A Pilot Randomized, Controlled Trial of a Wall Climbing Intervention for Gynecologic Cancer Survivors

Jennifer J. Crawford, MSc, Jeff K. Vallance, PhD, Nicholas L. Holt, PhD, Gordon J. Bell, PhD, Helen Steed, MD, and Kerry S. Courneya, PhD

Crawford is a doctoral candidate in the Faculty of Physical Education and Recreation at the University of Alberta in Edmonton; Vallance is an associate professor in the Faculty of Health Disciplines at Athabasca University in Alberta; Holt is a professor and Bell is a professor emeritus, both in the Faculty of Physical Education and Recreation at the University of Alberta in Edmonton; Steed is a gynecologic oncologist at Cross Cancer Institute in Edmonton; and Courneya is a professor in the Faculty of Physical Education and Recreation at the University of Alberta, all in Canada.

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Crawford, Steed, and Courneya completed the data collection and provided the statistical support and analysis. All of the authors contributed to the conceptualization, design, and manuscript preparation.

Crawford can be reached at jcrawfor@ualberta.ca, with copy to editor at ONFEditor@ons.org.

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Purpose/Objectives: To examine the feasibility and preliminary efficacy of an eight-week supervised climbing intervention for gynecologic cancer survivors (GCSs).

Design: A pilot randomized, controlled trial.

Setting: The Wilson Climbing Center in Edmonton, Alberta, Canada.

Sample: 35 GCSs who had completed cancer therapy.

Methods: GCSs were randomized to an eight-week (16 session) supervised wall climbing intervention (WCI) (n = 24) or usual care (UC) (n = 11).

Main Research Variables: Feasibility outcomes included recruitment rate, adherence rate, skill performance, and safety. Preliminary efficacy outcomes were objective health-related and functional fitness assessed before and after the eight-week intervention using the Senior Fitness Test.

Findings: Median adherence to the WCI was 13.5 of 16 sessions. Most GCSs were proficient on 16 of 24 skill assessment items. No serious adverse events were reported. Based on intention-to-treat analyses, the WCI group was superior to the UC group for the 6-minute walk, 30-second chair stand, 30-second arm curls, sit and reach, 8-foot up-and-go, grip strength-right, and grip strength-left assessments.

Conclusions: The Gynecologic Cancer Survivors Wall Climbing for Total Health (GROWTH) Trial demonstrated that an eight-week supervised WCI was safe, feasible, and improved functional fitness in GCSs. Phase II and III trials are warranted to further establish the safety, feasibility, and efficacy of WCIs in cancer survivors.

Implications for Nursing: Oncology nurses may consider a climbing wall as an alternative type of physical activity for improving functional fitness in GCSs.

Gynecologic cancers are the fourth most common cancer in women, with about 100,000 new cases diagnosed per year and more than 1 million survivors in the United States (American Cancer Society, 2016). Gynecologic cancer survivors (GCSs) experience negative physical and psychological side effects following diagnosis and treatment, such as psychological distress, fatigue, menopausal symptoms, sexual dysfunction, pain, cognitive dysfunction, and sleep disturbances (Grover et al., 2012; Salani, 2013). In addition, GCSs have lower physical fitness than matched controls based on a cross-sectional comparison (Peel et al., 2015). Systematic reviews and meta-analyses have confirmed the importance of physical activity for the physical and psychological health benefits of cancer survivors (Courneya & Friedenreich, 2007; Fong et al., 2012; Mishra et al., 2012), but few studies have focused on GCSs (Peel et al., 2015).

Similar to physical activity interventions in other cancer survivors, most physical activity interventions in GCSs have focused on walking (Peel et al.,

2015), likely because it is the most feasible and safe activity for older adults. Walking has demonstrated health benefits in many groups; however, it does not improve upper body muscular strength or flexibility, does not usually engage the mind, is not novel, is not physically challenging for many healthy adults, and does not result in a heightened emotional state (e.g., arousal, fear). Consequently, walking may be less likely to improve outcomes important to GCSs, such as cognitive dysfunction, peripheral neuropathy, fatigue, psychosocial distress, and posttraumatic growth (Salani, 2013).

Therapeutic wall climbing is a newer rehabilitation approach adapted from rock climbing where artificial indoor climbing walls are used to mimic rock climbing in a controlled environment (Buechter & Fechtelpeter, 2011). Therapeutic wall climbing is becoming increasingly popular in rehabilitation settings and has been shown to have physical and psychological benefits in various clinical populations, including older adult patients (Fleissner et al., 2010), patients with multiple sclerosis (Velikonja, Curic, Ozura, & Jazbec, 2010), patients with chronic lower-back pain (Engbert & Weber, 2011; Kim & Seo, 2015), children with disabilities (Böhm, Rammelmayr, & Döderlein, 2015), and adults diagnosed with depression (Luttenberger et al., 2015). These studies are limited, however, by small sample sizes and rarely report recruitment rates, adherence rates, description of the content of the intervention, the setting, and by whom and how the intervention was delivered. In addition, no studies, to date, have examined therapeutic wall climbing in any cancer survivor group.

The primary purpose of the Gynecologic Cancer Survivors Wall Climbing for Total Health (GROWTH) Trial was to assess the feasibility and preliminary efficacy of an eight-week supervised wall climbing intervention (WCI) in improving physical functioning, quality of life, psychosocial outcomes, and symptom management in GCSs. In this article, the authors report on the feasibility and physical functioning outcomes. Feasibility was assessed by evaluating the recruitment rate, adherence rate, skill performance, and safety of the intervention. Preliminary efficacy was assessed by evaluating the changes in objective health-related and functional fitness outcomes. The authors hypothesized that adherence to the WCI would be high (greater than 70%), the majority of GCSs would become proficient at most climbing skills (greater than 70%), and no serious adverse events would be reported. In addition, the authors hypothesized that the completion of the eight-week WCI would result in greater improvements in objective health-related and functional fitness parameters compared to usual care (UC).

Methods

Setting and Participants

The GROWTH Trial was conducted at the University of Alberta from June 2015 to November 2015. The study received ethics approval from the Health Research Ethics Board of the Alberta Cancer Committee and the Health Research Ethics Board at the University of Alberta. All participants provided informed consent prior to participating in this study. Inclusion criteria included (a) histologically confirmed diagnosis of cervical, endometrial, or ovarian cancer that was cured or in remission; (b) aged 18–70 years; (c) living in Edmonton or surrounding areas; and (d) willing to attend the supervised WCI. Exclusion criteria included (a) any absolute contraindication to exercise testing or participating in the WCI; (b) any uncontrolled medical condition or psychiatric illness that would prevent completion of the WCI or interfere with the study assessments; (c) not cleared to participate in exercise as determined by Physical Activity Readiness Questionnaire Plus or Physical Activity Readiness Examination form; and (d) unable to understand and provide informed consent in English.

Design and Procedures

The study was a pilot randomized, controlled trial with assessments completed before and after an eight-week supervised WCI. Participants were recruited in two ways: (a) from a previous survey in which they expressed interest in future research (Crawford, Holt, Valiance, & Courneya, 2015) or (b) from the Alberta Cancer Registry using a mailed invitation. Participants were instructed to contact the research coordinator if they were interested in participating in the study. All individuals who were interested in participating were screened and scheduled for a baseline assessment, if eligible.

Randomization and Blinding

The wall climbing program was offered in a group-based format on set days and times and could accommodate as many as six participants per group. Four classes (days and times) were available, and prospective participants were asked to indicate their required or preferred class schedule at the time of recruitment. To facilitate intervention delivery, participants were stratified by their required/preferred class schedule before being randomized to the WCI or UC. To fill the necessary class size of six participants, the randomization within each strata was blocked so that six participants were randomized to the WCI regardless of the total strata size available for that schedule. For example, nine women preferred to climb on

Tuesday and Friday from 4–6 pm, therefore, the block randomization was set so that six participants were randomized to the supervised WCI and three were randomized to UC. This process was repeated for all four stratas (classes). A research assistant, not otherwise involved in the trial, generated the randomization sequence.

Participants were randomized following baseline measurements using a computer-generated allocation sequence. Outcome assessors (i.e., fitness testers and wall climbing instructors) were not blinded to group allocation; however, assessors were trained on the importance of following standardized assessment procedures and intervention delivery to enhance intervention fidelity.

Wall Climbing Intervention

The eight-week intervention took place at the Wilson Climbing Center, located on the University of Alberta campus. The Wilson Climbing Center contains several versatile, modular climbing structures with climbing routes to a maximum of 48 feet. The standardized intervention consisted of twice-weekly, two-hour wall climbing sessions designed to provide a comprehensive introduction to wall climbing. All wall climbing sessions were delivered in the same order and with the same content. In these classes, participants learned basic safety considerations, essential movement skills, rope management techniques, communication and terminology, bouldering and top rope climbing strategies, how to safely fall, and other essential instructions.

The WCI was individualized based on baseline fitness assessments immediately prior to beginning the WCI. The rate of progression was adjusted based on the individual's response to the WCI by varying the difficulty of the route, the time set to complete the route, or the height to be achieved while climbing. All wall climbing sessions were supervised by certified wall climbing staff and a certified personal trainer. Table 1 outlines the order and content of the eight-week supervised WCI. Participants in the WCI group were instructed to continue their previous physical activity routine as normal during the eight-week intervention period.

Usual Care

Participants assigned to UC were asked not to participate in any WCI during the eight-week intervention period and were informed they would receive four supervised wall climbing sessions after the postintervention assessments. Participants in the UC group were instructed to continue their previous physical activity routine as normal during the eight-week intervention period.

Demographic, Behavioral, and Medical Characteristics

Demographic and behavioral variables were assessed by self-report and included age, marital status, education, annual family income, employment status, ethnicity, height and weight (to calculate body mass index [BMI]), and drinking and smoking status. Medical variables were also assessed by self-report and included date of diagnosis, type of cancer, disease stage, treatment type, recurrence, general health, and comorbidities. Baseline aerobic exercise was assessed by using a modified version of the Leisure Score Index from the Godin Leisure-Time Exercise Questionnaire (Godin & Shephard, 1997). Strength exercise was measured using items developed from a previous survey in colorectal cancer survivors (Speed-Andrews et al.,

TABLE 1. Content of Wall Climbing Intervention by Week and Session

Week	Session	Session Topic
1	1–2	Facility orientation Equipment orientation Introduction to essential movement skills Introduction to bouldering Introduction to top roping
2	3–4	Assessment 1: Proficiency of essential movement skills while bouldering Review of essential movement skills on bouldering and top rope climbing walls Introduction to belaying
3	5–6	Bouldering skill development Top roping skill development Belaying review
4	7–8	Assessment 2: Belaying technique Bouldering skill development Top roping skill development
5	9–10	Bouldering skill development Top roping skill development
6	11–12	Assessment 3: Top rope climbing (ascent of a 5.6–5.8 graded route) Bouldering skill development Top roping skill development
7	13–14	Bouldering skill development Top roping skill development
8	15–16	Assessment 4: Top rope climbing (ascent of a 5.9 graded route) Rappelling Bouldering skill development Top roping skill development

Note. All climbing sessions begin with a warm-up and dynamic stretch. All climbing sessions end with strength, conditioning, and stretch.

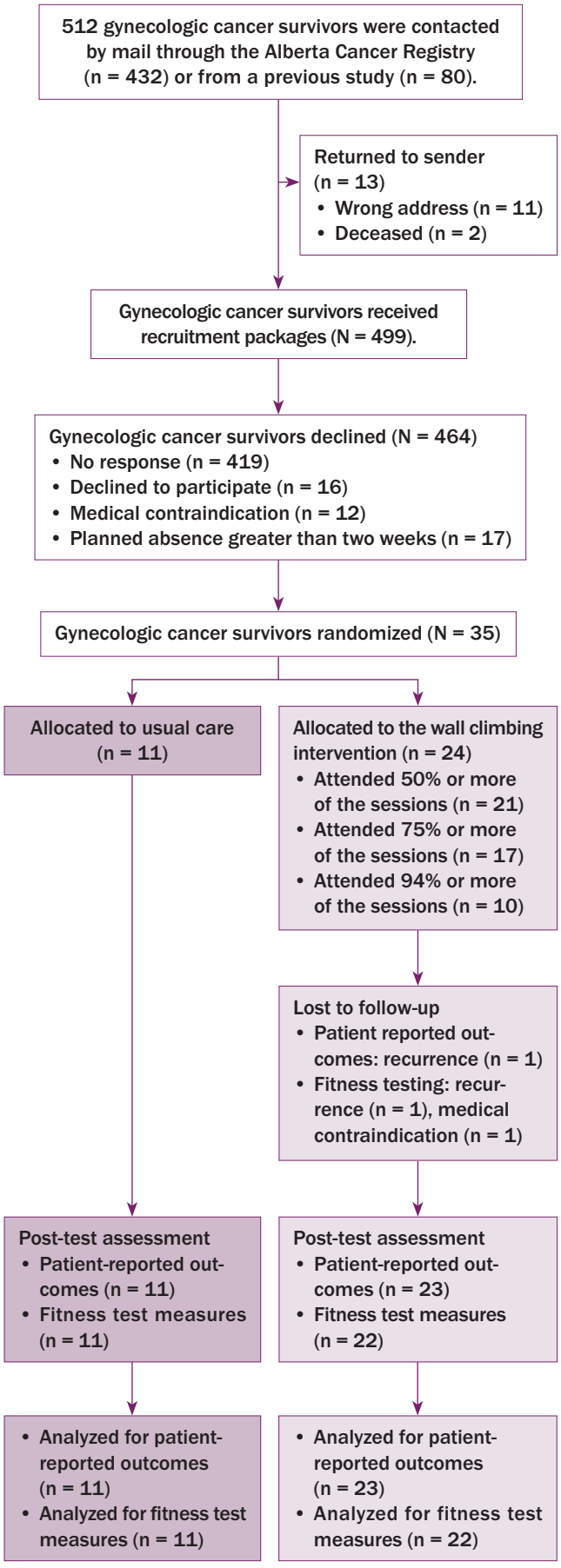

FIGURE 1. Participant Flowchart

2013). These items have previously been used in a study of exercise in GCSs (Crawford, Vallance, Holt, & Courneya, 2015). The authors calculated the percentage of participants meeting the 2008 Physical Activity Guidelines for Americans (U.S. Department of Health and Human Services, 2008), which have been endorsed for gynecologic cancer survivors by the American Cancer Society (Doyle et al., 2006) and the American College of Sports Medicine (Schmitz et al., 2010).

Feasibility Outcomes

Eligibility rate was determined by dividing the number of GCSs considered to be eligible for the study by the number who met the inclusion criteria. Recruitment rate was calculated by dividing the number of GCSs randomized in the study from those considered eligible. Adherence was measured by the total number of wall climbing sessions attended (out of 16). Skill assessments examined the proficiency of essential movement skills, use of safety commands and belaying, and top rope ascents of varying difficulties. Essential movement skills included spotting (i.e., assisting a climber with controlling a fall by directing to a safe landing spot), straight arms (i.e., climbing with straight arms and bent legs), balanced triangle (i.e., flagging or stretching out a leg to act as either a counter balance, or as a third point of contact when moving to new holds), push with legs (i.e., extending both legs at the same time to reach higher handholds), smearing (pressing the sole of the climbing shoe directly on the wall and using friction to gain vertical ground), back step (i.e., rolling the hip inward toward the wall and placing a foot behind the body), hip lock (i.e., rotating hips from a front to a sideways position and bringing the hip closer to the wall) and sit-start (i.e., beginning a climb while sitting on the ground). Participants completed the climbing skills assessment at weeks 2, 4, 6, and 8, and were assessed by the certified wall climbing instructor on a five-point scale ranging from 1 (unable) to 5 (exemplary). Strategies for achieving standardization across multiple skills assessors included training for skills assessment delivery in which (a) the philosophy and goals of the wall climbing skills assessment were discussed, (b) objectives and procedures of the wall climbing skills assessment were covered in detail, and (c) all outcome assessors had the opportunity to practice the necessary skills needed for delivering the wall climbing skills assessment. The safety of study assessments and wall climbing were tracked throughout the study by the wall climbing instructors and personal trainers who attended all wall climbing sessions.

Health and Functional Fitness Outcomes

Functional fitness was assessed by the Senior Fitness Test (Rikli & Jones, 1999). The validity and reliability

of the Senior Fitness Test battery have been well established in a variety of populations (Rikli & Jones, 2013). The Senior Fitness Test consists of a sequence of six items that measure basic mobility-related parameters associated with functional abilities in the everyday living of older adults (Jones & Rikli, 2002; Rikli & Jones, 1999). The 30-second chair stand test examined lower body strength. The arm curl test examined upper body strength. The chair sit-and-reach test examined lower body flexibility. The back scratch test examined upper body flexibility. The 8-foot up-and-go test examined agility and dynamic balance. Last, the 6-minute walk test examined aerobic endurance.

In addition, muscular strength was assessed using a hydraulic hand dynamometer to examine hand and forearm strength. Body composition was examined by height, weight, and waist circumference measurements. Standing height (cm) was measured using a stadiometer, BMI was measured on a Heath Carter balance beam scale, and waist circumference (cm) was determined using the National Institutes of Health protocol (Gledhill & Jamnik, 2003).

Statistical Analysis

This pilot study was designed to estimate the recruitment rate, adherence rate, and preliminary effect sizes for efficacy outcomes to inform larger phase II and III trials. Consequently, an a priori sample size calculation was not performed. For all efficacy analyses, the intention-to-treat principle was used to include all participants in their randomized condition regardless of adherence and who provided eight-week data. Paired t tests were undertaken to examine the change in the outcome of interest between baseline and postintervention assessments. Analyses of covariance were performed to compare the WCI and UC groups at postintervention on outcomes of interest, with adjustments for baseline value of the outcome, age, months since diagnosis, and type of gynecologic cancer. Because this was a pilot study with a small sample size, health-related and functional fitness outcome results were interpreted for statistical trends as well as for potential clinical significance. A statistical trend was defined as a two-tailed alpha < 0.1 and clinical significance was defined as a minimum standardized effect size of $d \geq 0.33$. All statistical analyses were conducted using SPSS®, version 23.0.

TABLE 2. Baseline Characteristics of Gynecologic Cancer Survivors by Group

	Wall Climbing (N = 24)		Usual Care (N = 11)	
Characteristic	**$\bar{X}$**	**SD**	**$\bar{X}$**	**SD**
Age (years)	52.5	12.7	54.1	10.5
Body mass index (kg/m^2)	26.1	5.1	27.3	5
Months since diagnosis	53.1	69.4	87.45	72.7
Characteristic	**n**		**n**	
Age (years)				
Younger than 50	8		3	
50 or older	16		8	
Marital status				
Married or common law	14		6	
Not married	10		5	
Education				
University or college	14		9	
No university or college	10		2	
Annual family income ($)				
Less than 100,000	14		4	
100,000 or more	8		3	
Missing data	2		4	
Employment status				
Employed full- or part-time	16		6	
Not employed	8		5	
Ethnicity				
White	22		10	
Other	2		1	
Body mass index				
Healthy weight	14		3	
Overweight	3		5	
Obese	7		3	
Smoker	4		–	
Met aerobic guidelines	12		6	
Met strength guidelines	4		4	
Months since diagnosis				
Less than 24	16		3	
24 or more	8		8	
Type of gynecologic cancer				
Cervical	8		2	
Endometrial	10		4	
Ovarian	6		5	
Disease stage				
Localized	23		9	
Metastatic	1		2	
Treatment[a]				
Surgery	23		11	
Radiation	3		1	
Chemotherapy	5		7	
Recurrence				
No	23		10	
General health rating				
Excellent/very good	14		8	
Good	8		3	
Fair/poor	2		–	
Number of comorbidities				
0	10		5	
1 or more	14		6	
Most common comorbidities[a]				
Arthritis	10		5	
Other cancer	5		3	
High cholesterol	4		3	
High blood pressure	2		3	

[a] Participants could select more than one response.

Results

Feasibility Outcomes

Figure 1 reports the participant flow through the study. In total, 35 of the 470 eligible GCSs were randomized (7%). Of the 24 participants randomized to the supervised wall climbing arm, the median attendance was 13.5 of 16 sessions (range = 1–16), representing an 84% adherence rate. The most common reasons for a missed supervised wall climbing session were previous work commitment, unable to find child care, illness, and vacation. No serious adverse events were experienced during the supervised wall climbing sessions. One adverse event was observed when a participant fell off a wall while top rope climbing and scratched her leg. The participant did not require medical care and continued with the intervention.

TABLE 3. Wall Climbing Skills Assessment in Gynecologic Cancer Survivors (N = 24)

Variable	$\bar{X}$	SD	n[a]
Proficiency of essential movement skills while bouldering (n = 21)			
Spotting	4.6	0.6	20
Straight arms	3.7	1	13
Balanced triangle	4.1	0.7	18
Push with legs	3.9	0.8	14
Smearing	3.9	1.3	15
Back-step	3.7	0.8	14
Hip lock	4	1.2	16
Sit-start	2.3	1.6	8
Safety commands and belaying (n = 21)			
Knots	4.5	0.8	19
Harness	5	0.2	21
Belay	4.7	0.5	21
Communication	4.9	0.4	20
Safety checks	5	0	21
Top rope ascent on a 5.6–5.8 grade top rope route (n = 17)			
Use of legs during ascent	4.7	0.5	17
Application of movement skills[b]	4.2	0.8	14
Difficulty of route	3.6	0.9	7
Overall quality of ascent	4.1	1.2	12
Demonstration of safety checks and commands before/while climbing	4.8	0.4	17
Quality of belay	4.8	0.4	17
Top rope ascent on a 5.9 grade top rope route (n = 15)			
Use of legs during ascent	4.3	1.1	12
Application of movement skills	3.9	1.3	12
Overall quality of ascent	3.5	1.6	8
Demonstration of safety checks and commands before/while climbing	4.8	0.4	15
Quality of belay	4.6	0.6	14

[a] Indicates those who were proficient
[b] Application of movement skills involved proficiently straight arms, back step, hip lock, and balanced triangle.
Note. Scores ranged from 1 (unable) to 5 (exemplary).

Sample and Representativeness

The baseline demographic and medical profiles of the participants are reported in Table 2. Overall, participants had a mean age of 53 years (SD = 11.9), 14 were married, 22 were employed, and the mean BMI was 26.5 kg/m^2 (SD = 5). The mean number of months since diagnosis was 63.9 (SD = 71.2), 10 had cervical cancer, 14 had endometrial cancer, 11 had ovarian cancer, and 34 received surgery. Overall, 18 were meeting public health aerobic exercise guidelines and 8 were meeting public health strength exercise guidelines. No participants reported previous experience with wall climbing.

Wall Climbing Skills Assessment

Descriptive results of the wall climbing skills assessments are summarized in Table 3. For assessment 1 (week 2), most participants were proficient at spotting (n = 20, 95%), balanced triangle (n = 18, 86%), and hip lock (n = 16, 76%) while bouldering. For assessment 2 (week 4), participants were proficient at tying knots (n = 19, 91%), putting the harness on correctly (n = 21, 100%), belaying (n = 21, 100%), communicating with their fellow climber (n = 20, 95%), and performing the required safety checks (n = 21, 100%). For assessment 3 (week 6), participants were proficient at use of legs (n = 17, 100%), application of movement skills (n = 14, 82%), demonstrating safety checks and commands (n = 17, 100%), and overall quality of belay (n = 17, 100%) while ascending a top rope route of 5.6–5.8 grade (level of climbing difficulty). Lastly, for assessment 4 (week 8), participants were proficient at use of legs (n = 12, 80%), applying movement skills (n = 12, 80%), demonstrating safety checks and commands (n = 15, 100%), and overall quality of belay (n = 14, 93%) while ascending a 5.9 grade top rope route.

Health-Related and Functional Fitness Outcomes

Table 4 provides the change in objective measures of fitness from baseline to postintervention for the WCI group versus UC. A statistically significant large effect favoring the WCI group was noted for the 30-second chair stand ($p < 0.001$) and 30-second arm curl ($p < 0.001$). A statistically significant medium effect size favoring the WCI group was noted for the 6-minute walk ($p < 0.001$), 8-foot up-and-go ($p = 0.039$), grip strength-right ($p = 0.013$), and grip strength-left ($p = 0.024$) assessments. A statistically significant small effect favoring the WCI group was noted in the sit and reach ($p = 0.016$) assessment.

Discussion

To the authors' knowledge, the GROWTH Trial is the first study to assess the feasibility and preliminary

TABLE 4. Effects of Wall Climbing on Health-Related Fitness Outcomes in Gynecologic Cancer Survivors (N = 24)

	Baseline		Postintervention		$\bar{X}$ Change		Adjusted Between-Group Difference in $\bar{X}$ Change[a]		
Variable	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	95% CI	$\bar{X}$	95% CI	p
6-minute walk (m)									
Intervention	564	70	591	60	28	[11, 45]	51	[26, 77]	< 0.001
Usual care	554	72	538	77	−16	[−34, 1]			
30-second chair stands (reps)									
Intervention	17	4	21	5	5	[3, 6]	4	[2, 6]	< 0.001
Usual care	18	5	18	5	0	[0, 1]			
30-second arm curls (reps)									
Intervention	19	4	23	4	4	[3, 6]	4	[3, 6]	< 0.001
Usual care	19	4	19	5	0	[−1, 1]			
Sit and reach (cm)									
Intervention	9	8.7	12.8	9.2	3.8	[2.2, 5.3]	3.1	[0.6, 5.5]	0.016
Usual care	8.1	8.7	9.2	8.1	1	[−0.9, 3]			
Back scratch (cm)									
Intervention	1	6.8	1.8	7.3	0.8	[−0.2, 1.8]	0.8	[−0.8, 2.3]	0.31
Usual care	1	7.4	1	1.1	0	[−1.3, 1.2]			
8-foot up and go (s)									
Intervention	4.3	0.6	4.1	0.6	−0.2	[−0.4, 0]	−0.4	[−0.7, 0]	0.039
Usual care	4.4	0.6	4.5	0.9	0.1	[−0.2, 0.4]			
Grip strength-right (kg)									
Intervention	31.8	5.5	34.9	5.2	3.1	[1.7, 4.6]	2.9	[0.7, 5.2]	0.013
Usual care	31.6	6.4	31	6.9	−0.5	[−2.5, 1.4]			
Grip strength-left (kg)									
Intervention	30.2	5	32.7	5.3	2.5	[0.9, 4.1]	3.1	[0.4, 5.9]	0.024
Usual care	29.7	7	28.9	7.3	−0.8	[−2.7, 1.1]			
Waist (cm)									
Intervention	90.3	12.8	89.4	11.8	−0.9	[−2.8, 1]	−2	[−4.8, 0.9]	0.17
Usual care	89.7	10.8	90.7	11.5	1	[−0.9, 2.9]			
Weight (kg)									
Intervention	72.2	14.5	72.5	14.4	0.3	[−0.8, 1.4]	−0.3	[−2.2, 1.5]	0.71
Usual care	73.1	14.5	73.7	15.6	0.6	[−0.9, 2.1]			

[a] Difference in mean change adjusted for baseline value, age, months since diagnosis, and type of cancer.
CI—confidence interval; reps—repetitions; s—seconds; SD—standard deviation

efficacy of a WCI in cancer survivors. Overall, the GROWTH Trial demonstrated that a WCI for GCSs is not only feasible and safe, but appears to produce substantial improvements in physical fitness. In addition, many of the participants were older, obese, and had significant comorbidities, suggesting that a WCI may be feasible for more than just young, slim, and healthy GCSs. Although the recruitment rate was low, the adherence rate was excellent, and participants were able to perform most wall climbing skills in a safe and proficient manner. Perhaps, most importantly, the large changes in physical fitness may portend improvements in other outcomes important to GCSs, including symptom management, quality of life, and overall survival.

The recruitment rate of 7% is low but comparable to a previous physical activity intervention in prostate cancer survivors (Norris, Bell, & Courneya, 2015). Unfortunately, no previous therapeutic WCI studies have reported on the eligibility or recruitment rate; therefore, whether the recruitment rate for a WCI in cancer survivors is worse or better than for other patient populations is unknown (Böhm et al., 2015; Engbert & Weber, 2011; Fleissner et al., 2010; Kim & Seo, 2015; Luttenberger et al., 2015). In addition, it is unclear how many of the 419 nonresponders in the study may have been eligible for the study. Finally, wall climbing is an experimental intervention that had never been tested in cancer survivors. If results show that wall climbing is safe, feasible, and improves outcomes important to GCSs, it may be promoted by cancer centers and, therefore, the recruitment rate and clinical uptake from GCSs may increase substantially. However, it must be acknowledged that rural towns and smaller cities are unlikely to have a climbing wall course or certified instructors to deliver such an intervention. Ultimately, cancer survivors should be offered an array of physical activity options that cater to their interests, including adventure-based options, such as wall climbing.

The GROWTH Trial achieved an excellent median adherence rate of 84% to the WCI. To reiterate, no

Knowledge Translation

- Gynecologic cancer survivors are willing and able to participate in a supervised wall climbing program.
- The wall climbing intervention was found to be safe for gynecologic cancer survivors and resulted in improved cardiovascular fitness and muscular strength.
- Oncology nurses can help gynecologic cancer survivors locate indoor climbing wall locations where programs are available, and even arrange free or low-cost trial periods.

previous WCI studies have reported adherence rates, so comparisons are not possible. However, the adherence rate to the WCI is similar to adherence rates reported for other physical activity interventions among GCSs. For example, von Gruenigen et al. (2012) reported an 84% adherence rate to an exercise and healthy diet intervention in endometrial cancer survivors. Kavanagh et al. (2009) reported a slightly lower adherence rate of 76% to a nutrition and physical activity intervention in overweight or obese endometrial cancer survivors. One of the challenges in optimizing adherence to group-based WCIs is the inability to reschedule missed sessions. Two of the primary reasons for missed climbing sessions in the current study were lack of child care and vacation. These barriers are not unexpected because of the mean age of the patient group and the time of year the intervention was conducted (summer). Offering child care and make-up sessions, and offering the intervention during other seasons, may improve adherence.

Despite being older, obese women with significant comorbidities and no experience in wall climbing, most GCSs were able to improve essential movement skills during the eight-week WCI. Participants were highly proficient at using safety commands and belaying. As expected, as the difficulty of the route increased, the quality of the ascent and application of the essential movement skills decreased. However, the majority of participants were proficient at the majority of skills. Future research may examine the frequency of climbing sessions or the length of the WCI to determine if participants' skills would continue to improve with increasing fitness and practice time.

No serious adverse events related to wall climbing were observed or reported. A study by Neuhof, Hennig, Schoffl, and Schoffl (2011) determined that the incidence of climbing-associated injuries was 0.2 injuries per 1,000 hours of outdoor rock climbing. The intervention was closely supervised by highly trained climbing staff in a highly controlled environment, which may have further reduced the risk of injuries and adverse events.

Consistent with the authors' hypotheses, significant differences were found in favor of the WCI group for a number of objective health-related and functional fitness parameters. Specifically, the WCI group achieved a significant increase of 51 meters in the 6-minute walk compared to those in the UC group. Research in a number of patient populations indicates that a change in the 6-minute walk of 43–54 meters is clinically meaningful (Perera, Mody, Woodman, & Studenski, 2006; Redelmeier, Bayoumi, Goldstein, & Guyatt, 1997), although no clinically meaningful change has been identified for cancer survivors. Climbing uses anaerobic and aerobic energy systems, leading to positive adaptations in aerobic fitness (Rodio, Fattorini, Rosponi, Quattrini, & Marchetti, 2008; Watts, 2004). Rodio et al. (2008) found that the intensity of climbing is similar to that recommended by the American College of Sports Medicine (2013) to sustain good cardiorespiratory fitness, suggesting that climbing may be an effective training modality for cancer survivors. Future research is warranted to confirm these results with heart rate monitoring during climbing and using a maximal cardiorespiratory fitness test. In addition, based on research in other chronic disease populations (Boxer et al., 2010; Pinto-Plata, Cote, Cabral, Taylor, & Celli, 2004), the 6-minute walk may be a prognostic indicator of survival and other disease outcomes. Therefore, wall climbing may be an effective type of physical activity for cancer survivors based on these valuable health benefits.

Muscular strength in the WCI group improved significantly in the 30-second chair stands, 30-second arm curls, and grip strength. No other studies, to date, have examined the effects of wall climbing on muscular strength in any cancer survivor group. Partly in line with the current study, Jolk, Dalgas, Osada, Platen, and Marziniak (2015) suggested that climbing may be an effective resistance training modality, resulting in significant improvement in leg strength performance in patients with multiple sclerosis in a descriptive five-week interventional climbing study. Similarly, other studies have reported improvements in grip strength, upper limb strength, and endurance induced from climbing compared with no climbing in novice climbers (Lopera, Porcari, Steffen, Doberstein, & Foster, 2007; Rodio et al., 2008; Watts, 2004). Resistance training has been shown to improve muscular strength, lean body mass, physical functioning, fatigue, and quality of life (Strasser, Steindorf, Wiskemann, & Ulrich, 2013), and may be linked to improved long-term survival in cancer survivors (Hardee et al., 2014). Wall climbing improved muscular strength in GCSs through the movement of body weight vertically and horizontally. Wall climbing may be a safe, novel, and effective form of functional resistance training

where women may reap similar benefits as strength training in a gym environment.

This feasibility trial should be interpreted within the context of its important strengths and limitations. To the authors' knowledge, this study is the first to assess a WCI in any cancer survivor group and one of the few in any patient population. The authors closely tracked the recruitment rate, adherence rate, and all reasons for missed climbing sessions. Lastly, a randomized, controlled trial design was used, as was a state-of-the-art climbing wall and reliable and validated measures to examine objective health-related and functional fitness parameters. Limitations include the low recruitment rate, which may limit generalizability, small sample size, no long-term follow-up, and the failure to blind outcome assessors.

The American College of Sports Medicine (Schmitz et al., 2010) and the American Cancer Society (Rock et al., 2012) recommend that GCSs perform 150 minutes per week of moderate intensity aerobic exercise and 2–3 days per week of resistance training. The pilot data suggest that wall climbing may be a novel intervention that can substantially improve cardiovascular fitness and muscular strength in GCSs. Larger phase II and III trials are needed to confirm and extend these findings to outcomes important to GCSs, such as symptom management, quality of life, psychosocial functioning, and overall survival. If improved outcomes are demonstrated in larger trials, these types of wall climbing programs may be offered by cancer centers, cancer support groups, and other cancer organizations.

Conclusion

Oncology nurses may play a role in facilitating access to indoor climbing walls for cancer survivors by learning where indoor climbing walls are located in the community, what programs are available, and possibly even arranging for free or low-cost trials for cancer survivors. By becoming knowledgeable about alternative forms of physical activity for cancer survivors, like wall climbing, oncology nurses are able to offer a broader array of physical activity opportunities that are likely to appeal to even more cancer survivors.

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