

Physical Activity Behavior Change in Middle-aged and Older Women: The Role of Barriers and of Environmental Characteristics

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Abstract The majority of North American women are insufficiently active. Using an ecological approach to examine physical activity behavior in a sample of middle-aged and older women, this study aimed to (1) describe barriers to physical activity behavior change as well as environmental characteristics present in their neighborhoods, (2) examine relationships between barriers and physical activity behavior change, and (3) investigate environmental characteristics that may contribute to physical activity behavior change. Participants were 149 women ranging in age between 39 and 68. At Time 1, self-reported physical activity was assessed. Six months later (Time 2), barriers and environmental characteristics were measured, and physical activity was re-assessed. The most prevalent barriers were daily activities and fatigue. Over time, inactive women reported higher levels of barriers (e.g. fatigue, lack of interest in physical activity) than women who remained active or increased their physical activity level. Certain environmental characteristics (e.g. enjoyable scenery, seeing others exercising in their neighborhood) are suggested as potential contributors to physical activity behavior change.

Keywords Physical activity · Behavior change · Socio-ecological perspective · Barriers · Physical environment · Middle-aged and older women

Introduction

Despite the numerous benefits of regular physical activity participation (Roberts and Barnard 2005; Elavsky and McAuley 2004), only approximately 15% of North American adult women meet physical activity recommendations (Canadian Fitness and Lifestyle Research Institute 2002; U.S. Department of Health and Human Services 1996). Unfortunately, lack of activity often translates into increased morbidity (Bauman 2004; Bhargava 2003) and, subsequently, increased health care costs (Katzmarzyk, Gledhill, and Shephard 2000). To address this issue, researchers have explored a multitude of variables potentially associated with physical activity and have attempted to use this information to inform intervention-based programs (Sallis and Owen 1999).

Physical Activity Barriers

One line of inquiry has examined physical activity *barriers*. Broadly defined, barriers refer to real or perceived individual, interpersonal, or contextual factors that prevent individuals from engaging in an activity or hinder their ability to do so (Sallis and Owen 1999). Among the most commonly reported barriers to women's physical activity are a lack of time, a lack of energy, fatigue, and health problems (Booth et al. 2002; Canadian Fitness and Lifestyle Research Institute 1996; King et al. 2000; Wilcox et al. 2000). What has been less studied is the prevalence of barriers in different age groups of adult women. Although there is evidence that some barriers are more commonly reported by older women (Booth et al. 1997; Chinn et al. 1999), additional research is needed, especially to inform age-specific physical activity interventions.

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Lacking time, fatigue, health problems, and a lack of social support have been inversely associated with physical activity (Booth et al. 1997, 2002; Chogahara et al. 1998; King et al. 2000; O'Brien Cousins 2003; Wilcox et al. 2000). Several studies have found relationships between barriers and physical activity; however, few have examined relationships between barriers and physical activity *behavior change* over time. In one of the few investigations in this area, perceived barriers—measured as a global construct—predicted a decrease in physical activity for women and men receiving a behavioral counseling intervention (Steptoe, Rink, and Kerry 2000). These results collectively suggest that barriers are not only associated with physical activity, but may hinder physical activity behavior change over time.

Environmental Correlates of Physical Activity

Another area that has been increasingly studied is the influence of environmental characteristics on physical activity behavior. Some of the most commonly reported facilitative environmental characteristics of middle-aged and older women are enjoyable scenery, frequently seeing others exercise, safe environments, social cohesion, and streetlights (Eyler et al. 2002; Fisher et al. 2004; King et al. 2000), whereas characteristics that seem to undermine their physical activity are costs, safety, heavy traffic, and a lack of programs or facilities (Craig et al. 2001; King et al. 2000). Other studies have demonstrated positive associations between the physical environment and walking to work (Craig et al. 2002). Despite this pattern of results, still other studies have not demonstrated relationships between environmental characteristics and physical activity (e.g. Salmon et al. 2003). Given these mixed findings, additional research is warranted, particularly in terms of the relationships between environmental characteristics and physical activity behavior change over time and in at-risk sub-populations such as middle-aged and older women. Indeed, many researchers (e.g. King et al. 2000; Spence and Lee 2003) have called for more research on the physical environment.

Purposes, Hypotheses and Contributions

Accordingly, the overall purpose of this study was to examine barriers and environmental characteristics in the context of women's physical activity behavior change. Specifically, the first purpose was to describe both barriers to physical activity behavior change in a community-based sample of middle-aged and older women and environmental characteristics present in their neighborhoods and to explore age group differences. It was expected that the

barriers of health problems would be more commonly reported by older women than by middle-aged women (Booth et al. 2002; De Bourdeaudhuij and Sallis 2002). The second purpose was to examine relationships over time between barriers, environmental characteristics and physical activity behavior change by correlating these variables and by comparing women who increased, decreased, or maintained their physical activity level over time.

This study used an ecological approach (Sallis and Owen 1999) to understand physical activity behavior change in middle-aged and older women. This framework describes influential factors at three levels: Intrapersonal, social environment, and the physical environment. Barriers are prevalent within all three levels of the ecological framework. In line with Caron et al.'s (2003) assertion that personal perceptions are a stronger determinant of behavior than the actual environment, subjective evaluation of environmental characteristics was sought in this study.

This study is important because relatively few investigations have examined barriers to physical activity behavior change and environmental characteristics in middle-aged and older women. As well, many studies have not reported barriers individually, nor that have examined the women by age group. Moreover, none to our knowledge have investigated relationships among specific barriers and change in physical activity behavior over time. Methodologically, the majority of studies have assessed barriers by asking participants to rate their reasons for not being physically active. In the current study, physical activity barriers and environmental characteristics were retrospectively assessed by asking women to rate the extent to which these variables were present over the past 6 months, in order to determine whether specific barriers and environmental characteristics were associated with change in physical activity over time. It was thought that taking this approach might lead to more accurate assessment of actual encountered barriers and environmental characteristics (over last 6 months) versus anticipated variables (over the next 6 months). Results of this study may inform interventions aimed at increasing middle-aged and older women's physical activity.

Methods

Study Design

This study employed a two-wave, longitudinal design. At Time 1, participants were administered a questionnaire assessing their current level of physical activity and a number of psychosocial variables. Six months later, at Time 2, a similar battery of measures was administered,

and physical activity was re-assessed. Participants were also asked about barriers they encountered over the past 6 months, as well as environmental characteristics present in their neighborhoods over that same time period. This design allowed for an examination of change in physical activity on a temporal basis. A six-month time interval was chosen based on previous work in this area (e.g. Prochaska et al. 1994). The time periods of October and May were chosen because they are similar with respect to Canadian climate normals (Environment Canada 2002).

Participants and Procedures

Participants were middle-aged and older women recruited from community centers (bridge & art classes), community health centers, fitness clubs, and professional women's groups in an urban center. Upon approval from the respective facilities, a total of 509 women were approached by trained researchers and invited to participate. Potential participants were informed about the study objectives and issues of confidentiality. They were given a baseline (Time 1) questionnaire package and asked to provide their contact information so that a six-month follow-up (Time 2) questionnaire could be sent via postal mail. All women provided written informed consent to participate in this study.

Two hundred and thirty-seven (46.6%) Time 1 questionnaires were returned. Eight (3.4%) failed to include either a signed consent form or return address, leaving 229 eligible participants at Time 1. The follow-up questionnaire package was sent to these 229 women at Time 2, and 178 (77.7%) questionnaires were completed and returned in the postage-paid envelope. Twenty-nine cases (16.3%) were subsequently omitted from the data set because of missing data or because women stated that they had no intention to increase their level of physical activity over the past 6 months and, as a result, could not complete the measures.

The final sample was comprised of 149 women, ranging in age from 39 to 68 years ($M = 51.76$, $SD = 6.69$). Twenty seven percent were from community centers, 11% from community health centers, 31% from fitness clubs and 31% were from professional women's groups. When categorized by age group, 23 women (15%) were younger than 45 years, 36 women (24%) were between 45 and 49 years, 39 women (26%) were between 50 and 54 years, 30 women (20%) were between 55 and 59 years, and 21 women (14%) were older than 60 years. The majority of women were of Caucasian descent (93%), married (66%), and had attended college or university (85%). More than half of the women (56%) reported a total annual revenue over \$75,000 CDN. Ethical approval for this investigation was obtained from the research ethics board of the University of Ottawa.

Measures

Physical Activity Behavior Change

To assess physical activity behavior change, the Community Health Activities Model Program for Seniors questionnaire (CHAMPS; Stewart et al. 2001) was administered at Time 1 and Time 2. This questionnaire was designed for older adults but has been used in other studies with younger (middle-aged) adults (Bennett et al. 2007). Participants were asked to think about and respond to questions about a typical week over the past month. They were presented with a comprehensive list of physical activities, including leisure-time activities, sports, and home-based activities, and asked to rate the frequency and duration of their involvement in each activity. For activities not included in this list, an "other" category was included. To arrive at an overall amount of physical activity, frequency was multiplied by duration (in hours) per activity. This total was multiplied by the estimated metabolic rate of energy expenditure (Ainsworth et al. 2000) to arrive at a per activity total energy expenditure. The same process was used for activities in the other category. After summing across activities, the total was multiplied by self-reported weight in kilograms, yielding a weight-corrected total energy expenditure in $\text{kcal kg}^{-1} \text{week}^{-1}$. The psychometric properties of this scale have been established by Stewart et al. (2001) and (Harada, Chiu, King, and Stewart 2001), with satisfactory test-retest, concurrent validity, and sensitivity to change.

A standardized residual change score was computed as one measure of physical activity behavior change. This was accomplished by regressing the 6 month (Time 2) total physical activity score on the baseline (Time 1) total physical activity score (see Cohen and Cohen 1983). Due to the standardization, this measure had a mean of 0 and a standard deviation of 1. Scores represent the degree of change from the mean change of the sample.

For the purposes of group comparisons, a second measure of physical activity behavior change was computed based on participants' attainment of a minimal total energy expenditure of $1,500 \text{ kcal week}^{-1}$ at Time 1 and Time 2. The criterion of $1,500 \text{ kcal week}^{-1}$ was founded on international physical activity guidelines (Health Canada and Canadian Society for Exercise Physiology 1998; U.S. Department of Health and Human Services 1996) and past physical activity research (Hambrecht et al. 1993). Participants who reported a minimal total energy expenditure of at least $1,500 \text{ kcal week}^{-1}$ were categorized as active, whereas participants expending less than $1,500 \text{ kcal week}^{-1}$ were categorized as inactive. Dichotomizing Time 1 and Time 2 total energy expenditure in this way resulted in the following four groups: *Stable inactive* (inactive at both

Time 1 and Time 2; $n = 16$), *regressed* (active at Time 1 and inactive at Time 2; $n = 14$), *progressed* (inactive at Time 1 and active at Time 2; $n = 22$), and *stable active* (active at both Time 1 and Time 2; $n = 97$).

Barriers to Physical Activity

Physical activity barriers were measured at Time 2 by asking participants, on a retrospective basis, their reasons for not doing more physical activity over the past 6 months. Items were based on those used in previously published studies (Booth et al. 2002; De Bourdeaudhuij and Sallis 2002; King et al. 2000; Salmon et al. 2003). All items were assessed on a 7-point Likert-type scale anchored by 1 (*strongly disagree*) and 7 (*strongly agree*). A total of fourteen items were used, including “Because my daily activities took the majority of my time,” “Because I didn’t like to exercise alone,” “Because I lacked confidence when it came to physical activity,” and “Because I was too tired.” Coefficient alpha (internal consistency) for this scale was .85.

Environmental Characteristics

Consistent with the work of Sallis et al. (1997), participants were presented with a list of 10 common environmental characteristics and asked to rate the extent to which each characteristic was present in their neighborhood over the past 6 months. Items were measured on a 7-point Likert-type scale ranging from 1 (*not at all present*) to 7 (*highly present*). Certain items were physical activity facilitating (e.g. sidewalks, street lights, other people exercising, enjoyable scenery, and walking trails), whereas others were physical activity hindering (e.g. heavy traffic, unattended dogs, and crime) (e.g. Eyster et al. 2002; Fisher et al. 2004; King et al. 2000). This and similar measures have been used in a number of recent studies of physical activity behavior of adults (King et al. 2000; Sallis, Johnson, Calfas, Caparosa, and Nichols 1997; Salmon et al. 2003) and have yielded satisfactory levels of validity and reliability. In our study, coefficient alpha was .73.

Statistical Analyses

All data were analyzed using SPSS, version 11. Descriptive statistics were used to summarize physical activity barriers and environmental characteristics for the entire sample and by age group. Differences among the different age groups were tested using χ^2 analyses. To examine bivariate associations among barriers and physical activity behavior change (residual difference score), Pearson correlations were computed. Multivariate analyses of variance (MANOVAs) were used to test for differences between

women who maintained (*stable active* and *stable inactive* groups), increased (*progressed* group), or decreased (*regressed* group) their level of physical activity over time and to protect the α -level as well as control for Type-1 error. Statistical significance was set at .05 for all univariate and multivariate analyses.

Results

Preliminary Analyses

Participants who dropped out of the study after completing the Time 1 questionnaire were compared to the final sample of participants ($n = 149$) using independent samples t -tests and χ^2 analyses. Participants who completed both questionnaires were more highly educated ($p < .05$) than participants who dropped out of the study between Time 1 and Time 2. No other significant differences were found. Any case with at least 10% missing data was excluded from the analyses. There were a small number of cases with less than 10% missing data, and these cases were individually inspected. There was no evidence of a pattern, indicating that the data were missing at random. Missing data were imputed with the mean. To assess the possibility that changes in physical activity were attributable to seasonal effects, weather data at Time 1 and Time 2 were obtained from Environment Canada (2002). Independent samples t -tests and χ^2 analyses did not reveal any differences in terms of the average daily temperature, average daily relative humidity, total daily precipitation, and the total number of rainy days, indicating that the weather at Time 1 and Time 2 was comparable. Finally, after categorizing women by age, analyses of variance (ANOVA) were used to compare these groups in terms of their total energy expenditure at Time 1 and Time 2. No significant differences were obtained.

Description of Physical Activity Barriers and Environmental Characteristics

The percentages of women reporting each barrier as the most or second-most important reason for not being more physically active over the past 6 months are presented in Table 1. The most commonly reported barriers for the entire sample were daily activities (39.6%), being too busy (31.5%), feeling too tired (20.1%), feeling too lazy (19.5%), experiencing health problems (14.8%), having difficulty managing time (14.7%), and not wanting to exercise alone (12.8%). Access to exercise/sport facilities and unsafe environments were endorsed by only 4.0% and 0.7% of the sample, respectively.

Table 1 Percentages of women reporting barriers to physical activity behavior change as most or second-most important

Physical activity barrier	Age group						χ^2
	Entire sample <i>n</i> = 149	<45 years <i>n</i> = 23	45–49 years <i>n</i> = 36	50–54 years <i>n</i> = 39	55–59 years <i>n</i> = 30	60+ years <i>n</i> = 21	
I didn't like to exercise alone	12.8	17.4	13.9	10.3	16.7	4.8	2.32
I didn't have access to an exercise/sport facility	4.0	4.3	2.8	2.6	6.7	4.8	0.94
I was too busy	31.5	47.8	36.1	38.5	16.7	14.3	10.01*
Health problems	14.8	13.0	16.7	15.4	10.0	19.0	1.02
My daily activities took the majority of my time	39.6	47.8	38.9	46.2	36.7	23.8	3.66
I didn't have enough money to exercise	6.7	13.0	0.0	10.3	10.0	0.0	6.87
I didn't have safe environments in which to engage in physical activity	0.7	4.3	0.0	0.0	0.0	0.0	5.51
I lacked confidence when it came to physical activity	4.7	4.3	8.3	2.6	3.3	4.8	1.59
I was not interested in physical activity	6.1	13.0	5.6	5.1	6.7	0.0	3.43
I didn't think physical activity would benefit me	1.4	4.3	2.8	0.0	0.0	0.0	3.35
I was too lazy	19.5	17.4	25.0	20.5	23.3	4.8	3.98
I felt uncomfortable about my body	8.1	8.7	5.6	15.4	6.7	0.0	5.06
I was too tired	20.1	26.1	25.0	25.6	16.7	0.0	7.29
I had difficulty managing my time	14.7	21.7	13.9	20.5	13.3	0.0	5.62

* $p < .05$

When the sample was categorized by age group, women over the age of 60 generally reported lower levels of physical activity barriers than women in all other age groups, especially in terms of being too tired ($ps < .05$). Of note, only 14.3% of women over 60 reported that being too busy was the most or second-most important barrier to being more physically active compared to 47.8% of women in the under 45 age group ($p < .05$). Women under the age of 45 and women between the ages of 50 and 54 similarly reported that being overly busy was a more important physical activity barrier than women between the ages of 55 and 59 ($ps < .05$). Proportionately, more women under the age of 45 and women between the ages of 50 and 54 identified having difficulty managing time as a more important barrier than women over the age of 60 ($ps < .05$). No woman over the age of 60 indicated that lacking an interest in physical activity or feeling uncomfortable about her body was an important barrier to physical activity. Conversely, over one quarter of women younger than 55 reported that being too tired was the most or second-most important barrier to doing more physical activity over the past 6 months. Health problems were most common in women older than 60 years.

With regard to environmental characteristics (Table 2), over half of women indicated that sidewalks, street lights, enjoyable scenery, seeing other people exercising, bicycle

paths, and walking trails were highly present in their neighborhoods. Crime, unattended dogs, hills, and heavy traffic were the least present environmental characteristics reported in this sample. When examined by age, women younger than 45 years reported a higher presence of heavy traffic than women in all other age groups ($ps < .05$), however, they reported a lower presence of walking trails than women in the age groups between 45 and 59 years ($ps < .05$).

Relationships among Barriers, Environmental Characteristics and Physical Activity Behavior Change

Correlations with physical activity behavior change (residual difference score) were modest. Specifically, physical activity behavior change was negatively associated with feeling too tired ($r(147) = -.21$, $p < .05$), whereas it was positively correlated with the presence of safe environments ($r(147) = .17$, $p < .05$) and enjoyable scenery ($r(147) = .19$, $p < .05$).

When the sample was subdivided into physical activity behavior change groups, overall, the majority of women (65.1%) were in the stable active group compared to the progressed (14.8%), stable inactive (10.7%), and regressed (9.4%) groups (Table 3). The greatest proportion of women in all age groups was in the stable active group, with the

Table 2 Percentage of women who reported each environmental characteristic as most or second-most present in their neighborhood

Environmental characteristic	Age group						χ^2
	Entire sample <i>n</i> = 149	<45 years <i>n</i> = 23	45–49 years <i>n</i> = 36	50–54 years <i>n</i> = 39	55–59 years <i>n</i> = 30	60+ years <i>n</i> = 21	
Sidewalks	56.4	52.2	58.3	56.4	56.7	57.1	0.23
Street lights	54.4	47.8	66.7	53.8	50.0	47.6	3.21
Enjoyable scenery	61.1	56.5	61.1	66.7	63.3	52.4	2.50
Frequently seeing people walking or exercising	50.0	43.5	52.8	56.4	66.7	52.4	3.05
Bicycle paths	50.4	30.4	52.8	56.4	60.0	42.9	5.90
Walking trails	50.3	26.1	55.6	61.5	56.7	38.1	9.50*
Hills	14.1	8.7	16.7	20.5	13.3	4.8	3.60
Heavy traffic	16.1	39.1	11.1	15.4	10.0	9.5	11.20*
Dogs that are unattended	8.1	13.0	0.0	10.3	13.3	4.8	5.62
High levels of crime	2.6	8.7	2.8	0.0	3.3	0.0	4.89

* $p < .05$ **Table 3** Percentage of women in each physical activity behavior change group for the entire sample and by age group

Physical activity group	Age group						χ^2
	Entire sample <i>n</i> = 149	<45 years <i>n</i> = 23	45–49 years <i>n</i> = 36	50–54 years <i>n</i> = 39	55–59 years <i>n</i> = 30	60+ years <i>n</i> = 21	
Stable inactive	10.7	13.0	19.4	5.1	6.7	9.5	4.81
Regressed	9.4	4.3	22.2	5.1	10.0	0.0	10.67*
Progressed	14.8	8.7	13.9	25.6	13.3	4.8	6.08
Stable active	65.1	73.9	44.4	64.1	70.0	85.7	11.81*

* $p < .05$

proportions ranging between 44.4% for women between the ages of 45 and 49 years, and 85.7% for women over the age of 60.

More women in the under 45, 55–59, and over 60 age groups were in the stable active group compared to women in the 45–49 age group ($ps < .05$). As well, a greater proportion of women between the ages of 45 and 49 were in the regressed group than women between the ages of 50 and 54 and over 60 years ($ps < .05$).

A multivariate comparison of the four physical activity behavior change groups (Table 4) revealed a significant overall effect for physical activity barriers, $F(14, 132) = 2.42$, $p < .001$, $\eta_p^2 = .20$ (see Table 4 for means and standard deviations). Significant differences were observed in terms of lack of interest $F(3, 145) = 8.49$, $p < .001$, $\eta_p^2 = .15$, feeling too lazy $F(3, 145) = 5.56$, $p < .001$, $\eta_p^2 = .10$, feeling too tired, $F(3, 145) = 9.34$, $p < .001$, $\eta_p^2 = .16$, and the expense associated with physical activity $F(3, 145) = 3.56$, $p < .05$, $\eta_p^2 = .07$. Women in the stable inactive group reported significantly lower interest in physical activity than women in either the

regressed ($p < .05$) or stable active ($p < .001$) groups. Women in the stable inactive group reported feeling significantly more lazy than women in the stable active group ($p < .01$), and significantly more tired than women in both the progressed ($p < .05$) and stable active ($p < .001$) groups. Women who regressed reported feeling more tired than women in the stable active group ($p < .01$). Moreover, women in the progressed group reported that physical activity expenses were a greater barrier than women in the stable active group ($p < .05$). A trend was observed for daily activities, $F(3, 145) = 2.58$, $p = .056$, $\eta_p^2 = .05$, with women in the stable inactive group reporting higher levels of this barrier than women in the stable active group. Finally, although no significant multivariate effect was found for environmental characteristics, $F(10, 136) = 1.37$, $p = .095$, $\eta_p^2 = .09$, a significant univariate effect was obtained for others exercising, $F(3, 145) = 5.43$, $p < .001$, $\eta_p^2 = .10$. Women in the progressed and stable active groups reported a significantly higher prevalence of others exercising in their neighborhood than women in the regressed group ($ps < .01$).

Table 4 Differences in barrier and environmental characteristics among physical activity behavior change groups

Variable	Physical activity behavior change group				Univariate ANOVA <i>F</i>
	Stable inactive <i>n</i> = 16 <i>M</i> (<i>SD</i>)	Regressed <i>n</i> = 14 <i>M</i> (<i>SD</i>)	Progressed <i>n</i> = 22 <i>M</i> (<i>SD</i>)	Stable active <i>n</i> = 97 <i>M</i> (<i>SD</i>)	
<i>Physical activity barriers^a</i>					
I didn't like to exercise alone	3.56 (2.25)	2.36 (1.91)	3.50 (1.97)	2.75 (1.87)	1.90
I didn't have access to an exercise/sport facility	2.31 (1.30)	2.21 (2.19)	1.68 (1.13)	1.88 (1.39)	.83
I was too busy	5.00 (2.03)	5.21 (1.58)	4.14 (1.88)	3.97 (2.06)	2.49
Health problems	3.69 (2.39)	2.43 (1.79)	2.55 (1.82)	2.61 (2.01)	1.48
My daily activities took the majority of my time	5.31 (1.78)	5.00 (1.41)	4.95 (1.96)	4.18 (2.00)	2.58
I didn't have enough money to exercise	2.38 (1.86)	1.36 (.93)	2.55 (2.15)	1.61 (1.31)	3.56*
I didn't have safe environments in which to engage in physical activity	1.50 (.82)	1.64 (1.28)	1.64 (1.29)	1.53 (1.05)	.11
I lacked confidence when it came to physical activity	2.81 (1.94)	2.14 (1.75)	2.32 (1.67)	1.82 (1.29)	2.49
I was not interested in physical activity	4.00 (2.00)	2.43 (1.79)	2.73 (1.86)	1.92 (1.41)	8.49***
I didn't think physical activity would benefit me	1.44 (.51)	1.14 (.36)	1.27 (.63)	1.39 (.97)	.46
I was too lazy	5.00 (2.00)	4.36 (2.44)	3.82 (2.08)	3.09 (1.86)	5.56***
I felt uncomfortable about my body	2.81 (2.10)	1.79 (1.63)	2.41 (1.74)	2.14 (1.62)	1.13
I was too tired	5.38 (1.36)	4.79 (.97)	3.55 (2.04)	3.10 (1.94)	9.34***
I had difficulty managing my time	4.00 (2.10)	3.29 (1.98)	3.64 (2.17)	2.88 (1.80)	2.21
<i>Environmental characteristics^b</i>					
Sidewalks	5.06 (2.17)	4.86 (2.68)	5.55 (2.02)	5.06 (2.25)	.35
Street lights	5.06 (2.26)	4.86 (2.18)	5.18 (2.28)	5.08 (2.00)	.07
Enjoyable scenery	4.88 (1.45)	5.00 (2.08)	5.50 (1.63)	5.71 (1.48)	1.90
Frequently seeing people walking or exercising	5.06 (1.44)	3.93 (1.54)	5.86 (1.42)	5.41 (1.48)	5.43***
Bicycle paths	5.00 (1.83)	5.00 (1.96)	4.23 (2.18)	4.81 (2.27)	.57
Walking trails	4.88 (1.93)	4.79 (1.81)	4.68 (2.12)	4.85 (2.20)	.04
Hills	3.00 (2.07)	3.36 (1.95)	3.82 (1.79)	2.97 (1.77)	1.38
Heavy traffic	3.88 (1.54)	4.00 (1.80)	3.59 (1.87)	3.67 (1.86)	.21
Dogs that are unattended	2.25 (1.39)	2.57 (1.65)	2.23 (1.77)	2.59 (1.65)	.44
High levels of crime	2.25 (1.13)	2.36 (1.78)	1.77 (.87)	2.02 (1.22)	.82

^a Overall MANOVA: $F(14, 132) = 2.42, p < .001, \eta_p^2 = .20$

^b Overall MANOVA: $F(10, 136) = 1.37, p = .095, \eta_p^2 = .09$

* $p < .05$, *** $p < .001$

Discussion

The current investigation is one of the few that have used an ecological framework to explore relationships among barriers and environmental characteristics and physical activity behavior change over time in a sample of middle-aged and older women. Our findings may be useful in guiding future research focused on promoting physical activity in older women.

Summary, Explanation and Implication of Findings

The most commonly reported barriers were daily activities, being too busy, feeling tired, feeling lazy, health problems, having difficulty managing time, and not wanting to exercise alone. These intrapersonal/social environmental barriers to physical activity are generally consistent with those identified in past research, especially daily activities and lacking time (Booth et al. 1997, 2002; Canadian

Fitness and Lifestyle Research Institute 1996; King et al. 2000; Wilcox et al. 2000). Of note, having difficulty managing time was identified as an important barrier in the current sample. Teaching time management skills may be one strategy for helping women become more physically active, especially for those who are very busy.

Older women reported lower levels of most physical activity barriers than women in all other age groups. This may be attributable, in part, to lifestyle changes, such as reduced care giving duties and/or retirement from full-time employment. In line with our hypothesis, older women, however, indicated that health problems were more of a physical activity barrier than younger women, and this finding concurs with past research (Booth et al. 1997, 2002; Canadian Fitness and Lifestyle Research Institute 1996; Chinn et al. 1999; De Bourdeaudhuij and Sallis 2002). From an applied perspective, these data suggest that developing a generic physical activity intervention may not be the most effective approach because it fails to address specific barriers that are most salient to different age groups of women. For instance, interventions aimed at older women should include activities that are sensitive to their health-related needs and abilities.

The current study examined relevant environmental characteristics of participants' neighborhoods with the aim of informing future studies of the potential contribution of those characteristics on physical activity behavior change. The high prevalence of sidewalks, streetlights, and frequently seeing others exercising reported in the current study were comparable to those reported by King et al. (2000). The presence of heavy traffic, unattended dogs, high levels of crime, and enjoyable scenery, however, were lower than those reported by King et al.; this may be attributable to the differences in socio-economic status and in geographic location. In the current sample, the prevalence of certain environmental characteristics varied with age. In particular, the presence of heavy traffic was highest in women younger than 45 years and lowest in women over the age of 60 years. Although speculative, it may be that, in the current study, younger women (i.e. those younger than 45 years) lived in more densely populated urban areas than older women.

From the vantage point of physical activity behavior change, women who maintained a level of physical inactivity reported feeling more lazy, more tired, and less interested in physical activity than women who increased or maintained their physical activity level. Women who remained physically inactive also reported that daily activities were more of a barrier than women who remained physically active. These results are in line with past studies of adult women demonstrating associations between barriers and physical activity (Booth et al. 1997, 2002; Cameron et al. 2002; King et al. 2000; Wilcox et al. 2000).

Furthermore, women who increased their physical activity over time reported the presence of others exercising more often than did women whose activity level did not increase. The presence of safe environments and enjoyable scenery were also positively related to change in physical activity over time. These findings are consistent with previous research that indicates the importance of safety and the social context (e.g. having others to exercise with, receiving support, and neighborhood social cohesion) (Chogahara et al. 1998; Craig et al. 2001; Fisher et al. 2004; O'Brien Cousins 2003).

What is unique about the present study is that it demonstrated relationships between barriers and physical activity behavior change on a temporal basis. Whereas past research has differentiated between active and inactive women, this investigation differentiated among groups of women who maintained, increased, or decreased their level of physical activity. A very limited number of longitudinal studies have shown that barriers are predictive of physical activity behavior change over a 12-month period (Steptoe et al. 2000). The current investigation provides insight into *specific* barriers associated with change in physical activity over time.

Interventions aimed at increasing physical activity in middle-aged and older women should address specific barriers. For example, interest in physical activity could be fostered by helping women identify physical activities that are enjoyable. Indeed, this would be expected to foster intrinsic motivation, a factor that has been consistently associated with physical activity (Frederick-Recascino 2002) and, more importantly, women's physical activity maintenance (Landry and Solomon 2004). Exercising with a partner/group in aesthetically pleasing settings and varying workouts could also increase interest in physical activity. Feelings of fatigue/laziness could be addressed by providing education about the importance of good sleep hygiene and adequate nutrition, as well as through the use of strategies such as positive self-talk and energizing imagery.

Limitations and Future Research

Several limitations should be considered when interpreting the current results. The generalizability of these findings should be made with caution, as this study only included women who intended to increase their physical activity level, most being well educated and of a high socio-economic status. These participants likely have increased motivation and greater access to participate in physical activity than the general population and this most likely impacted findings related to barriers as well as environment characteristics. The number of participants who fell into the "stable active" group was larger than the number of

participants in each of the other groups, which could also affect the accuracy of results.

Moreover, it is unclear how results extend to time frames longer than 6 months. Future studies would do well to recruit larger, more representative samples and to follow participants more frequently and/or over a longer period. This would allow for the use of more sophisticated statistical approaches to analyzing change, such as hierarchical linear modeling. In terms of barriers, it may be that attitudes and beliefs towards barriers are as important to physical activity participation as their perceived presence or absence (O'Brien Cousins 2003). Future studies could further explore variables associated with women's attitudes and beliefs towards physical activity barriers as well as the strategies used to surmount these barriers over time. With regards to environmental characteristics, it may be useful in future studies to add more objective data such as, geo-coded census and/or GIS data. Employing Latent Profile Analysis to determine if certain patterns of objective and/or subjective environmental characteristics are predictive of women who are stable active, progressed, regressed, or stable inactive would also be an interesting avenue.

Finally, another limitation is the retrospective assessment of barriers and environmental characteristics. As mentioned in the introduction, the authors felt that this approach would lead to more accurate assessments; however it might have introduced bias. What is suggested for future research is to measure both variables at each time-point, which could also allow for examination of change over time in these constructs and how these changes affect temporal change in physical activity behavior.

What is important to underscore is that interventions aimed solely at the individual may not be optimally effective in promoting physical activity behavior change. A growing number of recent studies have demonstrated that multilevel interventions (Sallis and Owen 2002) may be most effective in this regard (e.g. Bauman, Bellew, Owen, and Vita, 2001; Brownson et al. 2000; Fisher et al. 2004). The present investigation suggests that individual and social variables play an important role in physical activity behavior change, and point to the potential contribution of environmental variables. Specifically, for middle-aged and older women, this type of multilevel physical activity promotion approach could include increased spousal support for household chores, physician influence, increased physical activity opportunities in the workplace, and increased access to enjoyable and safe outdoor paths. Future research exploring the interplay between intrapersonal variables and physical environmental characteristics in influencing physical activity behavior change would further inform interventions geared toward promoting physical activity. Identifying key environmental elements that hinder or facilitate physical activity behavior change could

benefit urban planners and transportation researchers in their development of neighborhoods that are conducive to physical activity.

A growing number of investigations have shown that variables such as barrier self-efficacy, outcome expectations, and value expectancy (McAuley 1992; see also Sallis and Owen 1999) are important to overcoming physical activity barriers and, ultimately, becoming more active. Ideally, a more comprehensive investigation would include not only determinants of and barriers to physical activity behavior change, but a systematic examination of strategies that might facilitate or hinder women's ability to overcome these barriers. This could potentially shed light on strategies that are most salient to effect an increase in physical activity levels of middle-aged and older women.

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