and low-rise residents (building ≤ 4 stories) within 1 km of this intersection (20%) vs. beyond (20%). The 1 km radius was selected because most commercial centers, businesses, and bus routes converge within this proximity, and both this radius and building height categories were adapted from previous research. Outside this area, development is limited most commercial centers, businesses, and bus routes converge within this proximity, and both this radius and building height categories were adapted from previous research. A 1 km radius was selected because most commercial centers, businesses, and bus routes converge within this proximity, and both this radius and building height categories were adapted from previous research.

**Recruitment**

As the recruitment of low-SES minority populations presents significant challenges, participants were offered $30 gift certificates to a local grocery store as compensation for completion of the 20-minute survey. In each building, investigators knocked on doors and if a resident was home, explained the study and invited eligible residents to participate. If no one was home, an explanatory flyer was left. It contained information that enabled calls to a dedicated cell phone number for survey requests, which were responded to with hand-delivered surveys within 1 week. All surveys were returned to the study center by way of prestamped, preaddressed envelopes. The gift certificates were mailed to participants within 1 week of the receipt of a completed survey by investigators.

Each recruitment attempt was supported by a minimum of 1 repeat visit to the building to speak to residents who may have been missed. Detailed logs were maintained of residence units visited and the results of each contact (categorized as survey refused, survey accepted/in progress, survey completed, or ineligible). Reminder letters were sent on 2 separate occasions to residents who accepted but did not return surveys. To minimize the likelihood of fraud, contact information was checked against all previously returned surveys as they were received. When a survey matched a previously recorded address, it was scrutinized closely to ensure the participant’s name and responses were different. Three duplicate surveys were identified with the same names/information and were excluded. Data were actively collected from March to November 2008 and surveys were entered into the database until December 2008. A total of N = 401 valid surveys were included in final analyses. Ethics approval was obtained from the Research Ethics Board at York University, and written informed consent was collected as a part of the survey package.

**Measures**

PA was measured using the International Physical Activity Questionnaire—Short Form (IPAQ), a reliable instrument widely used with multiethnic populations for self-report of leisure and non-leisure-time PA. In past studies, additional social factors have been shown to predict PA: marital status has been found to be significantly associated with PA, as has engagement in social networking and social support. Car ownership/access was considered an important predictor variable, as well as possibly a more appropriate proxy measure of SES than education, as immigrants may have advanced degrees from their countries of origin that afford few opportunities in the Canadian context. Social support specific to exercise (PA), as measured using the Social Support for Exercise Scale was considered as a second predictor variable. Finally, perceptions of walkability, environmental characteristics, facilities, safety, and overall functionality were measured using the Neighborhood Environment Walkability Scale—Abbreviated (NEWS-A). Additional demographic and health variables (eg, age, native language, etc.) were assessed by questionnaire.

**Statistical Analysis**

Although the distribution of the IPAQ measure of PA was assessed as a continuous variable, a substantial proportion of respondents reported their PA values as 0 or close to 0, resulting in a bimodal distribution.
Accordingly, a 2-stage model was implemented which was similar to a 0-inflated or ‘hurdle’ model. In the first stage, all responses were classified as either insufficient to achieve PA-related health benefits (ie, sedentary) or sufficient PA to achieve health benefits (ie, active) using IPAQ Categorical PA scoring. The (logit-transformed) probability of being sedentary vs. active was then modeled as a function of the predictor variables. In the second stage, the log-transformed IPAQ continuous scores (in MET hours/week) of the active individuals (Moderate or higher on IPAQ Categorical score) were modeled as normally distributed, using the same predictor variables.

On the basis of previous literature, native language and car access have been shown to moderate the relationship between PA and other key variables. These may be seen as proxy variables for sociocultural integration or acculturation within communities such as the one sampled here. It follows that those whose first language is English may respond differently to car access than those whose first language is not English. We hypothesize that the less integrated or language acculturated (English as a secondary language) individuals with car access would be more likely to isolate themselves within vehicles than engage in direct community exposures via walking or cycling. As a result of this hypothesis, 4 categories were created: 1) car access/native English speaker, 2) car access/nonnative English speaker, 3) no-car access/native English speaker, and 4) no-car access/nonnative English speaker.

Generalized additive models (GAM) were used to allow the effect of age on PA to be represented in a complex nonlinear manner. GAMs are a more general form of multiple logistic regression, and in the first analysis log odds ratios for sedentariness were modeled as a linear combination of the predictor variables (social support for exercise, perceptions of walkability) and as a smoothly varying nonlinear function of age. As a result of car and language interaction hypotheses, all variables were interacted with each car access/language category. The second model, restricted to nonsedentary individuals, models the log-transformed IPAQ scores as normally distributed with the same predictor variables and a nonlinear age effect. Simulating an individual’s PA levels would consist therefore of first assigning a sedentary/active status according to the first model and subsequently, if the individual overcomes the ‘hurdle’ of sedentariness, assigning a PA value from the second model. Data management and descriptive analyses were conducted in SPSS 16. Final analyses were performed with the R statistical software (www.r-project.org), using the gam function in the mgcv package with the default options (penalized maximum likelihood estimation with the roughness penalty chosen with generalized cross validation). Statistical significance was set at an alpha <0.05.

Results

5.1 Participation

Attempts were made to contact residents in 1806 separate dwellings over the course of the study, with each dwelling visited by investigators in person on 2 or more occasions. Of the 1806 residences visited, 172 residences had occupants observed to be home who refused to answer or open the door and flyers were left at these residences. Nonetheless, residents in 1159 dwellings were successfully contacted. N = 170 dwellings were found to have no eligible residents; of these, 112 residences had no females, and another 58 residences had no females with adequate English proficiency. In total, 163 females who were otherwise eligible for inclusion refused participation. Overall, 899 surveys were distributed within 851 households. Of the 899 surveys distributed, 401 apparently valid surveys were received, yielding a return rate of 44.6%. The overall response rate was 37.8%, as 401 completed surveys were received from the 1062 eligible female residents contacted. Double entry and data verification was used to ensure accuracy for all surveys entered.

Descriptive Analysis of Independent Variables

Tables 1 and 2 describe characteristics of the sample. As the primary measure of walkability (Table 2), the NEWS-A score (500.8 ± 142.1) varied significantly by building category (Distal-High, Distal-Low, Proximal-High, Proximal-Low; F = 9.88, df = 3, P < .001), with higher scores (ie, greater walkability) in participants from proximal locations.

![Table 1](image-url)
Generalized Additive Model

Figure 1 shows the odds ratios for sedentariness as a function of age, stratified by native language and car access, as estimated by the first GAM. For nonnative English speakers without vehicle access, sedentariness increased with age at a consistent rate. However, for English speakers without vehicles, sedentariness decreased until middle age (approximately 45 years) after which sedentariness increased rapidly with progressing age. The equivalent groups with vehicle access (nonnative English speakers and native English speakers) had nonsignificant age effects \((P = .07\) and \(P = .10\), respectively). Those who were nonnative English speakers with no vehicle access also exhibited greater likelihood of inactivity over time at a modest but uniform \((P = .049)\) rate. No other group demonstrated the unusual preage-50 variation in PA likelihood observed in native English speakers with no vehicle access. The summary chart and Tables below present total N in each comparison group, followed by the specific results per interaction group.

Table 3 shows baseline probabilities as well as differences in the odds of inactivity for a participant at the 75th percentile of SSE/NEWS-A scores compared with another participant at the 25th percentile. In the generalized additive model, women with greater social support...
Figure 1 — Predicted log odds for being sedentary as a function of age (–) with 95% confidence intervals (—–), for combinations of individuals with and without car access, and native English speakers and nonnative English speakers.

for exercise were less likely to be sedentary, regardless of language or vehicle access; however, the significance level is marginal for English speakers without vehicles.

Figure 2 shows the variation in log MET-Hours per week with age for nonsedentary individuals, stratified by car/language groups. To accurately reflect the PA behaviors of those meeting the current recommendations for health, this continuous analysis does not include any participants who did not rank as at least moderately active on the IPAQ categorical PA scoring. Consistent with the dichotomous sedentariness model, the probability of low activity is complex, but associated with lower PA levels at higher ages for native English speakers without car access, while among those in this group who remain active in older age, a nonsignificant, inverse relationship between PA and age is observed.

Table 4 presents the mean PA per strata and the relative difference in weekly MET-Hours of PA between individuals within the 75th and 25th percentile of SSE/NEWS-A. SSE and NEWS-A were not associated with PA ($P > .10$ in several analyses) in all but the nonnative English/noncar access group, where a strong relationship between social support and total PA was observed ($P < .001$). With all other factors equal, a physically active individual at the 75th percentile of SSE would have 1.62 (CI: 1.22–2.17) times the MET-hours of physical activity than an active individual at the 25th percentile of SSE.

Discussion

There is little debate that lower SES immigrants, particularly visible minority immigrants, are often marginalized in health promotion programs and research. The demarginalizing process requires research addressing key health issues, like PA, walkability, and BE creation, in support of greater PA and healthier behavior. However,
Table 3  Estimated Probability of Sedentariness and Odds Ratios for 1 Standard Deviation Increases in SSE and NEWS, Based on Generalized Additive Model Analyses That Additionally Include Semiparametric Age Effects for Each Language-Vehicle Access Combination; the Baseline Probabilities of Sedentariness Refer to Individuals 40 Years of Age With Average SSE and NEWS Scores

<table>
<thead>
<tr>
<th>Group (N) (N = 377; 26 missing)</th>
<th>Vehicle access?</th>
<th>English as native language?</th>
<th>Probability</th>
<th>95% CI</th>
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<td>No</td>
<td>0.34</td>
<td>0.22, 0.47</td>
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<tr>
<td>2 (N = 110)</td>
<td>No</td>
<td>Yes</td>
<td>0.21</td>
<td>0.12, 0.33</td>
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<td>3 (N = 98)</td>
<td>Yes</td>
<td>No</td>
<td>0.36</td>
<td>0.25, 0.48</td>
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<td>4 (N = 91)</td>
<td>Yes</td>
<td>Yes</td>
<td>0.28</td>
<td>0.18, 0.41</td>
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<th>Group (N) (N = 377; 26 missing)</th>
<th>Vehicle access?</th>
<th>English as native language?</th>
<th>Odds Ratio</th>
<th>95% CI</th>
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<td>1 (N = 78)</td>
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<td>No</td>
<td>0.49</td>
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<td>Yes</td>
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<td>0.17, 1.00</td>
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<td>3 (N = 98)</td>
<td>Yes</td>
<td>No</td>
<td>0.37</td>
<td>0.18, 0.75</td>
<td>0.005</td>
</tr>
<tr>
<td>4 (N = 91)</td>
<td>Yes</td>
<td>Yes</td>
<td>0.27</td>
<td>0.09, 0.77</td>
<td>0.013</td>
</tr>
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</table>

such research involves challenges as low-SES, new immigrant populations do not participate in research as readily as affluent, nonminority populations. The added access difficulty makes it tempting for researchers to focus on more advantaged populations and avoid the challenges associated with attempts at overcoming these obstacles in disadvantaged groups.

In previous studies, modest but significant correlations were found between walkability measurements and health outcomes such as obesity and total physical activity. Large-scale analyses showed that residents in higher-walkability neighborhoods were more likely to be physically active and engage in more walking behavior. Few studies have specifically focused on the relationship between walkability and PA in low-SES, high-immigrant populations. One important observation derived from the analyses across study subgroups was the consistency of associations between Social Support for Exercise (SSE) and total PA. The estimated associations are in the hypothesized direction, with significant associations in the 2 groups with car access in terms of reducing sedentariness and in native English speakers without car access for increasing PA among nonsedentary subjects. This relationship warrants further investigation as social engagement strategies that emphasize SSE may prove important in increasing PA. Recent reviews have specifically identified the need for further research in low-SES/multiethnic/immigrant groups, particularly because the connection between walkability and actual ambulation requires further exploration in populations with limited MV access.

Our hypotheses suggested possible interactions between perceived walkability (PW), MV access, and native language (the latter as a proxy for greater vs. lesser sociocultural integration) on total PA. Vehicle access theoretically permits greater choice regarding active vs.
passive transportation. Conversely, with no alternatives to walking, environmental perceptions appear to be less influential. While in past studies, highly walkable neighborhoods were associated with increased walking behavior, such associations were not specifically analyzed in low-SES populations without MV access. Our study provides some insight into low SES individuals without MV access, due to a nearly even division of participants with respect to access (48.2% reported MV access, 47.1% reported no MV access, with 4.7% missing self reports). Further studies should specifically explore how women without MV access differ from women who have access, but choose not to use MV-based transport.

The associations between predictor and outcome variables appear complex. For example, before middle age, age was inversely associated with sedentariness in native English speakers without motor vehicle access. After middle age, a distinct reversal of the initial pattern was observed, resulting in the expected positive association between sedentariness and age, consistent with the expected pattern of PA decline at older ages in the general population.28,48 Other possible explanations for the observed relationships include 1) work-related PA decreases that might be associated with transitions to less active jobs, 2) women who decide to walk less because they feel more vulnerable or sensitive to neighborhood dangers, 3) age-related social isolation associated with fewer nonfunctional reasons to leave home and ambulate, and 4) decrease in overall PA, generally, due to transitions from adolescence, to postsecondary education, to workforce entry, time of first childbirth, and retirement.

**Figure 2** — Difference from baseline (age 40) of log IPAQ scores in MET-Hours as a function of age (–) with 95% confidence intervals (——), for combinations of individuals with and without car access, and native English speakers and nonnative English speakers.
Table 4  Estimated MET-Hours per Week for Baseline Individuals, Along With Proportional Change for a 1 Standard Deviation Increase in SSE and NEWS, for Each Car Access/Language Combination

<table>
<thead>
<tr>
<th>Group (N) (N = 377; 26 missing)</th>
<th>Vehicle access?</th>
<th>English as native language?</th>
<th>Estimate (lower, upper)</th>
<th>95% CI</th>
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<td>No</td>
<td>No</td>
<td>50.31 (38.38, 65.94)</td>
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<tr>
<td>2 (N = 110)</td>
<td>No</td>
<td>Yes</td>
<td>67.75 (54.29, 84.54)</td>
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<tr>
<td>3 (N = 98)</td>
<td>Yes</td>
<td>No</td>
<td>46.13 (36.02, 59.07)</td>
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<tr>
<td>4 (N = 91)</td>
<td>Yes</td>
<td>Yes</td>
<td>53.28 (41.75, 68.00)</td>
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SSE Scale (Proportional Change per 1 Standard Deviation increase)

<table>
<thead>
<tr>
<th>Group (N) (N = 377; 26 missing)</th>
<th>Vehicle access?</th>
<th>English as native language?</th>
<th>Proportional change in PA</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (N = 78)</td>
<td>No</td>
<td>No</td>
<td>1.21</td>
<td>0.87, 1.67</td>
<td>0.238</td>
</tr>
<tr>
<td>2 (N = 110)</td>
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<td>Yes</td>
<td>1.62</td>
<td>1.22, 2.17</td>
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<td>3 (N = 98)</td>
<td>Yes</td>
<td>No</td>
<td>1.19</td>
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<td>4 (N = 91)</td>
<td>Yes</td>
<td>Yes</td>
<td>1.20</td>
<td>0.84, 1.72</td>
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NEWS Scale (Proportional Change per 1 Standard Deviation increase)

<table>
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<th>Group (N) (N = 401; 26 missing)</th>
<th>Vehicle access?</th>
<th>English as native language?</th>
<th>Proportional change in PA</th>
<th>95% CI</th>
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</tr>
</thead>
<tbody>
<tr>
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<td>No</td>
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<td>0.78</td>
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<td>Yes</td>
<td>Yes</td>
<td>1.08</td>
<td>0.80, 1.47</td>
<td>0.589</td>
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It remains to be seen how PA levels and age may relate to work in and outside of the home, to childcare and to activities of daily living. Further research with validation of data through objective measures (eg, accelerometry or other activity monitoring) and improved questionnaire administration may improve interpretations and precision. For example, it is unclear whether persons in each MV/language group perceive their environment (and self-report PA) in similar ways. Previously, objective measures of walkability have been shown to have a high degree of similarity to subjective perceptions of the neighborhood, but it remains to be seen whether that finding will persist in low SES, high visible minority-immigrant groups, particularly in contexts where social-environmental forces invisible to GIS analyses are present.

Results from this pilot study revealed challenges that must be addressed in future research. One limitation is the use of snowball sampling, which accounted for approximately 35.2% of the sample. Recruited participants were encouraged to refer eligible family and friends to the study by providing them with investigator contact information—the coordinator verified their eligibility, and a survey was distributed to the individual. Participant characteristics in women who were recruited using the snowball and direct recruitment strategy were similar to directly sampled participants for some variables used, with statistically significant differences observed in lower levels of education and employment status (full time vs. other status) in the snowball-recruited participants. This suggests that the snowball sampling used resulted in improved representation of low-SES respondents and others within the target group, improving the representativeness of the sample to the community. The snowball sampling was justified by the need to recruit participants within a short time frame (ie, to avoid seasonal variability in PA), budget limitations, and the simultaneous goals of improving response rates and increasing trust and awareness of research activities within this community. An ideal sample would be larger and stratified geographically, and possibly more representative of the target population. However, participants recruited by direct vs. snowball approaches may in fact prove to have similar associations between PA, MV access and native language (the latter as a proxy for greater vs. lesser sociocultural integration). At the incentive levels used in this study, it appears likely that this is the case, considering the 84.6% survey acceptance rate observed. In future work and analyses, census data can also be used in the development of social-ecological models for larger communities and regions with similar characteristics. Despite these limitations, this study provides evidence that conducting large-scale survey based research within ethnic-minority, low SES communities is feasible, and demonstrates that with appropriate incentives, adequate participation levels are reached.
Another issue pertains to IPAQ self report measurement, as the IPAQ is known to produce elevated levels of self-reported PA when compared with population norms. This could be due to increased levels of nonleisure PA which are measured by the IPAQ but not fully captured in PA estimates from other Canadian surveillance data such as the Canadian Community Health Survey (CCHS). In the future, to achieve more precise self-report data, there should be comparisons with accelerometer measurement or other energy expenditure monitoring. It should be noted that this study found a 35% prevalence of inactivity among the women in our sample, significantly lower than the 60% to 70% inactivity prevalence for women Toronto-wide as reported in the 2010 Get Active Toronto Report on Physical Activity.50 However, those figures reflect only leisure-time PA (and are based on data from the 2007/2008 CCHS), and differences may be accounted for by work or transport-related PA in this population. Finally, because the study focused on new immigrant women of lower SES, it is challenging to obtain valid data for by work or transport-related PA in this population. Currently, because the study focused on new immigrant women of lower SES, it is challenging to obtain valid data using English-only questionnaires, despite use of translation services of the participants’ family and friends. From the identification of 43 unique languages in the sample represented here, it should be clear that it is not feasible to translate the survey into every relevant language but future studies should incorporate community representatives and/or family members as translators to increase the reach and validity of the measures used.

Conclusion

Perceived walkability is a potentially important determinant of activity for ethnic ‘minority’ women who have choices about whether to access a motor vehicle or walk. Social support for exercise appears to be an important determinant of PA in minority females, regardless of native language and MV access. Moreover, motor vehicle access and native language appear important moderators of the relationships between age, PA and perceptions of walkability in the built environment. Taken together, these results provide a better understanding of the interaction between environmental and behavioral factors that contribute to health inequities in high-risk neighborhoods in North America.

Acknowledgments

Graduate and undergraduate student volunteers Meysam Pirbaglou, Natasha Radhu, Crissa Guglietti, Daniel SantaMina, Michelle Athaide, and Noah Wayne all contributed to the completion of this project. Their support and hard work is much appreciated. We gratefully acknowledge the Ontario Ministry of Health Promotion (Communities in Action Fund) for their support of this research.

References