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Feasibility and acceptability of home-based strength training in endometrial cancer survivors

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Abstract

Purpose Physical activity is important for healthy cancer survivorship, yet many endometrial cancer survivors do not participate in recommended muscle-strengthening activity. The purpose of this study was to determine the feasibility of home-based muscle strengthening activity in endometrial cancer survivors.

Methods Forty post-treatment endometrial cancer survivors were enrolled in a randomized trial, of twice-weekly home-based strength exercise versus wait-list control. The intervention included educational materials, exercise equipment (dumbbells, resistance bands), and support/feedback via video coaching sessions. Participants completed the exercises twice per week for 10 weeks, with a 5-week follow-up period. Feasibility was measured by program adherence, as well as safety of and satisfaction with the study.

Results On average, participants were 60.9 years old (SD = 8.7), had a BMI of 39.9 kg/m^2 (SD = 15.2), and were 2.9 years (SD = 1.2) since diagnosis. The majority (83%) had stage I disease at diagnosis. Seventy-five percent adhered to the exercise prescription of twice/week, with 85% of participants missing fewer than 3 of the workouts. Forty percent of participants continued workouts during the 5-week follow-up. Participants were highly satisfied with intervention. No injuries or adverse everts occurred.

Conclusion This home-based program was feasible in endometrial cancer survivors. While adherence was measured, future research should focus on long-term maintenance of exercise and should explore progressions and modifications of exercises at a distance for various abilities.

Implications for Cancer Survivors Muscle strengthening activities are recommended for all cancer survivors. This study shows that a home-based muscle strengthening exercise is feasible in endometrial cancer survivors.

Keywords Endometrial cancer · Survivorship · Exercise · Muscle · Strength · Home based

Introduction

With improvements in detection and treatment, cancer survivors are living longer than ever before [1]. Among all cancers that affect women, endometrial cancer is the most strongly linked to obesity and inactivity [2]. Endometrial cancer is projected to have a large increase in survivors, due in part to increases in obesity and inactivity [3, 4]. Despite a favorable 5-year survival rate of 81% for endometrial cancer, survivors remain at increased risk for cardiovascular disease, diabetes, and secondary cancers [2, 5]. Many endometrial cancer survivors have persistent post-treatment health and lifestyle concerns including glucose dysregulation, hypertension, and metabolic syndrome, among others, that may be improved by regular exercise [6]. Endometrial cancer survivors are more likely to die from cardiovascular disease than from any other cause [7].

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Regular physical activity can prevent cardiovascular disease, improve quality of life, and reduce symptoms of anxiety and depression in adults with and without a cancer history [8–10]. Current guidelines from the US Department of Health and Human Services recommend that cancer survivors achieve 150 min of moderate intensity activity, avoid inactivity, and complete muscle strengthening activities at least 2 days per week [11]. Muscle strengthening activities can be completed using external resistance, called resistance training or resistance exercise referring to the source of external force (resistance), where other interventions focus on strength as a performance outcome, also known as strength exercise or strength training. These terms are often used interchangeably, but for the rest of this paper, the term strength training will be used. These exercise guidelines were published alongside expert panel-written consensus reports summarizing the evidence for aerobic, strength, and aerobic plus strength trials in cancer survivors [12]. Part of this consensus report included that benefits for cancer survivors can be observed in strength training-only interventions as well [12]. Regular strength training can improve muscle health and physical function through hypertrophy (larger muscle cells), improved muscular strength/endurance and increases in muscle quality, improved bone health, reduced hypertension, and improved function in adults and female cancer survivors alike [13]. Both aerobic and strength exercise confer health benefits for survivors, and this study targeted strength exercise as a primary behavioral target to move survivors closer to meeting physical activity recommendations.

The majority of published strength-alone or strength-combination studies used in-person supervision (by a fitness trainer and/or research staff), demonstrating that strength training is feasible in cancer survivors [14, 15]. New and innovative approaches are being investigated in hybrid clinic-to-community centers, focused on implementation and engagement of cancer survivors [16]. Gym-based interventions and/or interventions requiring a personal trainer (or direct supervision) are resource intensive and can be difficult to scale. Community-based programs can be useful for physical activity in cancer survivors but only if those locations are accessible [17]. Specifically, these interventions may exacerbate disparities among those unable to access these resources due to socioeconomic factors or rurality [18]. Gyms and recreational facilities are the most centralized location for strength equipment and knowledge. However, the gym environment can exacerbate endometrial cancer survivor's body image concerns and is not appealing for some women [18, 19]. There are specific barriers to participation in strength training including lack of resources, lack of knowledge of both the benefits, and how to perform the exercises [20].

Given these barriers, few endometrial cancer survivors regularly participate in strength training [21, 22]. Whether the lack of participation is due to the perceived barriers [22], lack of time, or other reasons, regular strength training is still important for overall and musculoskeletal health [23]. This study implemented a home-based strength training program in endometrial cancer survivors designed to combat these barriers and make strength exercise more broadly accessible. A home-based program eliminates geographic barriers, facilitating participation by rural individuals that may not have access to traditional locations such as gyms, community centers, or clinics. Additionally, the investigation utilized tele-coaching to allow for individualized coaching and support, via a distance-based resource, and allow for supervision and support without the need to interact in person which has been shown to be a key supportive element for distance-based interventions [24].

Both supervised [24] and home-based [25] strength training programs have been shown to be feasible in other cancer survivor populations [26], but to our knowledge, this is the only investigation with a specific home-based strength training program in endometrial cancer survivors. Endometrial cancer survivors have more prevalent obesity and infrequently undergo chemotherapy as part of their treatment, and other distance-based interventions have shown success for aerobic interventions in other cancer survivor groups with obesity, and have also found distance-based interventions effective for those who have and have not underwent chemotherapy [26]. Previous investigations in endometrial cancer survivors used a combined aerobic and strength exercise program, often supervised or delivered via a personal trainer [25, 27]. One previous study by Basen-Enquist et al. [28] used a home-based physical activity program in endometrial cancer survivors to increase walking or other moderate intensity cardiovascular activity [28]. Emerging research areas in cancer survivorship include rural health disparities, healthy aging through preserving function, and accessibility of resources such as those necessary for physical activity [29]. To date, no other published studies have used home-based strength exercise alone in endometrial cancer survivors. We aimed to establish the feasibility (adherence, satisfaction, and safety) of a novel home-based strengthening resistance exercise program in endometrial cancer survivors. We hypothesized that participants would be adherent, adverse events would be rare, and satisfaction would be high. Ideally, home-based strength exercise will serve as a gateway to regular strength training, participation in aerobic activity, and eventually sustained physical activity.

Methods

This was a pilot randomized controlled trial testing a 10-week home-based strength training program against wait-list

control. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was conducted in Madison, WI. The study was approved by the University of Wisconsin-Madison's Health Sciences Institutional Review Board (Protocol #2018-0953) and by the Carbone Cancer Center's Protocol Review and Monitoring Committee (Protocol UW18013). Prior to enrollment of the first participant, the study was registered at clinicaltrials.gov (NCT03722030). Written informed consent was obtained from all participants. This study was abbreviated as H-BEST for Home-Based Exercise for Strength Training to facilitate communication about the trial for participants.

Participants and recruitment

Endometrial cancer survivors were eligible if they met the following criteria: (a) age 18–74 years, (b) diagnosis of non-metastatic (stages I–III) type I endometrial cancer within the past 5 years, and (c) at least 10 weeks post-completion of primary treatment, defined as hysterectomy but may also include radiation or hormone therapy. Women were excluded if they (a) had recurrent or metastatic disease, (b) were currently (within the past 2 weeks) participating in strengthening exercise at least 2 days per week, (c) were unwilling to complete study measures, or (d) endorsed one or more items, indicating a potential safety risk with exercise on the Physical Activity Readiness Questionnaire (PAR-Q) [28] over the phone.

Women were recruited via provider referrals or mailed invitation letter at the UW Carbone Comprehensive Cancer Center from October 2018 to October 2019. Interested individuals participated in an initial telephone screening soliciting information on the eligibility criteria listed above before proceeding.

Study visits

Participants had their physical measures taken (height, weight, hip, and waist circumference) at baseline and at week 10. They also completed the short performance physical battery assessment at baseline and at week 10 to examine changes in functional fitness and strength. Participants were given an accelerometer to wear for 1 week and return via postal mail using a provided postage-paid envelope at baseline, week 5, and week 10. The accelerometer was not used for tracking intervention-specific exercises, as strengthening exercises are challenging to capture via waist-worn accelerometer. The accelerometer was used for ambulatory activity for both groups over time, to see if potential tradeoffs were observed via ambulatory activity (from accelerometer) for strengthening exercises (from the logs for the intervention). Additionally, use of accelerometers for both groups allowed for observation of potential measurement reactivity, which is a potential concern for exercise-based studies when participants volunteer for an exercise program as part of the study.

Randomization

After the research team confirmed adequate wear time on the accelerometer at baseline, each participant was assigned with equal probability to intervention or wait-list control group. The randomization allocation table was created by a study team member who was blinded to assessments; allocation numbers were then placed in sealed envelopes. Both study groups received email communication (or telephone if preferred) from the study team throughout the intervention. Email communication was used to clarify questions and comments from participants and was used to inform intervention timing of the week 5 and week 10 assessments.

Wait-list control arm

This group received print materials about healthy survivorship developed by the American Cancer Society [30]. Participants were asked to not make any deliberate changes to their lifestyle. At the week 10 final assessment, participants in this group were given the exercise material resources (dumbbells, resistance bands) as the intervention group.

Intervention arm

The intervention group had an additional in-person visit to learn the exercises, receive the materials, and obtain personalized coaching from the study coordinator (with professional experience as a certified personal trainer) completed within 1 week of randomization. Participants then began twice-weekly sessions at home. Participants were instructed that they could exceed the twice-weekly prescription as long as they allowed themselves at least 48 h for recovery between sessions [13]. This group also had seven scheduled check-in calls which tapered off over time (two calls in week 1; one call in each of weeks 2, 3, 4, 6, and 8). Key components of the intervention group are described below. The active intervention period was 10 weeks in length, with an additional 5 weeks without active monitoring for a total intervention length of 15 weeks.

Exercise materials and resources: bands, dumbbells, videos, and exercise manual The exercise program was a full-body routine consisting of eight exercises covering all major muscle groups and compliant with federal activity recommendations [11]. The exercise program was developed by the research team using professional personal training experience. Each participant received a set of graded resistance bands with

handles (Black Mountain Products, Elkhorn, WI) and a pair of dumbbells (options of 5-, 6-, 8-, 10-, and 12-pound sets), both of which were used to quantify load lifted via band or dumbbell. Each participant had access to a private YouTube channel exercise library. They also received a printed manual with exercise cards with progressions and regressions, photos of incorrect and correct form, information about self-monitoring and logging the exercises, guidelines for increasing difficulty of the exercise program (via progressive overload), and information about how to rate the intensity. All study materials were developed by research staff which included expertise in sedentary and exercise behavioral interventions, professional personal training experience, and use of motivational interview techniques.

Exercise logs and intensity rating Participants were asked to complete two to three sets of 8 to 12 repetitions of each exercise, logging the reps and perceived intensity after each set using the logs. Participants were provided with a structured exercise log on paper to record exercises. Participants were using the OMNI-Res scale [31] and were asked to work at a 7 or 8 out of 10 to reap strength benefits [13]. Instruction was delivered that if after 3 sets of 12 repetitions the exercise intensity was not self-rated as a 7–8 out of 10, the participant should increase the difficulty of the exercise, often meaning a stronger band. Participants also provided their ratings of perceived exertion (RPE) [32]. Participants were asked to complete one log (one physical document of all exercises, sets, reps, and type of equipment used) per session and mail the completed logs to the study team on a weekly basis. A log was considered "complete" if the participant completed most (> 60%) of the exercises on the log.

Study check-ins: tele-coaching Participants were provided with a tablet (returned at study completion) if they did not have access to a front-facing camera or other means to video conference. Participants could use any software for the tele-coaching calls. Each coaching call had the same script assessing exercise issues, injuries or pain, barriers and facilitators to exercise, and including time for questions for the study coordinator. The study coordinator had formal training in motivational interviewing techniques as well as personal training certification and professional experience.

Outcome measures

Feasibility The primary outcomes were adherence to the program, safety of the program, and satisfaction with the program. Adherence was measured by completed and returned logs. Safety was measured by number of injuries and adverse events attributable to study participation. Satisfaction was collected via electronic survey (delivered via email following final visit) and measured by Likert ratings of satisfaction (options of "extremely satisfied," "very satisfied," "satisfied," "slightly dissatisfied," or "very dissatisfied"), with an importance (options of "extremely important," "very important," "moderately important," "slightly important," and "not at all important") for each component of the study.

Device-measured activity Participants wore an accelerometer (wGT3-x, ActiGraph Pensacola, FL) for 1 week at baseline, week 5, and week 10 on the right hip (mid-axillary line) to primarily measure ambulatory physical activity. Data were downloaded in 10-s epochs, and the Troiano (2007) wear time validation algorithm was used to determine valid wear. A valid wear period was defined as at least 4 days of 10 h of wear. The Freedson Adult (2008) moderate to vigorous physical activity (MVPA) cut points were used for scoring.

Data analysis

The sample size of 40 participants (20 per group) was chosen to be consistent with other similar pilot studies of exercise interventions (range 17–60) (references 29, 33–35). The primary analyses focus on feasibility of the intervention and trial procedures. Baseline characteristics were reported using means and standard deviations for continuous variables and frequencies and percentages for categorical variables. Log data was analyzed using descriptive statistics. Urban influence codes were used to classify residential groups based on their population size and proximity to largest city or town, and the schema has two metro and 10 non-metro categories [36]. Descriptive statistics were utilized for accelerometer-measured activity. All analyses were conducted using SAS 9.4 (SAS; Cary, NC).

Results

Study population

As a result of the clinic pre-screening, sixty women were telephone screened for eligibility, 40 were eligible and willing to participate, and all 40 eligible women chose to participate. Reasons for ineligibility or declining participation were as follows: already participating in strength exercise regularly ($n = 9$), unwilling to undergo study measures ($n = 6$), not interested or declined to participate ($n = 4$), or not meeting age eligibility criteria ($n = 1$). The four who were not interested or declined to participate did not complete the telephone screening questionnaire, and study eligibility was not formally determined. Post-baseline visit, all 40 were randomized into the two study groups (Fig. 1).

At baseline participants were an average of 60.9 (SD = 8.7) years old, with mean BMI of 39.9 kg/m^2 (SD = 15.2), and most were married with a college degree (Table 1). Over

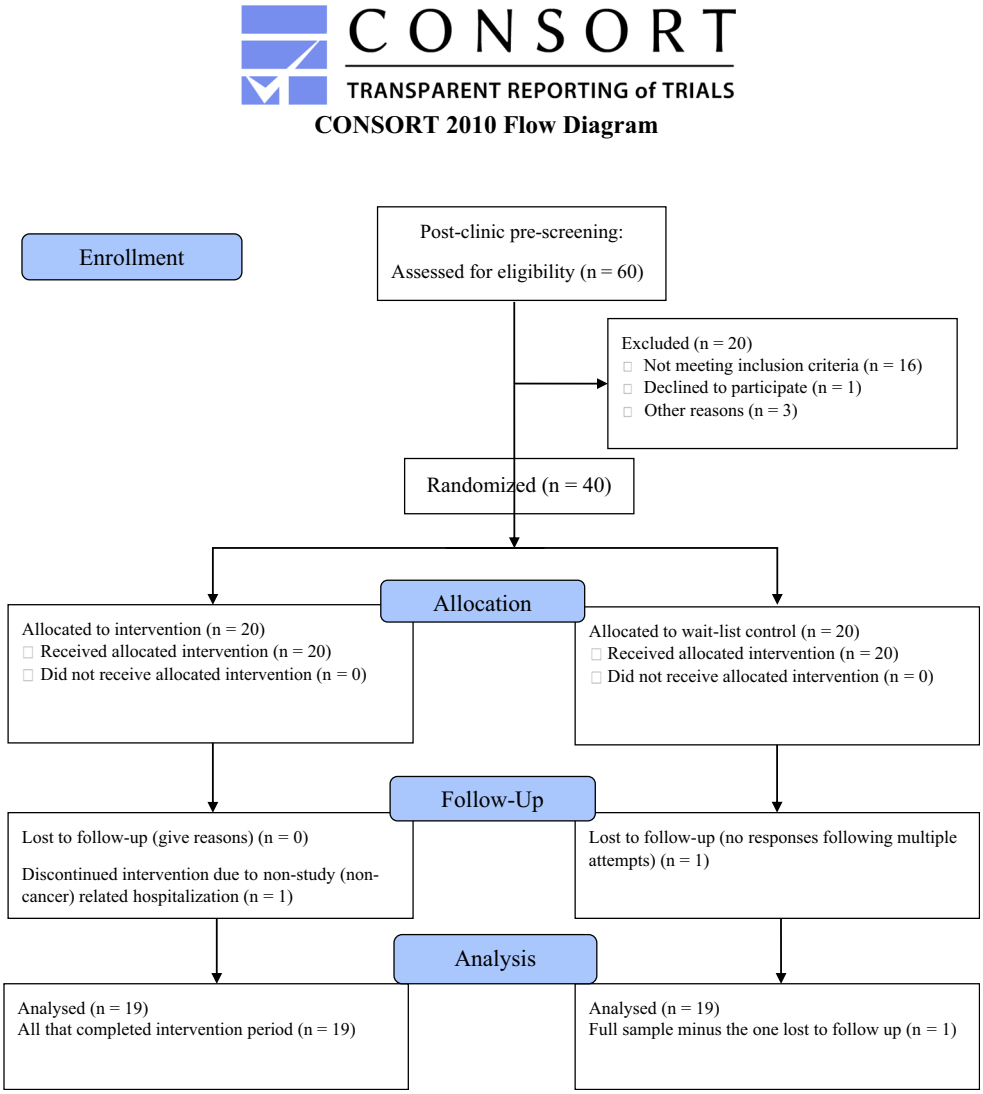

Fig. 1 CONSORT diagram of recruitment for study

80% of participants were diagnosed with stage I cancer, and all underwent hysterectomy. Participants had a mean time since diagnosis of 2.9 (SD = 1.2) years. Ten participants (25%) resided in non-metropolitan (rural) areas.

Adherence to exercise goals

Table 2 presents the adherence data to the exercise prescription (at least 2 sessions per week for 10 weeks), the number of logs received (independent of completion), and the number of coaching calls completed with study staff (out of 7 scheduled calls). Overall, 95% of the logs were received, and over 75% of the prescribed sessions to the program were completed. Coaching calls were completed using FaceTime ($n = 7$), Skype ($n = 5$), and Google Hangouts ($n = 2$) or via telephone ($n = 6$). Most calls focused on verbal coaching without a visual demonstration of an exercise. On average one call (out of 7) per participant included a demonstration or modification shown via video, and most calls lasted between 7 and 15 min. After the week 10 in-person visit, participants were asked to complete an additional 5 weeks of the program without supervision and return their completed logs. On average, participants completed 2.5 weeks (median 3.0 weeks) of the exercise program after the final visit, with 40% of participants in the group continuing for all 5 weeks (summarized in Table 2). The mean load lifted per exercise increased during the study (data not shown). The total load lifted increased by 10 pounds on average over the 10-week intervention (data not shown), while sets and reps were unchanged (on average 3 sets of 12 reps each).

Safety

There were no adverse (serious or otherwise) events due to study participation, which was assessed directly (via coaching calls) and indirectly (participants instructed to contact staff with injury).

Table 1 Baseline demographic characteristics[1]

	Overall (*N*=40)		Exercise intervention (*N*=20)		Wait-list control (*N*=20)	
	N (%)	Mean (SD)	*N* (%)	Mean (SD)	*N* (%)	Mean (SD)
Age in years		60.9 (8.7)		60.9 (9.6)		60.9 (8.0)
Married/partnered	28 (70%)		15 (75%)		13 (65%)	
Education						
High school or less	3 (7.5%)		1 (5.0%)			2 (10.0%)
Trade school/some college	13 (32.5%)		7 (35.0%)			6 (30.0%)
College graduate	14 (35.0%)		6 (30.0%)			8 (40.0%)
Post-graduate degree	10 (25.0%)		6 (30.0%)			4 (20.0%)
BMI (kg/m^2)		39.9 (15.2)		42.2 (19.5)		37.9 (8.6)
Healthy (BMI <25)	2 (5%)		1 (5%)		1 (5%)	
Overweight (25–29.9)	4 (10%)		1 (5%)		3 (15%)	
Obese I (30–34.9)	8 (20%)		4 (20%)		4 (20%)	
Obese II (35–39.9)	7 (17.5%)		5 (25%)		2 (10%)	
Obese III (40+)	19 (47.5%)		9 (45%)		10 (50%)	
% Total body fat (DXA)		51.2% (6.0)		51.6% (5.0)		50.4% (6.8)
Waist circumference (cm)		106.8 (16.0)		107.9 (16.9)		105.5 (15.2)
Hip circumference (cm)		129.7 (18.7)		130.2 (18.4)		129.2 (19.4)
Waist-to-hip ratio		0.83 (.06)		0.82 (.04)		0.83 (.07)
Lowest risk (≤0.8)[2]	18 (45%)		8 (47%)		10 (52.6%)	
Middle risk (0.81–0.85)	7 (17.5%)		4 (23.5%)		3 (15.8%)	
Highest risk (>0.85)	11 (27.5%)		5 (29.4%)		6 (31.6%)	
Tumor stage at diagnosis						
Stage I	33 (82.5%)		15 (75.0%)		18 (90.0%)	
Stage II	2 (5.0%)		2 (10.0%)		0 (0.0%)	
Stage III	5 (12.5%)		3 (15.0%)		2 (10.0%)	
Treatment						
Surgery only	30 (75%)		14 (70.0%)		16 (80.0%)	
Radiation alone	3 (7.5%)		2 (10.0%)		1 (5.0%)	
Chemotherapy alone	3 (7.5%)		0 (0.0%)		3 (15.0%)	
Chemotherapy + radiation	4 (10.0%)		4 (20.0%)		0 (0.0%)	
Years since diagnosis		2.9 (1.2)		2.8 (1.2)		3.0 (1.3)
Years since surgery		2.8 (1.3)		2.7 (1.4)		3.0 (1.3)

[1] None of the comparisons between these group baseline characteristics were statistically significant

[2] Categories defined by the World Health Organization

Satisfaction with study components

All electronic survey respondents ($n = 16$, 80% of exercise intervention group participants) reported that the study coordinator, instructional visit, exercise manual, and resistance bands were very or extremely important to study participation (Fig. 2). All respondents reported that they were very or extremely satisfied with the study coordinator, the instructional visit, and the intervention overall.

Moderate to vigorous intensity physical activity

On average, participants in the intervention group completed an average of 181 min per week of MVPA at baseline (standard deviation SD = 176 min), 165 min at week 5 (SD = 130 min), and 159 min (SD = 145 min) per week at the week 10. Participants in the control group completed 149 min (SD = 99), 151 min (SD = 85), and 156 min (SD = 96) per week of MPVA at baseline, week 5, and week 10, respectively. (Table of findings is available as supplemental material.)

Discussion

Home-based strength training was feasible in endometrial cancer survivors, with high adherence to the program, no adverse events, and highly rated satisfaction. The overall adherence rate during the intervention period was high with 75% of participants meeting the full goal and 85% missing fewer than 3 sessions. Our adherence rate is also similar to a lifestyle-focused intervention in endometrial cancer survivors which reported an adherence rate of 77% over a 24-week period [27]. In a recent meta-analysis, Bullard et al. report that the pooled overall adherence rate to exercise programs in individuals with chronic conditions was 77% [37]. Home-based aerobic programs were slightly higher overall at 80% (CI 65–91%) [37]. Another recent meta-analysis of distanced-based exercise intervention in cancer survivors found only one (of 29) randomized controlled trial in endometrial cancer survivors [26]. A small group of participants exceeded the twice-weekly strength-based prescription consistently (25% of the sample).

Table 2 Adherence and completion rates of exercises and video calls for the exercise group

	Intent to treat (n=20)	As treated[1] (n=19)
Mean (SD) calls completed (of 7)	5.4 (2.0)	5.6 (1.8)
Percent of logs returned	90%	95%
Adherence to strength training sessions during weeks 1–10		
Mean (SD) total workouts completed/participant (n=20 expected)	19.2 (8.7)	20.2 (7.6)
At least 1 session/week	17 (85%)	17 (90%)
At least 1.5 sessions/week	17 (85%)	17 (90%)
At least 2 sessions/week	15 (75%)	15 (79%)
More than 2 sessions/week	5 (25%)	5 (26%)
Adherence to strength training sessions during weeks 11–15		
Mean total workouts completed/participant (n=10 expected)	9.9 (4.5)	9.9 (4.5)
At least 1 session/week	8 (40%)	8 (42%)
At least 1.5 sessions/week	8 (40%)	8 (42%)
At least 2 sessions/week	8 (40%)	8 (42%)
More than 2 sessions/week	5 (25%)	5 (26%)
At least 1 week of 2 sessions/week	11 (55%)	11 (58%)
At least 2 weeks of 2 sessions/week	9 (45%)	9 (47%)
All 5 weeks of 2 sessions/week	8 (40%)	8 (42%)

[1] Excludes one participant who withdrew due to non-study-related hospitalization

[2] All participants who completed logs post-week 10 were doing at least 2 workouts per week

During the follow-up period, 40% of the intervention group still completed the exercises with regularity demonstrating that these participants established a new behavioral pattern after 10 weeks and no longer required high-contact involvement from study team. However, most participants did not complete the 5-week follow-up suggesting the importance of supervision and support from the research team to adhere to the goals. We used intervention components that have been shown to be key supportive elements for distance-based exercise programs in cancer survivors [24]. Participants were capable of appropriately reporting their volume of exercise (sets, reps, load) via the logs. Accurate knowledge of training load and volume is required to achieve the progressive overloading required for improvements in the musculoskeletal system [13]. These participants were not only consistently logging their exercises; they were also demonstrating progressive overload. While the numbers of sets and repetitions remained relatively constant across time, the load increased. Other interventions reported are the relative strength gains, assessed via estimated 1 rep max texting or other fitness assessment, but to our knowledge, this detail of exercise performance data has not been published in cancer survivors using a home-based intervention. Furthermore, as the load increased, participants were able to monitor the relative intensity of exercises providing preliminary evidence of strength improvements.

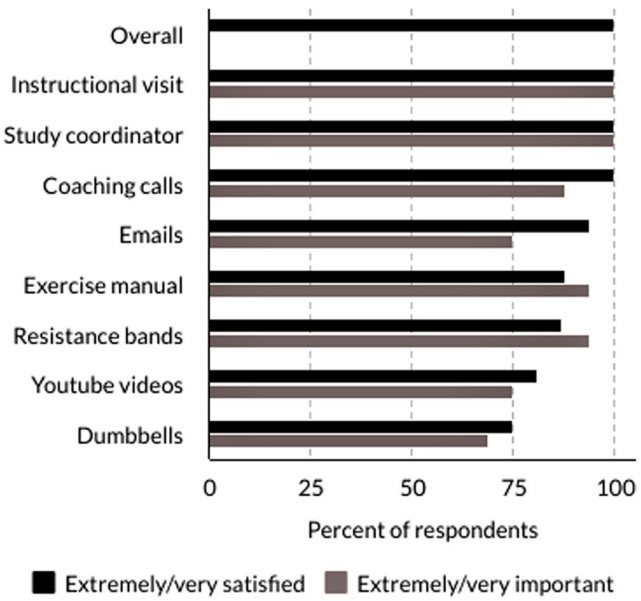

Fig. 2 Exercise intervention ratings of intervention components. Participants rated each component on satisfaction and importance in helping them to achieve the intervention goals. Responses were collected anonymously from the exercise arm, with 16/19 participants providing responses. Note: Participants were only asked to rate satisfaction for the study overall; they did not rate the importance of the study itself

Progressive overload, measured via logs with participants reporting more sets, reps, or a higher intensity band, were observed without reductions in aerobic activity. It is important to note that there were no obvious changes in accelerometer-measured physical activity based on descriptive statistics, which

partially reduces the concern for activity tradeoffs (strength for aerobic) in this study. In a meta-analysis of home-based exercise interventions, the overall mean effect size for physical activity was 0.21, showing a small but significant mean change of these distance-based intervention on physical activity [26]. While the accelerometer captures ambulatory physical activity well, it does not capture strength training activities. Therefore, with the completed strength training logs plus the accelerometer-measured estimates of physical activity, the intervention group was doing more physical activity over time compared to the wait-list control group. Both self-reported logs and accelerometers were used to capture different types of physical activity in this intervention, where the inclusion of accelerometers was seen in less than 10% of included studies in distanced based physical activity interventions in cancer survivors [26].

There are strengths and limitations to this investigation. Strengths include the randomized trial design, which bolsters internal validity, and the home-based approach which allows for greater reach and scalability for future work. In addition, most logs were returned to the research team, reducing the amount of missing data, as even an incomplete (but returned) log indicated a lack of participation and not an unknown session outcome. Finally, this sample included 25% rural residents providing preliminary evidence for use in rural populations that may not be willing to or capable of accessing other physical activity resources such as a community center or recreational facility. Previous investigations have shown that rural-dwelling adults are more likely to be diagnosed at later stages of cancer and have higher rates of mortality; thus, our ability to reach a population with health vulnerabilities is particularly important [38]. This sample had high body mass index and high levels of central adiposity with high mean body fat percentage, which should be considered when interpreting our findings. However, obesity is a known risk factor for endometrial cancer, and there is limited evidence on the expected body composition of endometrial cancer survivors; so our results uniquely contribute to the evidence base.

One key limitation is a lack of racial diversity (98% non-Hispanic white). Since African American women are more likely than non-Hispanic white women to be diagnosed with aggressive subtypes of endometrial cancer and to have poorer survival, these groups need to be engaged in interventions to more completely understand the feasibility and generalizability for all endometrial cancer survivors [39]. Effective culturally appropriate interventions such as those focused on physical activity and strength training may be especially important for historically disenfranchised groups. Also, data were not collected on the number of women approached by providers for study inclusion who were either not interested or expressed interest but did not follow up with research staff which provides a potential selection bias for this sample (as with all exercise studies). While the intervention was feasible, there were many different behavior-change techniques utilized including goal setting, feedback, and self-monitoring, making it difficult to identify the most important components of the study. Future work may include larger, more diverse samples of survivors and potentially could incorporate more sophisticated designs such as a multiphase optimization strategy (MOST) to identify an ideal package of intervention components [40]. Finally, cost is an important component for exercise interventions, especially for scaling and implementation. Costs associated with this study included exercise equipment ($50/participant), technology (varies), and tele-coaching (varies by provider). Personnel costs included a research coordinator at 33% time. However, it should be noted that certain fixed time demands (e.g., designing intervention materials, establishing recruitment workflows, IRB, and regulatory forms) contribute a higher per-participant cost in small pilot studies vs. large-scale trials. Thus, a future larger-scale study would have an economy of scale resulting in lower per-participant personnel costs. These costs are not remarkably high, but it greatly depends upon who would cover these costs if implemented into care delivery.

In conclusion, this home-based strength training intervention was feasible with respect to adherence, safety, and satisfaction with the intervention. Strength exercise was made feasible by providing participants with resources including the materials (dumbbells, bands), knowledge (instruction, exercise manual, exercise videos), and support (study coordinator) through a 15-week long intervention. Strength-based interventions need appropriate and specific measures of strength and quality of life to understand the impact of this behavior on the individual. Future work should consider specific guidance for those who are successful such as ideas for increasing difficulty or complexity of exercises and better ways to engage with those who are not succeeding with their home-based exercises, while also maintaining or increasing aerobic activity. This should be considered before proceeding to a large-scale trial. Overall, the lessons learned from this pilot should inform and encourage future studies of exercise and physical activity in endometrial cancer survivors.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11764-021-00990-3.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the University of Wisconsin-Madison's Health Sciences Institutional Review Board (Protocol #2018-0953) and by the Carbone Cancer Center's Protocol Review and Monitoring Committee (Protocol UW18013). Prior to enrollment of the first participant, the study was registered at clinicaltrials.gov (NCT03722030).

Informed consent Written informed consent was obtained from all participants.

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