Interaction of Perceived Neighborhood Walkability and Self-Efficacy on Physical Activity

Andrew T. Kaczynski, Jennifer Robertson-Wilson, and Melissa Decloe

Objectives: Few social ecological studies have considered the joint effects of intrapersonal and environmental influences on physical activity. This study investigated the interaction of self-efficacy and perceived neighborhood walkability in predicting neighborhood-based physical activity and how this relationship varied by gender and body mass index. Methods: Data were derived from a cross-sectional investigation of environmental and psychosocial correlates of physical activity among adults (n = 585). Participants completed a detailed 7-day physical activity log booklet, along with a questionnaire that included measures of neighborhood walkability, self-efficacy, and several sociodemographic items. Factorial analysis of variance tests were used to examine the main effects of and interaction between walkability and self-efficacy. Results: In predicting neighborhood-based physical activity, significant interactions were observed between self-efficacy and neighborhood walkability for females (but not for males) and for overweight/obese participants (but not for healthy weight individuals). Women and overweight/obese individuals with low self-efficacy demonstrated substantially greater physical activity when living in a high walkable neighborhood. Conclusions: Physical activity research and promotion efforts should take into account both environmental and personal factors and the interrelationships between them that influence active living.

Keywords: built environment, active living, social ecological models

Physical activity can aid in addressing growing rates of chronic diseases and obesity, yet physical activity levels remain low in many countries. To enhance physical activity, social ecological models have frequently been adopted in acknowledgment of the complex factors that influence challenging health behaviors. Social ecological models propose a number of principles for understanding and improving health behavior, including the idea that multiple levels of factors—individual, interpersonal, environmental, policy—should be studied and targeted. In this paper, we focus on 2 well-documented correlates of physical activity at the individual and environmental levels—self-efficacy and neighborhood walkability.

Self-efficacy, which is defined as “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments” (p. 3), is likely the most widely studied individual-level correlate of physical activity. Self-efficacy is often hypothesized to be a strong influence on behavior because higher levels are related to a propensity to undertake more challenging tasks, to expend more effort in pursuit of goals, and to demonstrate greater resilience in the face of aversive stimuli. Indeed, numerous studies and reviews have reported self-efficacy to be strongly related to physical activity and exercise levels.

Neighborhood walkability “may be conceptualized as the extent to which characteristics of the built environment and land use may or may not be conducive to residents in the area walking for either leisure, exercise or recreation, to access services, or to travel to work” (p. 113). Interest in walkability and related concepts (eg, bikeability, smart growth) has increased dramatically in recent years as an increasing body of evidence has described the role of the built environment in facilitating or restricting the opportunities people have to be active. Several studies have reported that people living in more walkable neighborhoods engage in greater physical activity, especially for transportation.

Although there is growing recognition that factors at different levels influence physical activity and despite the fact that self-efficacy and walkability are 2 of the most studied individual and environmental correlates of physical activity, little to no research has examined the interrelationship of these constructs in influencing physical activity. Several studies have looked at numerous individual and environmental correlates concurrently, with various findings about the relative predictive ability of individual variables and each level of variables.
However, more research is needed to understand how personal and neighborhood factors work together or interact to influence active living. For example, Cerin and colleagues found that the relationship between self-reported leisure-time physical activity and perceived presence of outdoor physical activity facilities was moderated in that “presence of these facilities had a small positive effect on respondents with a below-average enjoyment and self-efficacy for vigorous leisure-time physical activity only” (p. 130). Further researching how personal and environmental variables act in concert to affect physical activity participation can help in identifying tailored interventions depending on the characteristics of an individual or his or her neighborhood.

In addition to looking at the potential interaction between self-efficacy and neighborhood walkability in predicting physical activity, it may be important to examine this relationship by gender and weight status. Research has shown that physical activity levels differ according to both gender and body mass index. Gender differences may also be observed when examining self-efficacy and adults’ perceptions of their neighborhood environment. Further, another study showed that weight classification impacted the strength of the association found between self-efficacy and physical activity. Thus, the purpose of this study was to investigate the interaction of self-efficacy and perceived neighborhood walkability in predicting neighborhood-based physical activity and how this relationship varies by participant gender and body mass index.

**Methods**

**Data Collection**

Data for this paper were derived from the Physical Activity in the Community Study, a cross-sectional investigation of environmental and psychosocial correlates of physical activity among adults in Waterloo, Ontario, Canada. The study was conducted in August and early September 2007 when temperatures varied minimally and were conducive to outdoor physical activity (average of 20°C or 68 degrees Fahrenheit). At the time of the study, the population of Waterloo was approximately 100,000 individuals, which, according to the 2001 Canadian census, included limited racial/ethnic diversity (13.5% minority background), relatively high median annual household incomes ($62,747), and high education levels (over 50% graduated college). According to the 2004 Canadian Community Health Survey, 62.3% of adults in the Kitchener census metropolitan area (that includes Waterloo and 2 other large cities) were classified as overweight or obese, which was not significantly different from the provincial or national averages.

Four neighborhoods in Waterloo (as designated by municipal planning boundaries) that were each approximately 1 square mile in size were selected for inclusion in the study. Neighborhoods were chosen based on their differing ages of construction and land use and street patterns. One that was largely developed in the first half of the 20th century encompassed the downtown area of the city and had substantially diverse land uses (eg, retail, residential, parkland, etc.), 2 others were mostly built between the 1950s and 1970s and were primarily residential with some significant commercial and retail activity on their fringes, while construction on the fourth neighborhood began in the 1990s and included only single-detached and semidetached housing at the time of the study with almost no retail locations within walking distance. According to the 2001 Canadian census, the median household income levels for the 4 neighborhoods ranged from $40,060 to $82,738 (Can $). Initially, 1000 households (250 per neighborhood) were randomly selected from property lists provided by the municipality and trained research assistants delivered study packages door-to-door to adults (18 years of age or older) in the selected homes. A total of 585 of the 960 packages that were originally distributed were returned for a response rate of 60.9%. The study was approved by the Office of Research Ethics at the University of Waterloo.

**Measures**

Participants completed a questionnaire addressing a variety of physical activity determinants as well as a detailed 7-day physical activity log booklet. As part of the questionnaire, participants reported their age, gender, and height and weight. Weight and height were used to calculate body mass index (BMI) via the standard formula for adults [weight (kg)/height(m)²]. Initially, 3 BMI categories within the overweight/obese classification were considered: 25–29.9, 30–34.9, and 35 and above. However, analysis of variance tests, controlling for relevant factors, showed that mean values for self-efficacy (F = 1.72, P = .18) and level of neighborhood physical activity (F = 1.24, P = .29) were not significantly different across participants in these 3 overweight/obese categories. Thus, the analyses reported herein that examine the interactions of interest according to weight status simply compare under or healthy weight individuals (BMI < 25) with all overweight/obese participants combined (BMI > 25).

Participants also completed the subscales of the abbreviated version of the Neighborhood Environment Walkability Scale (NEWS-A), which has demonstrated acceptable to high reliability and validity in previous studies. The items and dimensions of the NEWS-A (residential density, land use mix-diversity, land use mix-access, street connectivity, infrastructure and safety for walking/cycling, aesthetics, traffic hazards, and crime) were analyzed according to procedures described previously. Summary scores for each of the dimensions were standardized from −1 to +1 and summed to form an overall measure of neighborhood walkability.

Self-efficacy for physical activity was measured using an 11-item scale capturing one’s confidence to overcome barriers to being active, which has demonstrated strong
Participants rated each item on a 7-point scale ranging from ‘not at all confident’ (1) to ‘very confident’ (7) and the mean of the 11 items was calculated.

Finally, participants maintained a 7-day log booklet in which they recorded details about all physical activity episodes greater than 10 minutes in duration. Using detailed instructions, participants provided location descriptions for each episode in the form of open-ended text (e.g., street names, parks, etc.). These were subsequently manually coded as i) at home, ii) in the participant’s neighborhood (in whole or in part) based on the municipally-defined planning boundaries, or iii) in another location. A total of 5816 physical activity episodes were reported by participants in the study and only 101 (1.7%) contained location descriptions that were insufficient to accurately classify the episode into 1 of these 3 categories. For this analysis, only episodes that occurred within the participant’s neighborhood (in whole or in part) are examined here to increase conceptual correspondence with the walkability predictor variables. The outcome variable of weekly minutes of neighborhood-based physical activity was calculated by summing the duration of all episodes that occurred within these boundaries over the 7-day period.

Statistical Analyses

The measures of perceived neighborhood walkability and self-efficacy were each divided into high and low designations using the median value for each variable. A 2 × 2 factorial analysis of variance was used to examine the significance \((P < .05)\) of the main effects for both neighborhood walkability and self-efficacy and the presence of an interaction between walkability and self-efficacy in predicting neighborhood physical activity. As is reported below, these tests were conducted for the full sample of participants, for males and females independently, and for healthy weight and overweight/obese persons independently. All analyses controlled for the participant’s neighborhood of residence, age, gender, education level, and BMI (when these variables were not used to stratify the sample).

Results

As shown in Table 1, of the 585 respondents, the majority were female (55%), over the age of 40 (59%), married (77%), and college-educated (66%). After calculating BMI, the sample was evenly divided between those classified as being underweight or a healthy weight (BMI

<table>
<thead>
<tr>
<th>Characteristic</th>
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<tr>
<td>Gender</td>
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<td>48.1%</td>
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<td>Weekly minutes of neighborhood-based physical activity (mean, SD)</td>
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<td>37.6</td>
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<tr>
<td>Self-efficacy (median)</td>
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</tr>
<tr>
<td>Neighborhood walkability index (median)</td>
<td>-0.28</td>
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< 25), hereafter referred to simply as ‘healthy weight,’ and those classified as overweight or obese (BMI > 25). Participants’ median self-efficacy on the 7-point scale was 4.18 and the median standardized score on the neighborhood walkability index was –0.28. The mean weekly minutes of neighborhood-based physical activity was 111.2 (SD = 37.6).

Figures 1 through 3 graphically depict the relationship between perceived neighborhood walkability and self-efficacy in predicting neighborhood-based physical activity across the 5 different samples examined. The graphs also show the mean values for minutes of neighborhood physical activity for each of the 4 neighborhood walkability-self-efficacy groups within each subsample. When examining the full sample (Figure 1), the high neighborhood walkability/high self-efficacy group exhibited the highest level of physical activity, while the low neighborhood walkability/high self-efficacy and high neighborhood walkability/low self-efficacy groups reported similar amounts, and persons in the low neighborhood walkability/low self-efficacy group engaged in substantially lesser neighborhood PA than the other 3 groups. The factorial ANOVA results revealed significant main effects for both neighborhood walkability (F = 4.23, P = .04) and SE (F = 4.82, P = .03). However, the test of the interaction of neighborhood walkability and self-efficacy in the full sample was not significant (F = 1.27, P = .26). As can be seen in Figure 1, the difference in physical activity for persons with high self-efficacy living in low neighborhood walkability versus high neighborhood walkability areas was similar to that for low self-efficacy persons living in low neighborhood walkability versus high neighborhood walkability areas.

When examining the results by gender, divergent relationships were found for males and females. For males (Figure 2a), a significant main effect was observed for self-efficacy (F = 6.74, P = .01) but not for neighborhood walkability (F = 2.43, P = .12), and the test of the interaction among males was not significant (F = 77, P = .38). However, for females, the impact of neighborhood walkability appeared to be more dramatic (Figure 2b). The main effects for both neighborhood walkability (F = 7.16, P < .01) and self-efficacy (F = 5.21, P = .02) in predicting neighborhood physical activity were significant, and the test of the neighborhood walkability x self-efficacy interaction was also significant (F = 4.85, P = .03). Women with low self-efficacy and women with high self-efficacy living in high neighborhood walkability areas reported comparable levels of neighborhood activity, but in low neighborhood walkability areas, women with higher self-efficacy reported considerably more activity than women with low self-efficacy.

Finally, we conducted similar tests for participants who were a healthy weight and those who were overweight/obese. Among healthy weight individuals (Figure 3a), the main effects for both neighborhood walkability (F = 3.86, P = .05) and self-efficacy (F = 5.02, P = .03) were significant, but the test of the interaction was not (F = 1.76, P = .19). However, for overweight/obese persons, along with the significant main effects for both neighborhood walkability (F = 4.36, P = .04) and self-efficacy (F = 5.53, P = .02), a significant interaction

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**Figure 1** — Interaction of walkability and self-efficacy in predicting minutes per week of neighborhood physical activity among the full sample of participants, controlling for participant’s neighborhood of residence, age, gender, education level, and BMI (F = 1.27, P = .26).
Figure 2 — a) Interaction of walkability and self-efficacy in predicting minutes per week of neighborhood physical activity among males, controlling for participant’s neighborhood of residence, age, education level, and BMI ($F = 0.77, P = .38$). b) Interaction of walkability and self-efficacy in predicting minutes per week of neighborhood physical activity among females, controlling for participant’s neighborhood of residence, age, education level, and BMI ($F = 4.85, P = .03$).
Figure 3 — a) Interaction of walkability and self-efficacy in predicting minutes per week of neighborhood physical activity among healthy weight participants, controlling for participant’s neighborhood of residence, age, gender, and education level \( (F = 1.76, P = .19) \). b) Interaction of walkability and self-efficacy in predicting minutes per week of neighborhood physical activity among overweight/obese participants, controlling for participant’s neighborhood of residence, age, gender, and education level \( (F = 6.28, P = .01) \).
between neighborhood walkability and self-efficacy was observed ($F = 6.28, P = .01$). For overweight/obese individuals with high self-efficacy, there was little difference in PA between those living in low neighborhood walkability areas and those living in high neighborhood walkability areas. However, overweight/obese persons with low self-efficacy who lived in high neighborhood walkability areas had considerably higher activity levels compared with those with low self-efficacy living in low neighborhood walkability areas (Figure 3b).

**Discussion**

Self-efficacy and neighborhood walkability are concepts that have received substantial attention in the physical activity literature independently. However, little research has examined interrelationships between psychosocial and environmental variables, including the key constructs studied here. Therefore, the purpose of this study was to investigate the interaction between self-efficacy and perceived neighborhood walkability in predicting neighborhood-based physical activity.

In the overall sample, a statistically significant interaction between self-efficacy and neighborhood walkability was not observed. The main effects for both variables were significant, but the relationship of walkability with physical activity did not vary at different levels of self-efficacy. However, it is worthwhile to consider that people with high self-efficacy living in high walkable neighborhoods reported substantially greater neighborhood-based physical activity than the other groups of participants, thus supporting the cumulative impact of a multilevel approach to health promotion.$^4$ As well, participants with high self-efficacy living in low walkable areas or those with low self-efficacy living in high walkable areas reported a comparable amount of physical activity. Thus, for the former group, greater self-efficacy allowed them to overcome the constraints of living in an area less conducive to activity, while for the latter group, improved walkability close to home appeared to mitigate the effects of having low self-efficacy. Consequently, it may be important to improve at least 1 of these 2 factors to increase active behaviors, but also to understand the personal or environmental resources available to target groups and to take advantage of the assets available within each unique situation.

When stratified by gender, our data did not reveal a relationship between self-efficacy and neighborhood walkability for the male subgroup, but a statistically significant interaction was observed for females. More specifically, our findings suggested that among women with lower self-efficacy, there was a more of an advantage to living in a high walkable area, whereas for higher self-efficacy women, there was less of a difference between living in high versus low walkable areas. This is perhaps in part because women with higher self-efficacy are able to overcome the restrictions of living in a lower walkable area by finding and accessing opportunities to be active elsewhere or by extending greater effort to identify areas in their own neighborhood that are conducive to their physical activity. However, our data cannot speak to those explanations and future research would need to explore such issues further.

Nevertheless, other research underscores the importance of improving the activity-friendliness of areas with the fewest personal or environmental resources. For example, one study reported that as the number of available physical activity resources increased, women living in lower socioeconomic status areas demonstrated a greater increase in moderate-intensity activity compared with women in higher socioeconomic areas.$^{30}$ Of course, significant variations in other neighborhood features exist across socioeconomic strata, including real and perceived safety, that can influence women’s self-efficacy and deter or encourage physical activity.$^{19,41–44}$ Likewise, certain neighborhood elements may differentially benefit persons with lower self-efficacy who have more difficulty being active. For example, Cerin and colleagues found that the presence of nearby recreational facilities had an especially positive effect on persons with below average self-efficacy (although they did not report results disaggregated by gender).$^{23}$ Overall, additional research is needed to examine how self-efficacy and other psychosocial variables moderate environment-physical activity relationships and vice versa.

When our sample was stratified by body weight, no statistically significant interaction between self-efficacy and walkability was observed for healthy weight participants. However, for the overweight/obese group, a significant interaction was observed; among persons with low self-efficacy, those living in a high walkable area reported greater neighborhood physical activity than those living in low walkable areas, whereas the difference in walkability mattered less among overweight/obese participants who had higher self-efficacy. Thus, as was the case with gender, the relationship between self-efficacy and neighborhood walkability in influencing physical activity appears to differ according to body weight. A study by Blanchard and colleagues$^{29}$ also examined differences in neighborhood $\times$ self-efficacy interactions according to body weight, but with somewhat different findings. In their sample of adults, they found that as access to facilities in a neighborhood increased, physical activity participation was greater among people with higher as opposed to lower self-efficacy, and that this interaction was stronger for more obese persons. The different results between that study and ours may lie in the neighborhood variable examined. The Blanchard study looked at access to facilities and people with higher self-efficacy may have greater confidence to pursue the types of recreational, moderate to vigorous physical activity generally supported by such facilities. In contrast, our broader measure of neighborhood walkability may capture factors that are more influential for people with lower self-efficacy (eg, safety, aesthetics, nearby destinations, etc.). More research is needed to understand how
various neighborhood influences affect the active living behaviors of persons with diverse intrapersonal attributes.

Our study found similar relationships for women and overweight/obese participants in that persons from these groups with lower-efficacy seemed to benefit more from living in a higher walkable neighborhood than others with higher self-efficacy. This is perhaps not surprising given that both groups typically exhibit lower levels of physical activity and other research has shown that environmental features have a greater impact on the physical activity behavior of women and persons who are the least active. Future research should explore whether there are common mechanisms that explain the role of walkability in aiding persons with lower self-efficacy from different demographic groups.

Study Strengths and Limitations

The strengths of this study include the strong response rate and the fact that it is one of the first inquiries into how personal and environmental variables interact to influence physical activity. Moreover, we highlighted how this interaction differs for males and females and for healthy weight versus overweight/obese persons. That said, our sample as a whole was relatively well-educated and drawn from only 4 diverse neighborhoods, so future studies may wish to examine these issues within a broader population. As well, our cross-sectional design does not permit inferences about the causal implications for physical activity of a person with a certain level of self-efficacy or physical activity moving from one neighborhood to another. As well, all 3 of our key measures (self-efficacy, walkability, and neighborhood-based physical activity) were based on self-reported data. The relative value of objective versus perceived indicators of neighborhood walkability has not yet been established and our self-report log booklet permitted the collection of valuable contextual data about physical activity episodes, but future studies could explore these types of interactions using objective measures of key variables. Finally, we only examined such interactions between neighborhood walkability and self-efficacy according to weight status and gender. Future studies should consider similar analyses using a broader array of main effects and moderators.

Conclusion

This study highlighted a significant interaction between neighborhood walkability and self-efficacy and how, in particular, females and overweight/obese persons with low self-efficacy may exhibit greater levels of physical activity when living in high walkable areas. These findings would seem to support one of several hypotheses presented by Spence and Lee for the generation of more sophisticated social ecological physical activity models; namely, that “the influence of [personal] factors on physical activity are moderated by extra-individual factors such as physical ecology” (p. 17).

More practically, our findings ostensibly offer several suggestions for public health policy and practice. For starters, participants in our study who possessed both high self-efficacy and higher walkable neighborhoods demonstrated the greatest levels of physical activity. Such a result reinforces the fundamental premise of social ecological models that multiple levels of influence should be targeted when attempting to change complex health behaviors like physical inactivity. And indeed, public health professionals can play a role in affecting both personal and environmental resources. At the individual level, decades of experience with individual and group-based counseling and community-focused mass media campaigns can help in improving residents’ understanding of physical activity benefits, skills, strategies, and local resources. However, the sometimes ephemeral effects of such efforts suggest their effectiveness may be enhanced by more supportive environments. Thus, public health professionals can adopt an advocacy role in partnering with land use and transportation planners, parks and recreation professionals, and other municipal agencies to ensure the infrastructure to support physical activity is in place. Likewise, certain other efforts may indirectly benefit both self-efficacy and neighborhood perceptions, such as facilitating the development of neighborhood walking groups that can improve scheduling, social support, and safety, among other concerns that sometimes inhibit physical activity.

At the same time, our data would suggest that efforts to improve neighborhood walkability should focus on particular subpopulations, including women and more obese persons with low self-efficacy. Obviously, identifying segments of residents with low self-efficacy presents a challenge, but some markers may be available such as areas of low education or socioeconomic status. To that end, public health policies can disproportionately target walkability improvements—such as parks, sidewalks, lighting, aesthetic enhancements, and safe and practical destinations—to neighborhoods more likely to be deficient in self-efficacy. Such a compensatory equity strategy may be politically unpopular at times, but may be defensible in that such improvements appear to differentially benefit certain populations. Overall, our study suggests that physical activity promotion efforts should take into account both personal and environmental factors, and future research should explore the combined influence of other environmental (eg, green space) and personal (eg, attitudes toward physical activity) variables as well.

References

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