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ORIGINAL ARTICLE

Effects of the Strong Hearts, Healthy Communities Intervention on Functional Fitness of Rural Women

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Abstract

Purpose: The purposes of these analyses were to determine whether Strong Hearts, Healthy Communities (SHHC), a multilevel, cardiovascular disease risk reduction program for overweight, sedentary rural women aged 40 or older, led to improved functional fitness, and if changes in fitness accounted for weight loss associated with program participation.

Methods: Sixteen rural communities were randomized to receive the SHHC intervention or a control program. Both programs involved groups of 12-16 participants. The SHHC program met 1 hour twice a week for 24 weeks where participants engaged in aerobic exercise and progressive strength training. Program content addressed diet and social and environmental influences on heart-healthy behavior. The control group met 1 hour each month for 6 months, covering current dietary and physical activity recommendations. Objective measures of functional fitness included the 30-second arm curl, 30-second chair stand, and 2-minute step test. Self-reported functional fitness was measured by the Physical Functioning Subscale of the MOS Short Form-36 (SF-36 PF).

Findings: The SHHC program was associated with increased strength and endurance, as represented by greater improvement in the chair stand and step test; and with increased physical function, as represented by the SF-36 PF. Adjustment for change in aerobic endurance, as measured by the step test, accounted for two-thirds of the intervention effect on weight loss at the end of the intervention.

Conclusions: SHHC participants experienced improved performance on objective measures of functional fitness and self-reported measures of physical function, and changes in weight were partially accounted for by changes in aerobic fitness.

Key words cardiovascular disease, fitness, obesity, physical activity, rural.

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Functional fitness has been defined as the ability to perform the activities of daily living without difficulty and includes the physiological dimensions of strength, flexibility, aerobic capacity, and balance.[1,2] Higher functional fitness levels are associated with decreased mortality,[3-5] lower frequency of cardiovascular disease,[5-7] and are positively associated with self-reported health-related quality of life across various demographic groups.[8-11]

While physical activity has been found to be a protective factor for maintaining physical function as adults age,[12,13] only 21% of American adults are currently meeting the 2008 recommendations for physical activity[14] and 23.1% report not doing any physical activity other than their regular job in the past 30 days.[15] That percentage increases to 26.4% for women and 31.4% for rural populations.[16] Rural women are not only more sedentary than their urban counterparts but they face higher levels of obesity and related chronic diseases such as diabetes, and are at greater risk for cardiovascular disease.[17-21] Lack of access to environmental supports for physical activity and healthy food options, as well as to health care resources, contributes to this disparity.[17,22,23]

Evaluations of multiple healthy lifestyle programs to improve diet and increase physical activity have shown positive effects on functional fitness.[1,24-29] Rarely are any of these programs targeted at rural populations and rural women specifically. The purpose of this analysis was to determine whether a 6-month multilevel cardiovascular disease risk reduction program specifically designed for overweight, sedentary middle-aged and older rural women led to improved functional fitness and perceived function-related quality of life. Programs that consist of a dietary component or are a combination of physical activity and dietary interventions typically demonstrate better weight outcomes than those programs that focus only on physical activity.[30,31] An additional objective was to assess whether different dimensions of functional fitness were related to the weight loss associated with the intervention.[32]

Methods

Design

Strong Hearts, Healthy Communities (SHHC) was a community randomized 6-month trial for rural women aged 40 or older who were at increased risk for cardiovascular disease on the basis of being sedentary (not meeting the Physical Activity Guidelines for Americans or having an estimated total energy expenditure below 34 kcal/kg per day, per the 7-day Physical Activity Recall) and had a body mass index (BMI) ≥ 25 kg/m^2. As described in more detail elsewhere,[33] 16 communities (12 in Montana, 4 in New York) were randomized after participant enrollment to receive the SHHC multilevel intensive intervention or the reduced dose control program. All communities had a Rural Urban Commuting Area (RUCA) code of 7 or higher,[34] were designated as a medically underserved area (MUA) or population (MUP) by the Health Resources Administration,[35] and had a median household income at least 15% lower than the corresponding value for the state. Each program involved groups of 12–16 participants co-facilitated by local health educators. The SHHC program met for 1 hour twice a week for 24 weeks, utilizing experiential learning for a variety of heart health topics including nutrition, physical activity, and stress. Participants engaged in aerobic exercise (20–30 minutes) and progressive strength training (10–15 minutes) during most classes. Aerobic walking DVDs were utilized so participants could walk indoors if the outside rural environment was not safe (eg, poor weather conditions, lack of good sidewalks, poor lighting). Strength training components required only handheld weights. Participants were encouraged to track their aerobic exercise and strength training conducted outside of class, working toward a goal of 150 minutes of moderate to vigorous aerobic activity per week and 3 episodes of strength training per week. Program content addressed healthy eating aligned with the Mediterranean dietary pattern and DASH diet guidelines, and recognizing social and environmental influences on related heart-healthy behavior. Participants in each SHHC community were also involved in a HEART Club project that utilized a structured process to identify a key issue around the local food or physical activity environment and to plan and implement a project to address it.

The reduced dose control group met for 1 hour each month over 6 months. Classes covered current dietary and physical activity recommendations, but participants did not engage in any physical activity or any active learning modalities during these monthly meetings. The control program also did not include the civic engagement component that was part of the SHHC program.

Measures

Functional fitness tests conducted at baseline and 6 months consisted of the 30-second arm curl, the 30-second chair stand, and the 2-minute step test. These tests are valid and reliable measures of different dimensions of strength and endurance.[2] One trial of each test was conducted but participants first observed how the test was to be done properly and were able to practice it prior to beginning the trial.

Arm curls were done to measure upper body strength. The 30-second arm curl was conducted with a 5-pound weight using the dominant hand, while the participant was seated. On the signal “go” the participant curled the weight through the full range of motion from full extension to full flexion. If the arm was more than halfway up at the end of 30 seconds, the curl was counted.

Chair stands were conducted to measure lower body strength. Participants sat in a straight-back or folding chair with a seat height of about 17 inches with feet flat on the floor and arms crossed against the chest. On the signal "go" the participant rose to a full stand before returning to a fully seated position. If a participant was more than half way up at the end of 30 seconds, it was counted as a stand.

The 2-minute step test is an aerobic endurance alternative to the 6-minute walk test when space or time is limited. It measures the number of full steps completed in 2 minutes, raising each knee to a point midway between the patella and the iliac crest. This point on the thigh was marked with a piece of tape which was then transferred to the wall so that knee height could be monitored. If the participant had one hand on the wall during the test, the steps still counted. Although both knees had to be raised to the correct height, only the number of times the right knee reached the target was counted.

In addition to the functional fitness tests, participants were also asked to complete the Physical Functioning Subscale of the MOS Short Form-36 (SF-36 PF)[36] at baseline and at 6 months. The SF-36 PF asks about vigorous activities (eg, running, lifting heavy objects, participating in strenuous sports); moderate activities (eg, moving a table, pushing a vacuum cleaner, bowling, playing golf); lifting or carrying groceries; climbing several flights of stairs; climbing one flight of stairs; bending, kneeling, or stooping; walking more than a mile; walking several blocks; walking one block; and bathing or dressing oneself. For each activity, participants indicated whether their health limited the activity "a lot," "somewhat," or "not at all." Coded scores for high, medium and no limitations were 0, 50, and 100, respectively, and the total score for this scale was based on the average of all 10 responses. Height and weight were also measured at baseline and at 6 months and were used to compute body mass index.

Demographic characteristics recorded at baseline and adjusted for in these analyses were age, marital status, race and ethnicity, and years of education. In addition, self-reported rating of health (excellent, very good, good, fair, poor) was recorded at baseline and adjusted for in the analysis.

Analyses

Univariate descriptive statistics for baseline values of sociodemographic characteristics and functional fitness were calculated separately for the intervention and control groups using SAS software (version 9.4; copyright 2002-2012 by SAS Institute Inc., Cary, NC). The contrasts between SHHC and control for changes in each measure of functional fitness were analyzed using

Table 1 Between Group Differences in Weight Change, With Added Adjustment for Measures of Change in Functional Fitness

Model	Difference in Weight Change SHHC-Control (95% CI)	% Reduction From Primary Model
Primary Model[a]	−1.85 (−3.55, −0.16)	—
Primary Model plus adjustment for		
Arm curls	−1.82 (−3.39, −0.26)	1.6%
Chair stand	−1.63 (−3.55, +0.30)	11.9%
Step test	−0.58 (−2.45, +1.30)	68.6%
SF-36 PF	−1.35 (−3.35, +0.53)	27.0%

[a]Adjusted for study site, education, age, marital status, and baseline weight.

multilevel linear regression models (PROC MIXED) with study site as a random effect and adjustment for the sociodemographic characteristics and the baseline level of the functional fitness outcome being evaluated. Follow-up outcome measures were missing for 43 to 61 cases. The initial multivariate models used a complete case approach (ie, analyses based on nonmissing values for all variables in the models) on 128 to 144 cases; a sensitivity analysis was also conducted on all 194 cases using multilevel multiple imputation to address potential selective attrition in follow-up assessments. Missing values were estimated with a multilevel model that included site as a random effect using the Fully Conditional Specifications method of imputation[37] and 20 imputations. The software program, Blimp, was used for the multilevel multiple imputation.[38] Included in the imputation were all variables considered in the analysis: intervention group, age, education, marital status, and perceived overall health at baseline; arm curl, chair stand, step-test, and SF-36 from baseline and follow-up. After imputation, outcome change-from-baseline scores were calculated in each of the 20 imputed datasets, and in SAS version 9.4 PROC MIXED was used to re-run the analyses and PROC MIANALYZE was used to combine the results.

In the final set of analyses, shown in Table 1, each measure of change in functional fitness was added separately to the multilevel linear regression model for the analysis of intervention effects on weight change; these analyses were conducted to assess the degree to which changes in functional fitness accounted for the larger weight loss experienced by the participants in the SHHC program.

Results

Characteristics of the women from the communities assigned to the 2 programs are presented in Table 2. There were no significant differences between groups at baseline.

Table 2 Baseline Characteristics of Participants by Intervention Status

Characteristic	SHHC-Intervention N = 101	Control N = 93
Age: mean (SD)	59.0 (9.4)	58.7 (9.7)
Race/Ethnicity: % white, non-Hispanic	95%	94%
Marital Status: % married or with partner	74%	69%
Education: % college graduate	45%	50%
Body mass index: mean (SD)	34.9 (6.1)	35.5 (6.8)
Weight (kg): mean (SD)	92.2 (16.8)	95.5 (19.5)
Arm curls: mean (SD)	18.2 (6.4)	15.3 (4.3)
Chair stand: mean (SD)	12.6 (4.7)	11.5 (3.3)
Step test: mean (SD)	76.2 (23.1)	75.3 (22.5)
SF-36 PF subscale: mean (SD)	73.6 (21.4)	80.5 (20.6)
Perceived health		
Excellent or very good: %	22%	20%
Good: %	62%	60%
Fair or poor: %	16%	20%

Table 3 summarizes the 6-month changes in functional fitness observed for the women of each group and the difference between the changes by each group using the complete case approach. Both groups showed a similar improvement in the number of arm curls, but for the other 2 objective measures of fitness the more intensive SHHC program was associated with a greater increase in strength and endurance. The SHHC program participants also reported better physical functioning at 6 months relative to the control program participants. These conclusions were identical when examining multilevel models in the multiple imputed datasets (Table 4). In both analytic approaches, a few covariates were significant and are noted on Tables 3 and 4. Briefly, baseline functional fitness level was significant across all 3 functional fitness tests, age was a significant covariate for the chair stand, and perceived health was a significant covariate for SF-36.

The relationship between these changes in functional fitness and the intervention-related weight loss at 6 months are shown in Table 1. As reported previously,[32] the multivariable-adjusted weight loss after 6 months in the SHHC and control programs were 2.24 kg and 0.38 kg, respectively, leading to a net intervention effect of −1.85 kg. The values in Table 1 show the change in this intervention effect with additional adjustment for each measure of functional fitness. The addition of the objective measures of improved upper and lower body strength to the model had very little influence on the intervention effect on weight loss. In contrast, adjustment for change in aerobic endurance, as measured by the step test, accounted for 68.6% of the intervention effect on weight loss. As a composite measure of different types of functional fitness, the influence of improvement in SF-36 PF was somewhat in between the impact of the measures of strength and endurance (27%).

Discussion

The challenge of implementing programs to promote healthy diet and physical activity in rural communities has been recognized by others[39,40] and was addressed in an initial formative phase leading to the design of the SHHC intervention. Insights from environmental audits, focus groups and key informant interviews included the importance of having a structured program with a convenient indoor location for physical activity; recognizing limited local resources for healthy foods and being active and identifying feasible strategies for enhancing

Table 3 Change in Functional Fitness by Intervention Status and Difference Between the Changes Observed in Each Group[a]

	SHHC-Intervention		Control			
	N	Mean Change Baseline to Outcome (95% CI)	N	Mean Change Baseline to Outcome (95% CI)	N	Difference Between Changes Baseline to Outcome (95% CI)
Arm Curl[b]	77	+5.9 (+2.8, +9.0)	67	+4.4 (+1.3, +7.6)	144	+1.5 (−2.9, +5.8)
Chair Stand[b,c]	77	+5.6 (+3.2, +8.0)	65	+0.9 (−1.5, +3.3)	142	+4.7 (+1.4, +8.0)
Step Test[b]	75	+31.6 (+22.5, +40.7)	63	+9.7 (+0.5, +18.8)	138	+21.9 (+9.4, +34.5)
SF-36 PF[b,d]	69	+4.0 (−0.7, +8.9)	59	−4.0 (−8.6, +0.7)	128	+8.0 (+2.0, +14.0)

[a]Adjusted for study site, education, age, marital status, perceived health, and baseline value of the measure of functional fitness.
[b]Significant covariate: baseline value of the measure of the functional fitness test.
[c]Significant covariate: age.
[d]Significant covariate: perceived health.

Table 4 Change in Functional Fitness by Intervention Status and Difference Between the Changes Observed in Each Group (Multilevel Multiple Imputation)[a]

	SHHC-Intervention	Control	
	Mean Change Baseline to Outcome (95% CI)	Mean Change Baseline to Outcome (95% CI)	Difference Between Changes Baseline to Outcome (95% CI)
	n = 101	n = 93	n = 194
Arm Curl[b]	+6.1 (+3.2, +9.1)	+4.5 (+1.6, +7.4)	+1.6 (−2.5, +5.7)
Chair Stand[b,c]	+5.7 (+3.7, 7.7)	+1.5 (−0.5, +3.5)	+4.2 (+1.5, +7.0)
Step Test[b]	+30.6 (+22.2, +38.9)	+8.9 (+0.4, +17.3)	+21.7 (+10.2, +33.1)
SF-36 PF[b,d]	+5.6 (+0.4, +10.9)	−2.4 (−8.0, +3.2)	+8.1 (+1.2, +14.9)

[a]Adjusted for study site, education, age, marital status, perceived health, and baseline value of the measure of functional fitness.
[b]Significant covariate: baseline value of the measure of the functional fitness test.
[c]Significant covariate: age.
[d]Significant covariate: perceived health.

existing resources; and addressing how family and friends uniquely influence health-related behaviors in small, relatively isolated communities.[41,42] Accordingly, SHHC was designed as a low technology small-group program to improve functional fitness and reduce cardiovascular disease risk in rural communities. The program can be implemented in any community space such as a church or senior center and required minimal equipment. The scripted curriculum allows for ease of teaching, including the potential for groups of women to maintain programs after the initial program period without need for a long-term professional leader, which is essential in rural areas with limited resources.

Our findings are consistent with previous research on physical activity, functional fitness and weight, which also found that interventions combining physical activity with dietary change led to improved functional fitness and weight loss.[25,27,28,30,31,43,44] To our knowledge, this is the first report of functional fitness and quality of life changes for rural women enrolled in a randomized, community-based cardiovascular disease risk reduction program.

The analysis indicated that 68% of the difference between groups for weight loss, the primary outcome previously reported for the project,[32] was accounted for by changes in the step test, a measure of aerobic endurance. There was no significant change between groups in respect to arm curls (measure of upper body strength). While the change in chair stands (measure of lower body strength) was significant between the control and intervention groups, its statistical relationship to the group difference in weight loss was minimal. These findings are not surprising considering that strength training is more likely to have a greater effect on body composition (ie, percentage fat vs lean mass) than weight change.[45,46] However, strength training has been shown to independently contribute to reduced risk of diabetes and cardiovascular disease in middle-aged and older women[47] and to promote physical function through prevention of sarcopenia.[29,48]

It is of note that the SHHC study found that physical activity was the primary factor driving weight loss since kilocalories consumed showed no significant changes between groups postintervention (baseline: 1785.6 kcal control,1762.7 kcal intervention; postintervention: 1582.3 kcal control, 1592.6 kcal intervention) (Folta SC, Paul L, Nelson ME, et al. [in preparation]). These findings differ from most lifestyle modification studies.[30,31] It is possible that there was behavioral compensation occurring in the intervention group for the increased exercise, which led to diet not being a factor to the change in fitness.[49]

The strengths of this study include the randomization of communities to the intervention or control condition and the use of both objective and self-reported measures of functional fitness with well-established evidence of validity. The generalizability of the results may be limited for rural populations with different distributions of race, ethnicity, and education, though the formative phase of the study addressed many common challenges in rural communities. Another limitation is the lack of follow-up measurement beyond the end of the 6-month period for intervention and control activities. Studies of maintenance strategies for initially achieved weight loss by women in rural communities indicate the challenge for sustaining the benefits of interventions in these settings.[50,51] Due to these limitations, SHHC was revised[52] and evaluation of the impact on Simple 7 utilizing the revised multilevel curriculum is currently being undertaken. There are plans for an add-on maintenance program with dissemination and implementation components.

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