Journal of Exercise Physiology online
(JEP online)

Volume 13 Number 6 December 2010

Official
Research Journal of
the American Society of
Exercise Physiologists
(ASEP)

ISSN 1097-9751

Exercise and Health

Rural Versus Urban Residence Mitigates the Effects of Telemedicine on Exercise Capacity

TIMOTHY MCCONNELL[1], SHARON LARSON[2], WILLIAM SANTAMORE[3], CAROL HOMKO[3], KELLY TREVINO[4], ABDUL KASHEM[3], ROBERT CROSS[3], ALFRED BOVE[3]

[1]Bloomsburg University, Bloomsburg, PA, [2]Geisinger Medical Center, Danville, PA, [3]Temple University, Philadelphia, PA, [4]VA Boston Healthcare System, Brockton, MA and Harvard Medical School, Department of Psychiatry, Boston, MA

ABSTRACT

McConnell TR, Larson SL, Santamore WP, Homko CJ, Trevino KM., Kashem A, Cross RC, Bove AA. Rural Versus Urban Residence Mitigates the Effects of Telemedicine on Exercise Capacity. **JEP**online 2010;13(6): 1-13. We hypothesized that telemedicine treatment would impact exercise capacity despite differences between rural versus urban groups, demographics, health locus of control (LOC), and cardiovascular (CV) risk knowledge. Male participants from rural north central Pennsylvania (N=254; age=62.5±9.6) and urban Philadelphia (N=211; age=57.9±10.1) were randomized to Telemedicine or In-person contact groups. Distance walked in 6-min were regressed on a rural-urban indicator, demographic characteristics, LOC, and CV risk knowledge. Rural residence and an Internal LOC made a significant positive contribution to 6-min walk distance ($p<0.05$), while Powerful Others LOC had an opposite effect at both study entry and study completion. Knowledge of CV risk was also significantly associated with 6-min walk distance at study completion ($p<0.05$). Telemedicine treatment was not significantly associated with an increase in distance walked ($p>0.05$) and did not alter associations with rurality, demographics and LOC. These findings support a recommendation that for behavioral strategies, such as telemedicine, to be effective, health care providers may need to first assess and formulate approaches that address group differences (such as place of residence and LOC) that may more strongly influence outcomes beyond what the behavior change strategy can alter. (Clinical Trials.gov Registration Number NCT00778804)

Key Words: 6-Minute Walk Test, Behavioral Change, Locus of Control, Medical Knowledge

INTRODUCTION

Telemedicine (electronic communication) provides a rapid and efficient means for communication between patient and health care provider, data exchange, and education Telemedicine was proven effective for reducing cardiovascular (CV) risk, promoting motivational readiness, changing physical activity behavior, and increased volume of moderate physical activity and walking minutes (4,19,22). Although promising, the magnitude of outcome change attributable to telemedicine, as well as other behavioral change strategies, may be mediated by other group differences such as demographic characteristics and the environment in which the persons reside. Even though effective for reducing overall CV risk, there were differences between the magnitude of change that telemedicine imposed on specific risk factors between rural versus urban groups (4,22). Therefore, it appears that when investigating the impact of telemedicine there may be differences between rural and urban populations that may alter outcomes and mitigate the effects of telemedicine.

For the current analysis, we were particularly interested in the impact of telemedicine on exercise capacity as measured by the 6-min walk test. Improving exercise capacity requires a personal commitment to changing daily lifestyle physical activity and exercise habits, which vary due to divergent personal, physiological, social, and environmental factors found in rural versus urban settings (2,5,7,11,21).

Therefore, this study is unique in that it investigates whether telemedicine impacts exercise capacity beyond the confounding influences of rural versus urban living. The information obtained will inform health care professionals that differences between rural and urban groups may override or confound the effectiveness of telemedicine treatment.

We hypothesize that telemedicine treatment will not be predictive of exercise capacity at study entry but will impact exercise capacity beyond place of residence and other group differences at the end of the study.

METHODS

The objective of the study was to determine whether telemedicine predicted exercise capacity beyond the rural and urban group differences, demographics, health locus of control (LOC), and CV risk knowledge.

Subjects

Four hundred sixty five subjects were recruited (Rural: N=254; age=62.5±9.6; men=141; Urban: N=211; age=57.9±10.1; men=114) to participate in a Pennsylvania Department of Health (RFA-ME02-380) funded protocol investigating telemedicine and the reduction in CV risk in rural (north central PA) and urban (intercity Philadelphia, PA) medically underserved populations (4). Study eligibility included a Framingham 10-year CVD risk score of >10% (28) and treatable risk factors that if properly managed would reduce the risk score by 5% or greater from baseline values. The Framingham Risk Score is a tool for estimating the 10-year risk of developing hard coronary heart disease (myocardial infarction and coronary death). The score is based on the individual's age, gender, total cholesterol, HDL cholesterol, smoking habits, systolic blood pressure, and whether the individual is taking blood pressure medications.

Inclusion Criteria

The age range for inclusion was 25 to 80 years. All participants were required to be able to read and speak English and have telephone access. After review of the participant's eligibility for the study, the

study rationale and procedures were explained and written informed consent to participate, approved by the Medical Center's Institutional Review Board, was obtained from each participant.

Exclusion Criteria

Participants were excluded if physical assessment or history revealed overt CV disease, New York Heart Association Class 3 or 4 heart failure, severe angina, cognitive deficits from stroke or dementia, end stage renal disease on dialysis, residence in nursing homes or boarding homes, or if unable to use a scale or digital sphygmomanometer at home. Additional exclusions included pregnancy, or an inability to use the internet.

Study Design and Sample Size

Data for this current study were extracted from a Pennsylvania Department of Health (RFA–MEO2-380) funded protocol investigating the reduction in CV risk attributable to telemedicine in medically underserved rural and urban populations (4). For the main study, a block randomization was done to assure that an equal number of men and women were recruited into the urban and rural groups and assigned to the Telemedicine and Controls groups. The primary endpoint for the main study was a 5% reduction in the 10-year CV risk score obtained at study entry. It was expected that at least 37.5% of the participants in the Telemedicine group would achieve a 5% or greater reduction in their 10 year CV risk as compared to approximately 25% of the participants in the usual standard of care group (Controls). Based on this between group proportional differences, the study was powered to provide an alpha of 0.05, and a beta of 0.80. Between group differences were considered significant at $P < 0.05$ using a chi square analysis.

Medical Screening

At study entry (Time 1), all participants (Treatment and Control) had a medical history, physical examination, electrocardiogram, blood studies and urinalysis. In addition, all participants underwent a formal assessment of CV risk (Framingham Score), a 6-min walk for the evaluation of exercise capacity, and each participant completed a Multidimensional Health Locus of Control Scale (LOC) (25) and a CV risk knowledge written questionnaire (9). Both the control and treatment groups were followed every 4 months (4,8,12 months) where all the above evaluations were completed. For purposes of the current substudy we were only interested in outcomes at the beginning (Time 1) and end (Time 2) of the study.

Usual Care

Both the Treatment and the Control groups received usual care that included routine management by the participant's primary care provider and advice on management of high risk life style, need for exercise, opportunities to participate in a smoking cessation program, referral to an endocrinologist for management of glucose intolerance, and advice on weight reduction, physical activity, and dietary change.

Treatment Participants

Additionally, each participant in the Treatment Group was instructed on the details of the internet telemedicine program and introduced to the Insight Telehealth Website on a demonstration terminal. The Telemedicine system (InSight Telehealth Systems, Valley Forge, PA) is a disease-management interactive health surveillance system comprised of a secure Internet server and a database. Details of the Telemedicine system have been described in previous publications (9,12). The participants were provided with a password and login name to gain access to the secure web site. Each participant made practice entries with coaching by a research assistant. Throughout the study, all treatment group participants were required to record and transmit weight and blood pressure on a twice per week frequency using the internet telemedicine system. Each participant received an email

and telephone call as a reminder to transmit this information. In addition, when the information was sent, the participant received an electronic reply message confirming that their data were received.

Control Participants

The control group received usual care as described, but did not have access to the telemedicine website for reporting data and receiving information from research personnel.

Procedures

6-min Walk Distance

The dependent variable, exercise capacity, was measured by the 6-min walk test (17). The 6-min walk was performed on a measured course in a low-pedestrian traffic area in the hallways and corridors of the hospital. Participants were instructed to walk the course and cover as much distance possible, and that they could stop and rest as many times as needed. A research staff member was in visual contact with the participant throughout the 6-min walk. The score was the total distance walked during the 6-min time period and was recorded in meters (m). Test instructions given to the patients were in accordance with the protocol of the American Thoracic Society (1).

Health Locus of Control

The Multidimensional Health Locus of Control Scale (LOC) (25) is a questionnaire designed to measure beliefs about the basis of a person's health. Each item is a belief statement with which the participant may agree or disagree rated on a scale from 1 = strongly disagree to 6 = strongly agree. The final score is the average of the response from 1 to 6 for each question. Wallston et al. (25) developed the 3-component scale (Internal, Powerful Others, Chance) and found the scale to have good internal consistency (alpha reliabilities = 0.83 to 0.86). Participants were instructed that the scale is a measure of their personal beliefs with no right or wrong answer. LOC questions and results were categorized into three categories: 1) Internal Control (participant feels that they themselves are responsible for their health and health care and whether they get sick or not is a function of their behavior); 2) Powerful Others (others, such as family, friends, and healthcare providers, have a major role in the participants health and health care); and 3) Chance (getting sick or recovering from disease is attributed to chance and is out of the control of the participant and others). A research assistant was available to assist with any questions or difficulties participants had related to the questionnaires.

Knowledge of CVD Risk

Knowledge was assessed using a questionnaire developed for the current study and validated using the Cronbach alpha calculation with alpha = 0.72 (9). The Knowledge Questionnaire contained 4 or 5 multiple choice questions in each of the following content areas: cholesterol, diet, diabetes, exercise, smoking, nutrition, and blood pressure. The questions were formatted for each content area so that at least one question required participants to identify recommended targets or goals for each risk factor, one question targeted desirable life style or behavioral changes necessary to reduce risk, and one question required participants to recognize other associated risks, for example, that hypertension is associated with an increased risk of stroke, heart attack, and kidney problems. Scoring was additive and calculated for each section. In addition, a total knowledge score was calculated as a percentage of all correct answers.

Statistical Analyses

Bivariate analyses (Chi-Square and Mann-Whitney Rank Sum Test) were performed to compare demographics, 6-min walk distances, LOC and knowledge of CV risk between the rural and urban residents and again for the Telemedicine Treatment versus the Control group (SigmaStat 3.1, Systat Software, Inc., Point Richmond, CA). Ordinary least squares (OLS) regression models with

interactions and two-stage least squares regression were developed. Stepwise modeling, with the dependent variable 6-min distance walked at Time 1 (study entry) and again at Time 2 (study completion), was performed with the specific aim of answering the following questions.

- Is rural versus urban residence an independent predictor of exercise capacity (Model 1)?
- Do demographics improve the predictability of exercise capacity beyond that attributed to rural versus urban alone (Model 2)?
- Does LOC (Model 3) and knowledge of CV risk (Model 4) contribute to the predictability of exercise capacity beyond Models 1 and 2?
- And, finally, does telemedicine treatment impact exercise capacity beyond the other contributing independent variables (Model 5)?

RESULTS

Group Characteristics

A bivariate comparison of the two subpopulations, urban and rural (Table 1), found no significant differences with respect to percent male, body mass index, or Internal LOC. Rural residents were somewhat older [Median = 62.0 (Interquartile 56.0–70.0) versus 57.0 (50.0–65.0)] and the

Table 1. Characteristics of Urban and Rural populations at study entry (Time 1) [Median (Interquartile 25% to 75%)]

	Urban *n* = 211	Rural *n* = 254	*T* (*p*)
Men (%)	54	56	?^{2} = 0.51 (0.82)
Median Age (years)	57.0 (50.0-65.0)	62.0 (56.0-70.0)	41787 (0.001)
Body Mass Index	31.4 (27.0-36.3)	30.7 (27.3-35.0)	49902 (0.61)
Race/Ethnicity	13% -white 79% - black 8% - other	99% - white 1% - black 1% - other	?^{2} = 355 (0.001)
Income: Less than $15K	51%	4%	?^{2} = 142 (0.001)
Income: $15K-$25K	17%	20%	
Income: $25K-35K	15%	30%	
Income: $35K-45K	4%	21%	
Income: $45K-55K	5%	14%	
Income: $55K or more	8%	10%	
LOC: Internal (average score from responses 1 to 6)	4.5 (4.0-5.2)	4.7 (4.2-5.2)	46863 (0.26)
LOC: Powerful Others (average score from responses 1 to 6)	3.7 (3.0-4.3)	3.2 (2.7-3.8)	55638 (0.01)
LOC: Chance (average score from responses 1 to 6)	2.7 (1.8-3.4)	2.3 (1.8-2.8)	53437 (0.001)
Knowledge: Total Score (% of correct answers)	58.6 (48.3-65.5)	72.4 (62.1-79.3)	34222 (0.001)
6-min Walk (M): Time 1 (*n* = 458)	439 (361-491)	490 (445-535)	38448 (0.001)
6-min Walk (M): Time 2 (*n* = 370)	445 (388-535)	490 (401-535)	29877 (0.048)

race/ethnicity distribution was significantly different (?^{2} = 355, $p < 0.001$) between groups, such that 99% of the rural population was white and 79% of the urban population was black. Rural residents were less likely than urban residents to report income at less than $15,000 per year and more likely to report income in categories above $25,000 per year (?^{2} = 142, $p < 0.001$). Rural residents scored significantly lower on the Chance LOC (T = 53437, $p < 0.001$) and Powerful Others LOC (T=55638; $p < 0.01$) subscale. There were no significant differences between rural and urban residents for Internal

LOC (T = 46863, p = 0.26). Regarding knowledge of CV risk, the rural group scored significantly greater (T = 34222, p < 0.0001).

Regarding the Telemedicine Treatment group versus the Control Group (Table 2), there was a greater percentage of men in the Treatment group (54%) compared to controls (45%) ($?^2$ = 4.0, p < 0.05). The Treatment Group was more likely to report incomes between $25,000 to $34,999 per year and the Controls were more likely to report $15,000 to $24,999 per year ($?^2$=15.0, p < 0.01). The only other difference was that the Treatment Group scored greater for CV Knowledge (T=48755, p=0.006).

Predictors of Exercise Capacity at Time 1 and Time 2

Model 1. Rural residence was independently related to distance walked at Time 1 (ß = 214, p < 0.001) meaning that the rural group walked 214 meters farther during the 6-min walk test. *Model 2.* The inclusion of demographic characteristics, including, sex, age, race/ethnicity, and income did not significantly alter the relationship beyond the impact of rural location on distance walked (ß = 159, p = 0.007).

Table 2. Characteristics of Telemedicine (Treatment) and Control groups at study entry (Time 1) [Median (Interquartile 25% to 75%)]

	Telemedicine *n* = 211	Control *n* = 254	*T* (*p*)
Men (%)	54	45	$?^2$ = 4.0 (0.05)
Median Age (years)	59.0 (52.0-67.0)	60.0 (54.0-69.0)	55487 (0.10)
Body Mass Index	30.9 (27.3-35.2)	31.0 (27.1-35.6)	52892 (0.87)
Race/Ethnicity	62% - white 35% - black 4% - other	58% - white 38% - black 3% - other	$?^2$ = 0.92 (0.63)
Income: Less than $15K	23%	27%	$?^2$ = 15.0 (0.01)
Income: $15K-$25K	14%	25%	
Income: $25K-35K	27%	19%	
Income: $35K-45K	13%	14%	
Income: $45K-55K	12%	7%	
Income: $55K or more	10%	9%	
LOC: Internal (average score from responses 1 to 6)	4.7 (4.2-5.2)	4.5 (4.0-5.2)	57431 (0.39)
LOC: Powerful Others (average score from responses 1 to 6)	3.5 (2.7-4.0)	3.3 (2.7-4.2)	53439 (0.59)
LOC: Chance (average score from responses 1 to 6)	2.3 (1.8-2.8)	2.5 (1.8-3.2)	54661 (0.17)
Knowledge: Total Score (% of correct answers)	69.0 (57.8-75.9)	62.1 (51.7-72.4)	48775 (0.006)
6-min Walk (M): Time 1 (*n* = 458)	488 (402-534)	452 (396-524)	48526 (0.061)
6-min Walk (M): Time 2 (*n* = 370)	489 (399-534)	489 (399-534)	33193 (0.87)

Although female gender (ß = 186, p < 0.001) and income of ≥$55,000 (ß = 179, p = 0.001) were directly associated with an increase in distance walked, age (ß = -11, p < 0.001) was negatively associated with distance walked. As age increased, 6-min walk distance decreased by 11 meters per year. *Model* 3. At program entry (Time 1), the addition of LOC to Model 2 showed that Internal LOC (ß = 57, p = 0.001) was positively associated while Powerful Others LOC (ß = -60, p < 0.001) was negatively associated with distance walked. *Model 4.* The inclusion of CV risk knowledge to Model 3 at Time 1 (Table 2) did not alter these findings. *Model 5.* As expected, selection into the Treatment

(Telemedicine) or Control group was also not a significant predictor of distance walked beyond Model 3 at study entry (*ß* = -0.81, *p* = 0.98).

Study Completion

Models 1 and 2. Rural residence persisted as a positive association with 6-min walk distance after inclusion of demographic characteristics. *Model 3.* Similar to Time 1, Internal LOC (ß = 48, *p* = 0.03) was positively associated and Powerful Others LOC (ß = - 44, *p* = 0.02) and Chance LOC (ß = - 39, *p* = 0.04) were negatively associated with distance walked. Rural residence continued to be associated with 6-min walk distance (ß = 148, *p* = 0.05). *Model 4.* However, different than Time 1, knowledge of CV risk was positively associated with distance walked (*ß* = 295, *p* = 0.04) at Time 2. With the addition of knowledge of CV risk, rural residence was no longer statistically associated with distance walked (*ß* = 130, *p* = 0.07). R^2 though did not increase above that found for Model 3 (R^2 = 0.39). *Model 5.* Surprisingly, as in Time 1, assignment of Treatment or Control was again not a significant predictor of distance walked (*ß* = -15, *p* = 0.67).

Table 3. Models Predicting 6-Min Walk Distance at Study Entry (Time 1)

	Model 1 (ß)	Model 2 (ß)	Model 3 (ß)	Model 4 (ß)	Model 5 (ß)
Rural (ref: urban)	214.0****	158.5***	126.7**	118.2**	118.0*+
Male (ref: female)		185.5****	199.9****	206.3****	206.3****
Age		-10.6****	-9.3****	-9.0****	-9.0****
Race/ethnicity (ref: white)		-17.1	-13.7	-4.0	-4.1
Black					
Other		-167.1**	-151.0*	128.9	-129.0
Income (ref: $15K-$24.9K)		-78.5*	-67.7	-67.3	-67.2
≤$15K					
$25K-34.9K		46.4	40.6	35.8	36.0
$35K-44.9K		77.7	64.8	63.1	63.2
$45K-54.9K		74.7	62.8	56.5	56.7
≥ $55K		178.9****	146.7***	138.5***	138.6**
LOC: Internal			56.7****	54.7****	54.7****
LOC: Powerful Others			-60.0****	-58.0****	-58.0****
LOC: Chance			-12.8	-9.4	-9.4
CV Risk Knowledge: Total				153.5	153.7
Treatment (ref: Control)					-0.81
Constant	1381***	1561***	1523***	1409***	1410***
Adjusted R^2	0.09	0.34	0.37	0.37	0.37
Change in R^2		0.25	0.03	0.00	0.00

Abbreviations: * ; p < 0.10, ** ; p < 0.05, *** ; p < 0.01, **** ; p < 0.001. Model 1 Predictors: Rurality. Model 2 Predictors: Rurality, Sex, Race, Income. Model 3 Predictors: Model 2 plus LOC. Model 4 Predictors: Model 3 plus CV Risk Knowledge. Model 5 Predictors: Model 4 plus Telemedicine Treatment

DISCUSSION

We hypothesized that telemedicine treatment would impact exercise capacity beyond rural versus urban, demographics, LOC and CV risk knowledge, particularly at study completion, but our hypothesis was not supported. We found that rural residence and an Internal LOC made a significant positive contribution to 6-min walk distance, while Powerful Others LOC had an opposite effect at both study entry and study completion. Knowledge of CV risk was also significantly associated with 6-min walk distance at study completion. These variables were significant predictors after controlling for variables in previous models. Telemedicine treatment was not significantly associated with an increase in distance walked and did not alter findings related to rurality, demographics and LOC, which will each be discussed independently. These findings support our recommendation that for

behavioral strategies to be effective, health care providers may need to first assess and formulate approaches that address group differences that may influence outcomes.

There are differences between the Rural and Urban groups that would be expected to result in reduced exercise capacity and possibly mitigate the strength of the impact of telemedicine treatment or other behavioural strategies. For example, rural residents were less likely to report income at less than $15,000 per year than urban residents, and were far more likely to report income in categories above $25,000 per year. The inverse association between income and physical activity has been documented. Household income is positively associated with leisure time physical activity. Regardless of ethnicity, lower income children spend more time watching television, are less physically active, and are at a greater risk for lifelong obesity (15,24).

Table 4. Models Predicting 6-Min Walk Distance at Study Completion (Time 2)

	Model 1 (ß)	Model 2 (ß)	Model 3 (ß)	Model 4 (ß)	Model 5 (ß)
Rural (ref: urban)	281.0	177.8***	147.8*	129.5*	127.1*
Male (ref: female)		180.3****	194.7****	206.7****	207.4****
Age		-13.3****	-12.3****	-11.5****	-11.5****
Race/ethnicity (ref: white)		-94.9	-94.5	-69.5	-70.3
Black					
Other		-147.9	-117.2	-68.9	-69.8
Income (ref: $15K-$24.9K)		-91.1*	-77.1	-79.3	-78.0
≤$15K					
$25K-34.9K		10.9	1.4	-9.8	-6.3
$35K-44.9K		124.5**	109.4*	107.4*	109.0*
$45K-54.9K		113.5*	108.8**	95.2	98.3
≥ $55K		197.5***	162.1**	137.2*	139.1*
LOC: Internal			47.8**	43.1**	43.8**
LOC: Powerful Others			-44.2**	-41.8**	-42.1**
LOC: Chance			-38.6**	-31.4*	-31.8*
CV Risk Knowledge: Total				295.6**	301.1**
Treatment (ref: Control)					-14.6
Constant	1367***	1688***	1697***	1482***	1484***
Adjusted R^2	0.12	0.37	0.39	0.39	0.39
Change in R^2		0.25	0.02	0.00	0.00

Abbreviations: * ; p < 0.10, ** ; p < 0.05, *** ; p < 0.01, **** ; p < 0.001. Model 1 Predictors: Rurality. Model 2 Predictors: Rurality, Sex, Race, Income. Model 3 Predictors: Model 2 plus LOC. Model 4 Predictors: Model 3 plus CV Risk Knowledge. Model 5 Predictors: Model 4 plus Telemedicine Treatment

In addition, the racial differences between the rural (predominantly white) and urban (predominantly black) groups may have also contributed to the differences in exercise capacity. One study comparing white to black women, found that black women are more likely to live in poverty, have less education, experience greater weight gain during childhood, and have lower resting metabolic rates and energy expenditures, all of which are consistent with lower levels of physical activity (26). Lower income

African American women and Hispanic women are consistently less active than white women of higher income brackets (24). In agreement, others have shown lower energy expenditures in blacks when compared to whites, and in those with lower incomes, all suggesting we may expect lower levels of physical activity and exercise capacity for our urban group (6,10,20,26,27). A more equal race distribution (50% white and 50% black) in both rural and urban groups may have allowed the differentiation of race versus geographic, but this could only be demonstrated with an equal race distribution in both rural and urban groups.

Although not addressed in the current analysis, there are other environmental factors specific to urban settings that may influence lifestyle behaviour. For urban residents, there may be issues of safety, traffic patterns, availability of facilities and equipment, and pollution that may impact an individual's willingness to increase physical activity (13,18,23). In addition, it has been suggested that when confronted with a behavioural change, urban residents may remain in the pre-contemplation stage for a longer period, have a lower perception of the importance of exercise for health, or lack motivation and confidence in their ability to become more physically active (13,14,16). This appears consistent with our findings of the greater scores for Powerful Others and Chance LOC for the urban group, suggesting a lesser likelihood to take responsibility for their own health and adopt health lifestyle behaviours such as being more physically active.

Regarding LOC, individuals with an Internal LOC (those that believe that their health is contingent upon their own behaviors) are more occupationally and leisurely physically active than those with a Chance LOC (8). Those with a greater tendency toward Chance or Powerful Others LOC assert chance or the control of others as an explanation for health outcomes and believe they have little control over disease and disease risk. These concepts help explain our findings of Internal LOC being positively related to increases in distance walked, while Powerful Others LOC was associated with less distance walked. We found that urban residents have significantly greater scores on Chance LOC and Powerful Others LOC suggesting that urban residents may be less likely to assume responsibility for their own health and more likely to believe that fate influences their health outcomes or significant others are in control of their health. In addition, those with a greater Chance and Powerful Others LOC may not seek health related information, take medications as prescribed, make and keep physician appointments, maintain diets, give up smoking and practice other positive lifestyle behaviors, such as exercise and physical activity, all of which would contribute to the lower exercise capacity in the urban group (3,16).

The practical implications are that telemedicine and possibly other behavioral interventions may be more successful when LOC is considered. For those with a greater Chance or Powerful Others LOC, behavioral intervention programs may need to not only promote healthy behaviors, but involve individuals in their own health decisions. This may move individuals to believe their health is self-controlled. In addition, practitioners who intend to use telemedicine or other behavioral change methods need address change in a way capture the interest and motivation of those who have a more Chance or Powerful Others focused LOC.

Although knowledge of CV risk did not improve the predictability of exercise capacity, scores were greater for the Rural group versus the Urban Group. In addition, CV Risk Knowledge was greater for those who walked the furthest during the 6-min walk at study completion. This again is supported by others who have demonstrated that health knowledge and the perception of importance of a behavioral change leads to enhanced participation and compliance in healthful activities (14,16). Thus, for an enhanced likelihood of success, risk factor modification programs should consider a knowledge assessment and an educational strategy that focuses on deficient knowledge areas regarding the importance of the behavioral change being addressed.

Limitations

There are a number of limitations that readers should consider, particularly when generalizing results. The current study is a subanalysis of a clinical trial investigating telemedicine and CV risk in medically underserved populations and focuses only on 6-min walk distance, an estimate of cardiorespiratory fitness. Another limitation of the study is the racial homogeneity of the geographic groups. The rural group was predominantly white (99%) and the urban group predominantly black (78%). A more equal race distribution (50% white and 50% black) in both rural and urban groups may have allowed the differentiation of race versus geographic.

CONCLUSIONS

Rural and urban differences, LOC, particularly the influence of Powerful Others and Internal LOC, and knowledge of CV risk are significantly associated with exercise capacity. The strength of these between group differences mitigated the effects Telemedicine treatment. Therefore, to increase the likelihood of success, curriculum and behavioral strategies must address and provide individuals with the means for assuming responsibility for their health as well as offering education and alternative behaviors that can be accomplished within different geographic settings.

Implications for Practice

For healthy lifestyle strategies to be successful, health care providers must consider divergent barriers to success that may exist between those who live in a rural versus urban environment and address each group accordingly. Predicating behavior is extremely complex as demonstrated by the current findings where only 39% of the variance in cardiorespiratory fitness was predicted from the multivariable models. Confounding factors that the current study and others have identified that should be considered are differences in annual income, availability of facilities and safe areas for physical activity and exercise, and traffic patterns. Such suggestions may include increasing physical activity within the home by walking throughout the inside of the house, using stairs, using household items for resistance training, such as books and food cans, or traveling by car or public transportation to safer areas for exercise, such as parks, schools, or shopping malls. In addition potential differences in LOC must be addressed. For those who have a more Chance or Powerful Others focused LOC Health, they should be encouraged to participate in or be included in their health care with the intent of establishing the awareness that individual actions and responsibilities do indeed impact health. In addition, health knowledge should be assessed and educational strategies developed that focuses on deficient areas.

Therefore, future research should confirm whether the success of telemedicine or other behavioral strategies are dependent on health care providers developing an understanding of specific environmental and behavioral barriers to success and tailoring strategies to provide doable alternatives.

ACKNOWLEDGEMENTS

This study was supported by Pennsylvania State Grant No. RFA-ME02-380; a grant from the Commonwealth of Pennsylvania. The Pennsylvania Department of Health specifically disclaims responsibility for any analyses, interpretations, or conclusions.

Address for correspondence: McConnell TR, Ph.D., Chair, Department of Exercise Science, Bloomsburg University (CEH 122), 400 East Second Street, Bloomsburg, PA 17815-1301, Office Phone: 570-389-4376, Office Fax: 570 389-5047. E-mail: tmcconne@bloomu.edu

REFERENCES

1. American Thoracic Society. ATS Statement: Guidelines for the Six-Minute Walk Test. ***Am J Respir Crit Care Med*** 2002;166:111-117.

2. Becker LB, Han BH, Meyer PM, Wright FA, Rhodes KV, Smith DW, et al. Racial differences in the incidence of cardiac arrest and subsequent survival. ***New Engl J Med*** 1993;329:600-606.

3. Bettencourt BA, Talley AE, Molix L, Schlegel R, Westgate SJ. Rural and urban breast cancer participants: health locus of control and psychological adjustment. ***Psychooncology*** 2007;17(9):932-939.

4. Bove AA, Santamore WP, Homko CJ, McConnell TR, Shirk G, Cross R, et al. Communication strategies to reduce cardiovascular disease risk in underserved populations. ***J Am Coll Cardiol*** 2008;51(10):A244-A245.

5. Clark LT, Ferdinand KC, Flack JM, Gavin JR III, Hall WD, Kumanyika SK, et al. Contemporary treatment of heart failure: Is there adequate evidence to support a unique strategy for African-Americans? Pro position. ***Curr Hypertens Rep*** *2002;*4(4):307-310.

6. Gannon B, DiPietro, L, Poehlman ET. Do African Americans have lower energy expenditure than Caucasians? ***Int J Obes Relat Metab Disord*** 2000;24:4-13.

7. Gillum RF, Mussolino ME, Madans JH. Coronary heart disease risk factors and attributable risks in African-American women and men: NHANES I epidemiologic follow-up study. ***Am J Public Health*** 1998;88:913-917.

8. Gregg EW, Kriska AM, Narayan KMV, Knowler, WC. Relationship of locus of control to physical activity among people with ad without dabetes. ***Diabetes Care*** *1996;*19(10):1118-1121.

9. Homko CJ, Santamore WP, Zamora L, Shirk G, Gaughan J, Cross R, et al. Cardiovascular disease knowledge and risk perception among underserved individuals at increased risk of cardiovascular disease. ***J Cardiovasc Nurs*** 2008;2:332-337.

10. Hunter GR, Weinsier RL, Darnell BE, Zuckerman PA, Goran MI. Racial differences in energy expenditure and aerobic fitness in premenopausal women. ***Am J Clin Nutr*** 2000*;*71:500–506.

11. Kahn EB, Ramsey LT, Brownson RC, Heath GW, Howze EH, Powell KE, et al. The effectiveness of interventions to increase physical activity: a systematic review. ***Am J Prev Med*** 2002;22(4):S73-S107.

12. Kashem A, Droogan MT, Santamore WP, Wald JW, Bove AA. Managing heart failure care using an internet-based telemedicine system. ***J Card Fail****,* 2008;14:121-163.

13. Kerr J, Norman GJ, Sallis JF, Patrick K. Exercise aids, neighborhood safety, and physical activity in adolescents and parents. ***Med Sci Sports Exerc*** 2008;40:1244-1248.

14. Kloek GC, van Lenthe FJ, van Nierop PW, Schrijvers CT, Mackenback JP. Stages of change for moderate-intensity physical activity in deprived neighborhoods. ***Prev*** **Med** 2006;43:325-331.

15. Kumanyika S, Grier S. Targeting interventions for ethnic minority and low-income populations. ***Future Child*** 2006;16(1):187-207.

16. Laffrey SC, Isenberg M. The relationship of internal locus of control, value placed on health, perceived importance of exercise, and participation in physical activity during leisure. ***Int J Nurs Stud*** 2003;40:453-459.

17. Larsson UE, Reynisdotter S. The six-minute walk test in outpatients with obesity: reproducibility and known group validity. ***Physiother Res Int*** 2008;13:84-93.

18. Lees E, Taylor WC, Hepworth JT, Feliz K, Cassells A, Tobin J.N. Environmental changes to increase physical activity: Perceptions of older urban ethnic-minority women. ***J Aging Phys Act*** 2007;15:425-438.

19. Napolitano MA, Fotheringham M, Tate D, Sciamanna C, Leslie E, Owen N, et al. Evaluation of an internet-based physical activity intervention: A preliminary investigation. ***Ann Behav Med*** 2003;25(2):92-99.

20. Nicklas BJ, Berman DM, Davis DC, Dobrovolny CL, Dennis KE. Racial differences in metabolic parameters of obesity in postmenopausal women. ***Obes Res*** 1999;7:463–468.

21. Potts JL, Thomas J. Traditional coronary risk factors in African Americans. ***Am J Med Sci*** 1999;317(3):189-92

22. Santamore WP, Homko CJ, Kashem A, McConnell TR, Menapace FJ, Bove AA. Accuracy of blood pressure measurements transmitted through a telemedicine system in underserved populations. ***Telemed J E-Health*** 2008;14(4):351-356.

23. Strath S, Isaacs R, Greenwald MJ. Operationalizing environmental indicators for physical activity in older adults. ***J Aging Phys Act*** 2007;15:412-424.

24. Taylor WC, Baranowski T, Young DR. (1998). Physical activity interventions in low-income, ethnic minority, and populations with disabilities. ***Am J Prev Med*** 1998;15:334-343.

25. Wallston KA, Wallston BS, DeVellis R. Development of the multidimensional health locus of control (MHLC) scales. ***Health Edu Monogr*** 1978;6(2):160-171.

26. Weinsier RL, Hunter GR, Zuckerman PA, Redden DT, Darnell BE, Enette Larson D, et al. Energy expenditure and free-living physical activity in black and white women: Comparison before and after weight loss. ***Am J Clin Nutr*** 2000;71:1138-1146.

27. Weyer C, Snitker S, Bogardus C, Ravussin E. Energy metabolism in African Americans: potential risk factors for obesity. ***J Clin Nutr*** 1999;70:13–20.

28. Wilson PW, D'Agostino RB, Levy D, Belanger AM, Silbershatz H, Kannel WB. Prediction of coronary heart disease using risk factor categories. ***Circulation*** 1998;97(18):1837-47.