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Community SES, Perceived Environment, and Physical Activity During Home-Based Cardiac Rehabilitation: Is There a Need to Consider the Urban vs. Rural Distinction?

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ABSTRACT *Physical activity (MVPA) levels during home-based cardiac rehabilitation (CR) remain problematic. Consequently, the present study examined the association between MVPA and urban vs. rural residential status and the perceived environment in patients attending home-based CR. A total of 280 patients completed a questionnaire assessing demographic, clinical, MVPA, and perceived environmental variables measured at baseline and 3 months later. Patient addresses were geocoded and linked to the 2006 Canadian census to establish the urban/rural distinction. Results showed that urban and rural patients had similar baseline MVPA and improvements in MVPA by 3 months. Several perceived environmental variables were significantly related to MVPA throughout home-based CR that were common and urban/rural-specific. Therefore, although there does not appear to be an urban vs. rural advantage in MVPA levels during home-based CR, there does appear to be environmental/MVPA-specific relationships specific to urban and rural patients that may warrant attention.*

KEYWORDS *Physical activity, Home-Based cardiac rehabilitation, Urban, Rural, Community SES, Perceived Environment*

INTRODUCTION

While home-based cardiac rehabilitation (CR) has numerous benefits (e.g., improved fitness and quality of life),[1,2] they only occur for patients who engage in moderate-to-vigorous physical activity (MVPA) during the program. Regrettably, a growing body of literature indicates that patients attending home-based CR programs do not adhere to their MVPA prescriptions.[2,3] Research in other CR contexts have attempted to explain MVPA levels via intrapersonal (e.g., self-efficacy) and interpersonal (e.g., social support) variables.[4] Although important, such studies

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ignored the potential impact of broader environmental MVPA correlates.[5] The question to ask, however, is which environmental variables should be considered in patients attending home-based CR? Given that a large proportion of these patients live in rural areas (e.g., up to 50% in our program), it is important to delineate whether there is an urban vs. rural MVPA advantage (i.e., urban MVPA > rural MVPA) similar to that shown in non-diseased populations.[6,7] However, when considering this relationship, previous research in non-diseased populations[8,9] would suggest the need to consider the community socioeconomic status (SES) that the patients live in given its positive association with MVPA. Therefore, it is important to discern whether the urban MVPA advantage exists (i.e., controlling for community SES) in home-based CR and whether this relationship is stable, particularly since MVPA levels have been shown to fluctuate during home-based CR.[3]

In the home-based CR context, it is also important to consider the patients' perceptions of their home and community environments. Research in non-diseased populations has shown that increased MVPA was significantly associated with having more pieces of home physical activity (PA) equipment[10,11] and various community characteristics such as reduced crime and access to walking paths.[12,13] Whether similar findings would emerge in a home-based CR population and whether the various perceived environment/MVPA relationships are similar for urban and rural patients remains unknown.

The present study's first purpose was to determine whether baseline and a change in MVPA (i.e., from baseline to 3 months) was the same for urban and rural home-based CR patients controlling for individual (e.g., gender, etc.) and community-level SES covariates. It was hypothesized that urban patients would engage in significantly more MVPA at baseline,[6] but that the change in MVPA would be the same for urban/rural patients. Second, we examined whether MVPA was significantly related to the patients' perceived home and community environments and whether they were moderated by the urban vs. rural distinction controlling for the same individual- and community-level SES covariates. It was hypothesized that the MVPA/perceived environmental variables would be significantly related to each other[12] and would be moderated by the urban/rural distinction.[6]

METHODS

The Home-Based CR Program

The 12-week INTER$_x$VENT[14] mentored health program required a cardiopulmonary exercise stress test and physician assessment after the patients' orientation meeting. Once completed, they met face-to-face (≈3 weeks from their initial orientation meeting) with their clinical mentor (i.e., a nurse) to conduct a risk factor assessment and receive a personalized action plan that included an MVPA prescription using results from the stress test and the Frequency–Intensity–Time formula. Patients were then provided an educational kit on various PA, nutrition, stress management, and prevention/health promotion topics that they were asked to read during the 12-week program. The patients' progress with their action plans were monitored via weekly phone calls from their mentors ($n=10$) in addition to discussing a given topic in their educational kits. At the end of the program, patients met face-to-face with their mentors to discuss their overall progress on various clinical outcomes (e.g., blood work and stress tests) and their action plans, after which their plans were finalized prior to discharge.

Participants

Detailed eligibility criteria, recruitment rates, and demographic characteristics have been published elsewhere.[3] Briefly, 280 participants completed a baseline questionnaire; however, ten participants were excluded from the current analysis due to the inability to classify the patients' addresses as urban vs. rural. Detailed information for the remaining 270 participants can be found in Table 1.

Procedure

At the initial hospital orientation meeting, which ranged from 1 to 3 months after hospital discharge, patients had the option to choose between a traditional center-based CR program or the home-based CR program. Patients who chose the home-based program were informed about the current study and those interested were asked to speak to the research coordinator from whom they received an information letter, consent form, and a more detailed explanation about the study. If interested, patients signed the consent form and received a questionnaire that included the theory and PA questions that they completed at home and brought back to their initial face-to-face session with their mentor. The PA questionnaire was mailed to the patients 2 weeks prior to their scheduled 3-month follow-up assessment at the

TABLE 1 Individual- and community-level demographics by patients living in urban and rural communities

Characteristic	Urban ($n=141$)		Rural ($n=129$)		Effect size
Individual level	%		%		Φ
Male	68.1		76.7		−0.10
>Grade 12	64.5		58.6		−0.06
Spring/summer (baseline)	46.1		46.2		−0.00
Myocardial infarction	30.9		35.7		−0.05
First cardiac event	70.0		70.5		−0.01
Has metabolic syndrome	46.1		43.4		−0.03
	Mean	SD	Mean	SD	*d*
Age	62.55	12.06	63.16	10.99	−0.05
BMI	30.37	5.28	30.05	5.00	0.06
Total # of comorbidities	0.71	0.80	0.79	0.81	−0.11
Community level					
SES—10 min[a]	−0.04	0.67	0.06	0.34	−0.19
SES—15 min[a]	−0.01	0.56	0.08	0.28	−0.18
SES—20 min[a, b]	−0.02	0.52	0.09	0.21	−0.27
MVPA (minutes per week)					
Baseline	78.62	113.12	98.86	132.75	−0.16
3 months	166.91	177.51	217.56	195.51	−0.25

% percentage, *SD* standard deviation, *BMI* body mass index, *MVPA* moderate-to-vigorous physical activity, Φ phi, Φ*=0.1 to 0.23* small effect, Φ*=0.24 to 0.36* medium effect, Φ*=≥0.37* large effect,[24] *D* Cohen's *d* effect size, $d=0.3$ small effect, $d=0.5$ medium effect, $d\geq0.8$ large effect[24]

[a]Socioeconomic status based on a 10-, 15-, and 20-min walks for urban patients and 10-, 15-, and 20-min drives for rural patients

[b]Rural SES was significantly higher than urban SES

hospital with their mentor, at which time the research coordinator obtained the questionnaire and provided the patients with funds to cover parking costs (i.e., $13.00). Ethical approval was obtained prior to study onset.

Measures

MVPA. A modified version of the Godin Leisure–Time Exercise Questionnaire[15,16] previously validated in heart disease patients was used.[3] Patients were asked, (a) "How many days in a typical week out of the past 3 months did you do moderate (e.g., fast walking, easy bicycling, easy swimming, and dancing) exercises for at least 10 minutes at a time?" _____days and (b) "On the days when you did moderate exercises, how much total time on average did you spend per day doing these moderate exercise(s)?" _____ minutes per day. The same two questions assessed the frequency and duration of vigorous (e.g., running and jogging) activities. The total minutes of MVPA was then calculated via the following formula: (moderate frequency × moderate duration) + (vigorous frequency × vigorous duration) at baseline and 3 months.

Individual-Level Correlates. Age, gender, years of education, body mass index, comorbidities (the presence or absence of diabetes, stroke, lung disease, arthritis, and cancer that were summed to obtain a total score), diagnosis, whether it was the patients' first cardiac event, whether or not they had metabolic syndrome, and season the questionnaire was completed were recorded.

Perceived Environment. The *home environment* was assessed via "What PA equipment, if any, do you own or will you have access to during the next 3 months?" using a yes/no response format (see full list in Table 2).[11] *Perceived community characteristics* were assessed using the self-administered environmental module from the *International Physical Activity Prevalence Study*.[17] Specifically, patients were asked to "Please circle the number (i.e., from 1 = strongly disagree to 4 = strongly agree) that best applies to your community during the next 3 months" (see Table 2 for a full list of items).

Urban/Rural Distinction. Patients' addresses were geocoded using the Ontario Road Network file[18] in ArcGIS 9.3, and patients living in census metropolitan areas (i.e., an urban core population ≥100,000) and census agglomerations (i.e., an urban core population between 10,000 and 99,999) were coded urban, and all remaining patients were coded rural.[19]

Community SES. To create the community SES variable, three steps were necessary. First, the SES variable was created for each dissemination area (DA; i.e., a small area composed of one or more neighboring blocks with a population of 400 to 700) using the 2006 census data and summing the z scores of net educational level (the proportion of people aged 15 and over without a high school certificate or diploma—the proportion of people aged 15 and over with a university degree or post-secondary diploma), the median income of all census families, and the proportion of unemployed (i.e., unemployed people aged 15 and over as a percentage of people aged 15 and over who were in the labor force).[20] In the second step, buffers around the patients' homes had to be created. In the case of urban patients, we created buffers that were equivalent to 10- (i.e., 800 m), 15- (i.e., 1,250 m), and 20-min (i.e., 1,667 m) walks based on a pace of 5 km/hr. To do so, we created 750, 1,200, and 1,617 m line-based buffers along the road network for each patient.[21] A 50-m simple buffer was then

TABLE 2 Descriptive statistics for home and neighborhood environmental characteristics by urban and rural communities at baseline and 3 months

Predictor	Baseline			3 months		
	Urban (%)	Rural (%)	ES Φ	Urban (%)	Rural (%)	ES Φ
Home environment						
Treadmill	44.7	44.2	−0.01	49.6	51.2	0.02
Stationary Bike	41.8	41.1	−0.01	44.7	42.6	−0.02
Outdoor Bike	49.6	53.5	0.04	48.9	50.4	0.02
Skis	27.7	31.0	0.04	29.8	27.1	−0.03
Skates	31.9	31.0	−0.01	32.6	33.3	0.01
Weights	41.8	35.7	−0.06	44.7	41.1	−0.04
Shoes	91.5	93.0	0.03	93.6	93.8	0.00
	$\overline{X}$ (SD)		*d*	$\overline{X}$ (SD)		*d*
Many shops, markets, etc.	2.31 (1.23)	2.12 (1.25)	0.15	2.37 (1.20)	2.05 (1.19)	0.27
Transit nearby	2.66 (1.39)	1.98 (1.35)	0.49	2.61 (1.37)	1.93 (1.34)	0.50
Sidewalks on most streets	2.58 (1.31)	2.47 (1.36)	0.08	2.57 (1.26)	2.38 (1.38)	0.14
Lanes, paths to cycle	2.64 (1.33)	2.40 (1.38)	0.18	2.72 (1.26)	2.49 (1.33)	0.18
Free or low-cost recreation facilities (e.g., parks and trails)	2.80 (1.21)	2.58 (1.30)	0.18	2.92 (1.09)	2.64 (1.23)	0.24
Crime makes it unsafe	1.70 (0.92)	1.53 (0.87)	0.19	1.72 (0.89)	1.54 (0.83)	0.21
Too much traffic	1.67 (0.87)	1.71 (1.00)	−0.04	1.72 (0.82)	1.65 (0.88)	0.08
See many people exercising	3.05 (0.97)	3.02 (1.02)	0.03	3.04 (0.88)	2.87 (0.98)	0.18
Interesting things to look at	3.00 (0.85)	3.02 (0.84)	−0.02	2.92 (0.85)	2.92 (0.92)	0.00

ES effect size, *%* percentage, $\overline{X}$ mean, *SD* standard deviation, Φ phi, $\Phi=0.1$ *to 0.23* small effect, $\Phi=0.24$ *to 0.36* medium effect, $\Phi=\geq 0.37$ large effect,[24] Cohen's *d* effect size, $d=0.3$ small effect, $d=0.5$ medium effect, $d\geq 0.8$ large effect[24]

constructed around this line-based buffer (i.e., 50 m on either side of the road) to create the final buffers. For rural patients, we chose to equate "time" in an attempt to standardize the buffers between urban and rural patients. Specifically, we created 10-, 15-, and 20-min line-based network buffers based on driving time. Once established, a simple 100 m buffer around this line was created for the final buffers. We chose 100 m for rural patients based on an analysis that showed the average distance from the patients' homes to the nearest street/highway was 68 m (range = 15 to 287 m). Finally, the third step used the DA boundary file from the 2006 Canadian census to identify the number of DAs within a given buffer and create a weight for each DA based on the proportion of the surface area it covered within the buffer (i.e., DA area weight = proportion of surface for DA_1 within the network buffer/total surface area for the network buffer + proportion of

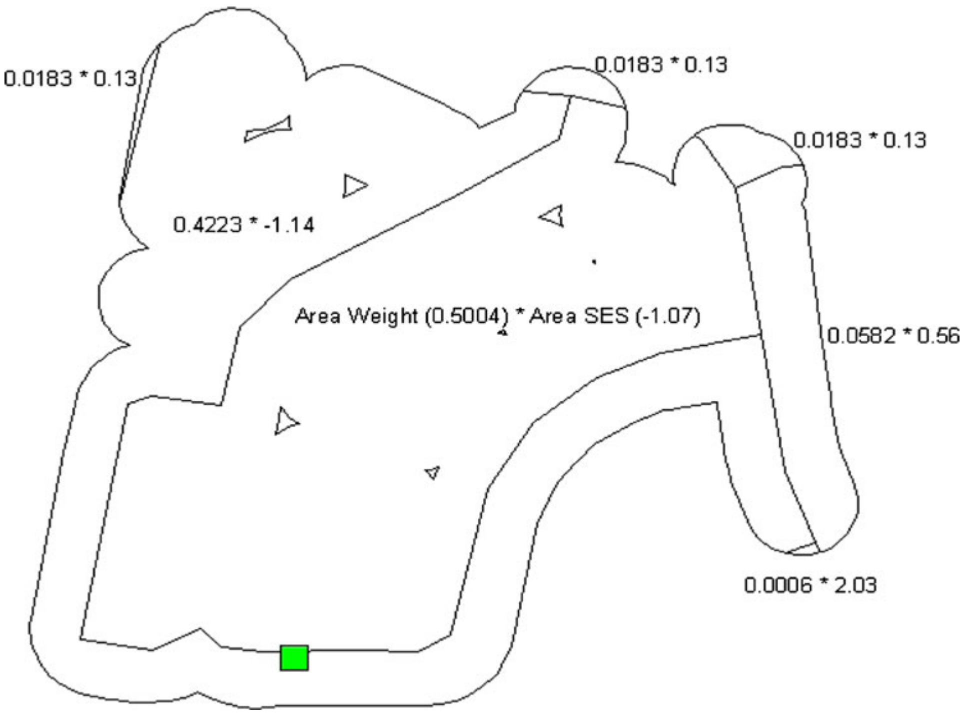

FIGURE 1. Weighted community socioeconomic status for an urban participant. The *green square* represents the patient's home. The *area weight* represents the proportion of surface area covered by a particular dissemination area within the network buffer that ranges from 0 to 1. Area socioeconomic status (*SES*) represents the SES at the DA level. The weighted community SES variable is then created via the following formula: sum of [area weight for each DA×SES for each DA].

surface for DA_2 within the network buffer/total surface area for the network buffer, etc.). Once the weights for each DA were established, they were multiplied by the SES variable associated with that particular DA and summed to establish the overall community SES for the network buffer for a given patient (see Figure 1).

DATA ANALYSIS

Descriptives were generated for the individual covariates, community SES buffers, and the home and community environmental correlates by urban/rural patients. Potential urban/rural differences were examined via χ^2 analyses and between-subject ANOVAs using SPSS 18.0. Next, given the nested nature of the data (i.e., repeated assessments at level 1 nested within the participants at level 2), regression analyses were performed using hierarchical linear modeling[22] (HLM 6.08). First, to determine whether significant variation existed across participants in baseline MPVA, MVPA was predicted by a linear trend (0=baseline; 1=3 months) with a fixed slope and random intercept (i.e., baseline MVPA) to calculate the conditional intra-class correlation coefficient (ICC). The second series of analyses added a given covariate at level 1 (e.g., season was treated as a time-varying covariate: 0=spring/summer; 1=fall/winter) or level 2 (e.g., age, body mass index, etc.) to determine its significance. Continuous level 2 covariates were grand-mean centered, whereas the categorical covariates were dichotomized. All significant covariates were then entered simultaneously into a model to identify the key ones to be controlled for in the main analyses. Once completed, the third analysis added the urban vs. rural (0 = urban; 1 = rural) variable at level 2 to predict the intercept (i.e., baseline MVPA) and the linear trend (i.e., the change in MVPA) at level 1 to address purpose #1. The fourth series of analyses addressed purpose #2. Specifically, a given perceived home or community-level variable was added to the aforementioned regression equation at level 1 as a time-varying covariate with a fixed slope. Then, an urban vs. rural variable was added at level 2 to predict the level 1 time-varying environmental variable (i.e., to determine whether the patients' perceived home and community environments/MVPA relationships were moderated by the urban vs. rural distinction). All interactions were followed up via separate analyses for urban and rural patients using the same covariates. All variables were standardized prior to conducting the HLM analyses.

RESULTS

Descriptive statistics are presented in Tables 1 and 2. In terms of Table 1, the χ^2 and ANOVA analyses showed that the individual-level covariates were similar between the urban and rural patients. However, rural patients had significantly higher SES for the 20-min buffer $F(1, 268) = 4.99$, $p = 0.03$, but not the 10- and 15-min buffers. For Table 2, ANOVAs showed that urban patients were more likely to agree that they had many shops within walking distance at 3 months $F(1, 268) = 4.82$, $p = 0.03$ and transit nearby at baseline $F(1, 268) = 16.55$, $p = 0.001$ and 3 months $F(1, 268) = 16.69$, $p = 0.001$.

In terms of the regression analyses, the first analysis produced an ICC of 0.35 confirming that significant variation existed in baseline MVPA across participants. Next, the covariate analyses showed that age, gender, total number of comorbidities, and community SES (20-min buffer) accounted for 28% of the variation in baseline MVPA across participants (see Table 3). Finally, with respect to purpose #1, results showed that urban and rural patients had similar baseline MVPA ($\beta = 0.09$) and changes in MVPA ($\beta = 0.04$) (see Table 3).

Regarding purpose #2, the results (see Table 4) showed that urban and rural patients engaged in significantly more MVPA if they reported having an outdoor bike ($\beta = 0.10$), skis ($\beta = 0.12$), skates ($\beta = 0.15$), weights ($\beta = 0.09$), and if they saw interesting things to look at in their communities ($\beta = 0.15$). Significant interactions were also present between MVPA and having sidewalks on most streets ($\gamma_{21} = 0.11$), several free or low-cost recreation facilities such as parks, trails, etc. to engage in MVPA ($\gamma_{21} = 0.11$), and seeing many people engaging in MVPA ($\gamma_{21} = 0.10$). Follow-up analyses showed that the MVPA/sidewalk relationship was negative for urban patients ($\beta = -0.10$, $p = 0.09$) and positive for rural patients ($\beta = 0.13$, $p = 0.06$), which was also the case for the MVPA/access to free or low-cost parks, trails, etc. relationship (urban $\beta = -0.07$, $p = 0.33$; rural $\beta = 0.15$, $p = 0.02$). Finally, the MVPA/seeing others in your community relationship was nonsignificant for urban patients ($\beta = 0.02$, $p = 0.68$), but significant for the rural patients ($\beta = 0.23$, $p = 0.00$).

DISCUSSION

The current study showed that baseline MVPA levels were the same for urban and rural patients, which is inconsistent with previous research.[6] However, this may be attributed to differences in geography (e.g., USA vs. Canada) and samples (e.g., non-

TABLE 3 Results from hierarchical linear modeling analyses examining the association between moderate-to-vigorous physical activity and the demographic/clinical covariates and the urban vs. rural distinction

Predictor	*β*	SE	*p* value
Regression # 1 (covariate model)			
Intercept—baseline MVPA			
Age	−0.11	0.04	0.01
Gender (0 = male)	−0.13	0.04	0.01
Body mass index	−0.08	0.05	0.10
Comorbidities	−0.15	0.04	0.00
First cardiac event (0 = no)	0.07	0.07	0.12
Have metabolic syndrome (0 = no)	−0.05	0.05	0.29
Community SES (20-min buffer)	0.19	0.09	0.03
Slope—change in MVPA			
Linear trend	0.30	0.03	0.00
Regression # 2 (urban vs. rural + covariates)			
Intercept			
Age	−0.11	0.04	0.01
Gender (0 = male)	−0.13	0.04	0.00
Comorbidities	−0.18	0.04	0.00
Community SES (20-min buffer)	0.19	0.09	0.02
Urban vs. rural (0 = urban)	0.09	0.04	0.05
Slopes			
Linear trend	0.30	0.03	0.00
Urban vs. rural	0.04	0.03	0.25

β standardized beta, *SE* standard error, *SES* socioeconomic status, *MVPA* moderate-to-vigorous physical activity

Regression #2

Level 1: MVPA = $\beta_{0j} + \beta_{1j}$ [linear trend] + r_{ij}

Level 2 $\beta_{0j} = \gamma_{00} + \gamma_{01}$ [age] + γ_{02} [gender] + γ_{03} [comorbidities] + γ_{04} [community SES] + γ_{05} [urban vs. rural] + u_0

$\beta_{1j} = \gamma_{10} + \gamma_{11}$ [urban vs. rural]

diseased vs. heart disease). More novel, however, is that the change in MVPA levels during home-based CR was the same for urban and rural patients. Coupling these findings may actually be interpreted positively because it suggests that patients are not at a disadvantage by living in a rural area when participating in a home-based CR program. Nonetheless, the novelty of these results warrants replication before any firm conclusions can be drawn.

Another novel finding is that higher community SES was significantly associated with higher baseline MVPA in urban and rural patients, which is consistent with previous research.[6,9,23] Of note, however, is that this relationship was only present when the 20-min walk (urban patient)/20-min drive (rural patient) SES buffer was analyzed. This emphasizes the importance of utilizing multiple buffers when examining the community SES/MVPA relationship in heart disease patients and needs replication in other physical activity contexts (e.g., center-based CR, patients who do not attend CR, etc.).

In terms of the perceived environment, the results showed that having an outdoor bike, skis (water or snow), skates (roller or ice), and weights in the home and interesting things to look at in the community was associated with

TABLE 4 Results from hierarchical linear modeling analyses examining the association between moderate-to-vigorous physical activity and the home and neighborhood environmental characteristics

Home environment	β_2	p value	γ_{21}	p value
Treadmill	−0.01	0.77	0.01	0.80
Stationary bike	0.08	0.06	0.01	0.77
Outdoor bike	0.10	0.03	−0.01	0.73
Skis	0.12	0.01	−0.01	0.66
Skates	0.15	0.00	−0.03	0.43
Weights	0.09	0.02	−0.03	0.47
Shoes	0.02	0.61	−0.01	0.83
Neighborhood				
Many shops, markets, etc.	0.07	0.17	0.09	0.06
Transit nearby	−0.02	0.58	0.02	0.64
Sidewalks on most streets	0.001	0.98	0.11	0.02
Lanes, paths to cycle	0.01	0.90	0.02	0.64
Free or low-cost recreation facilities	0.03	0.52	0.11	0.02
Crime makes it unsafe	0.03	0.52	−0.04	0.26
Too much traffic	−0.04	0.26	0.03	0.49
See many people exercising	0.11	0.01	0.10	0.01
Interesting things to look at	0.15	0.00	−0.02	0.46

B unstandardized beta, *SE* standard error, β standardized beta, *SES* socioeconomic status
Regression equation (combined sample testing urban vs. rural interaction)
Level 1: MVPA $\beta_0+\beta_1$ [linear trend] $+\beta_2$ [a given environmental variable: time-varying covariate] $+r_0$
Level 2 $\beta_{0j}=\gamma_{00}+\gamma_{01}$ [age] $+\gamma_{02}$ [gender] $+\gamma_{03}$ [comorbidities] $+\gamma_{04}$ [community SES] $+u_0$
$\beta_{1j}=\gamma_{10}$
$\beta_{2j}=\gamma_{20}+\gamma_{21}$ [urban vs. rural]

increased MVPA regardless of urban/rural status, which is consistent with previous research.[11,12] However, urban/rural differences emerged such that having increased access to free or low-cost recreation facilities (e.g., parks, walking trails, bike paths, recreations centers, and playgrounds) and seeing more people actively engaging in MVPA in their communities was significantly associated with MVPA for rural patients only. Hence, home-based CR programs may want to consider these potential urban-/rural-specific “targets” when they probe their patients concerning their environments. Nonetheless, it is important to point out that the current study focused on the perceived environment only and future studies will want to include subjective and objective measures[12] to further tease out the potential importance of the urban vs. rural distinction when it comes to examining the environment/MVPA relationship.

Limitations

First, we only examined the perception of the environment and future studies need to discern whether similar findings would emerge using objective measures. Second, MVPA was measured via self-report that may have led to an under- or overestimation of MVPA levels. Given that objective measures are becoming more inexpensive (e.g., pedometers), future studies should attempt to incorporate them into their designs. Third, the present study was designed to explain MVPA during home-based CR. Whether similar results would emerge after patients complete their home-based CR program will be important to delineate.

SUMMARY AND CONCLUSIONS

Patients living in urban and rural communities appear to have similar MVPA levels during home-based CR. Additionally, community SES is associated with baseline MVPA levels. However, various MVPA/perceived community characteristic relationships appear to be stronger for rural vs. urban patients that should be considered when counseling patients in this context. Nonetheless, the results from the current study are in their infancy and replication is warranted using different methodologies before any firm conclusions can be drawn.

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