THESIS

FEASIBILITY, ACCEPTABILITY AND PRELIMINARY EFFECTIVENESS OF A VIDEO CONFERENCE DELIVERED, GROUP-BASED PHYSICAL ACTIVITY PROGRAM FOR CANCER SURVIVORS.

Submitted by

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ABSTRACT

FEASIBILITY, ACCEPTABILITY AND PRELIMINARY EFFECTIVENESS OF A VIDEO CONFERENCE DELIVERED, GROUP-BASED PHYSICAL ACTIVITY PROGRAM FOR CANCER SURVIVORS.

Background: Although supervised cancer rehabilitation and exercise programs are effective for improving health outcomes among cancer survivors, widespread access is lacking, and the COVID-19 pandemic highlighted the need for innovative ways to reach and serve cancer survivors in their homes. Method: A single arm, pre-post study to assess feasibility, acceptability and preliminary effectiveness of **Fit**ness for **C**ancer **T**herapy (Fit Cancer), an 8-week, group-based videoconference delivered exercise program. Feasibility and acceptability were captured by accrual, attendance and adherence rates and participant satisfaction and analyzed using descriptive statistics. Preliminary estimates of the effects of Fit Cancer on physical function, Quality of Life (QOL) and Exercise Self Efficacy (ESE) were measured at pre- and post-program and analyzed by percent change and one-tailed, paired sample t-tests. Results: A total of $n = 39$ participated in the study. Accrual (91%), retention (90%), adherence (88%) rates along with acceptability (94%) findings support feasibility. Physical activity measured by moderate-vigorous aerobic and resistance exercise had a percent change increase of 69.9% ($p < 0.05$). Lower (10.4%, $p < 0.05$) and upper body muscular endurance (22.4%, $p < 0.05$) and single-leg balance (12.1%, $p < 0.05$) all increased significantly. No changes were seen in QOL or BARSE and a reduction was seen in ESE (-8.1%, $p < 0.05$). Conclusion: Results indicate that a videoconference delivered exercise program was feasible and acceptable and may help cancer

survivors increase physical activity and muscular strength/endurance. A controlled trial is required to confirm these findings.

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Introduction

The American Cancer Society estimates nearly 1.9 million new cases of cancer diagnosed in the US in 2021 [1]. Due to advancements in the therapeutic treatment of cancer, mortality rates of several cancer types have declined over the last 30 years resulting in a growing number of cancer survivors within the US [1][2]. The harsh nature of cancer treatment leaves cancer survivors reporting an average of five additional health issues, with those that are sedentary reporting more than those who are physically active [3]. It is well researched that physical activity (PA) can play a critical role in improving treatment related outcomes in cancer survivors, including reduced anxiety, depressive symptoms, and fatigue, and improved health-related quality of life and physical function [4]. Despite the positive effects of PA, PA rates are significantly lower following cancer diagnosis than before cancer diagnosis [5].

PA interventions aim to increase PA levels and subsequently improve treatment related outcomes in cancer survivors. Both non-supervised and supervised PA interventions have had success, however supervised interventions tend to have greater adherence to prescribed exercise compared to non-supervised exercise [6][7]. This suggests that interventions including supervised exercise sessions result in higher PA levels and thus elicit greater improvements in treatment-related outcomes such as quality of life (QOL), than non-supervised interventions [6][7]. Furthermore, supervised interventions that incorporate PA behavior change strategies also demonstrate greater success in increasing PA compared to interventions that do not include theoretically informed strategies [8]. For example, a systematic review by Stacey et al. (2015) found that interventions using the social cognitive theory (SCT) were effective for increasing PA [9]. Another review by Rossi et al. found significant improvements in PA in breast cancer survivors when the interventions utilized the SCT [10]. Another element of PA interventions

that has demonstrated success in increasing PA among cancer survivors is group cohesion and social support. Group cohesion (feelings of camaraderie) and social support (opportunity to be surrounded by others with shared experiences) have been acknowledged by cancer survivors as a facilitator in engaging in PA [11]. This suggests group-based supervision may confer additional benefits, while being more cost-effective than individual supervision (e.g., personal training) [11] [12].

Cancer survivors acknowledge the importance of peer support for PA [10], have reported that one of the quintessential facilitators for engaging in PA is the social benefit [11], and describe camaraderie, and the opportunity to be surrounded by others with a shared experience as motivating for being physically active [12-14].

In summary, extensive literature supports supervised, SCT and group-based delivery as important elements of PA interventions. Given this, the **Fit**ness for **C**ancer **T**herapy (Fit Cancer) program was developed at Colorado State University in 2017, utilizing supervised, group-based exercise and a SCT informed PA behavior change approach [13]. Unfortunately, because of the vulnerability to illness of many cancer survivors, the global COVID-19 pandemic forced many in person cancer rehabilitation and supervised exercise programs to pause or cease operations. These programs have either closed indefinitely or adapted their operations for delivery in a virtual format to continue to support cancer survivors engaging in PA. Fit Cancer elected to adapt the program for virtual delivery, and to date there are few studies that have examined the feasibility and effects of an exclusively videoconference delivered exercise program for cancer survivors.

Currently, only one previous study has published the effects of supervised exercise delivered via video conferencing in cancer survivors. This study by Wonders et al. reported on a 12 week program, with weekly personal training sessions delivered via video conferencing. This study found significant increases in physical function and quality of life outcomes, concluding that virtual exercise training is feasible for cancer survivors [14]. However, to our knowledge there is no current evidence for the feasibility of *group-based* exercise delivered via video conferencing, or its effects on PA. Group-based PA interventions present additional challenges, in particular suitable exercise prescription for a variety of people with a variety of comorbidities and/or physical limitations. Therefore, the purpose of this study is to examine the feasibility, acceptability and preliminary effects of virtual Fit Cancer; a group-based PA program for cancer survivors delivered via video conferencing.

Methods

Our intervention was a single-arm study with pre and post intervention assessments. The research aims were to: (1) assess feasibility, acceptability; and (2) gain a preliminary estimate of the intervention effects on PA (primary outcome), exercise self-efficacy, QOL, and measures of physical function. Outcomes were assessed at baseline and immediately post 8-week intervention.

Participants

Participants were cancer survivors recruited with a convenience sampling method through support groups, friends and family & internet/social media. Inclusion criteria were (1) ≥18 years old, (2) able to speak and read English, (3) diagnosed with any stage and type of cancer, and (4) have internet access and possess a computer, tablet, or smart phone with a front facing camera. Exclusion criteria were (1) already doing more than 150 minutes per week of at least moderate intensity exercise, (2) pregnant or planning to become pregnant in the next 9 months, (3) surgery planned in the next 9 months, and (4) does not receive medical clearance from health care provider if he/she answered 'yes' to one or more of the items on the Physical Activity Readiness Questionnaire (PARQ+) health screening questionnaire [15].

Procedures

Consent & Enrollment

Eligible participants received written information of the study procedures including the data being collected, weekly exercise and data input commitments and privacy information. Following this, eligible participants had a phone call with an ACSM certified exercise

physiologist where they were given the opportunity to ask questions before giving informed consent to participate. Once consented, a detailed medical history was collected.

Limited study staff lead to an upper limit of participants in the program at one time. Because of this, the first 20 participants to complete the consent and enrollment procedure were allocated to an immediate start. The next 19 to complete the enrollment procedure were allocated to start following the completion of the first 20. Finally, eligible participants who were not in the first 39 to enroll were placed on a waitlist to partake in future rounds of the program.

Once enrolled, participants' baseline assessment was scheduled and they were mailed program materials which included resistance bands, a FitBit Inspire 2, Fit Cancer workbook, towel, Fit Cancer branded t-shirt, and water bottle. All study procedures were pre-approved by Colorado State University's institutional review board (IRB number 20-9781H) prior to commencing data collection.

Pre & Post Program Assessments

All enrolled participants met with a study staff member via "Zoom" 1-2 weeks prior to the program commencing. During this visit anthropometrics were collected and tests of physical function measuring lower and upper body muscular strength and endurance and balance were administered. Participants were also given an explanation on how to set up and use the equipment they had been sent in preparation for their first exercise session. At the end of this visit participants were given the opportunity to ask questions regarding the questionnaires they received via email. These questionnaires were completed online via data collection software REDCap [16]. The baseline questionnaire collected sociodemographic information, PA, exercise self-efficacy, and quality of life. Within 1-2 weeks of completing the program the post program assessment was conducted by the same assessor and included the same tests and questionnaires.

Measures

Feasibility

Measures of feasibility included accrual, adherence and retention rates and adverse events. Accrual rate was calculated by dividing the number of participants who enrolled by the number of participants who competed the screening form (PARQ+). Adherence was calculated by dividing the number of sessions attended out of the number offered. Retention rate was calculated recording anyone who did not complete the program and the reason for this. In addition, reasons for not enrolling, missing sessions, withdrawing from the program, and adverse events were recorded. An adverse event was categorized if a participant was unable to complete an exercise session that resulted in medical attention. Feasibility data was recorded by program staff and input into the database throughout the program.

Acceptability

Acceptability was assessed via a program satisfaction self-reported questionnaire which participants completed at the end of the program via REDCap [16]. The questions were opened ended with Likert Scale [17] responses ranging from "1-"definitely no" to "7-"definitely yes". Responses aimed to evaluate the program in a range of areas including enjoyment, perceived changes in physical function, program staff, environment and social support. Additionally, the questionnaire required participants to evaluate the technological aspects of the program including personal comfort in using Zoom and the quality of visuals and audio during sessions.

Physical Activity

PA levels were self-reported using the *Godin Leisure-Time Exercise questionnaire (GLTEQ)* Questionnaire [18]. The GLTEQ was administered at baseline and post-program via REDCap. The GLTEQ contains three open-ended questions to determine the average frequency

of light moderate and vigorous aerobic and resistance exercise performed in a typical week for at least 15 minutes at a time. Participants were asked to recall this for both their aerobic and resistance exercise during a typical 7-day period over the last month. An example question would ask; “Considering a typical week (7 days) over the past month, how many days on average did you do moderate intensity aerobic exercise (e.g., fast walking, tennis, easy bicycling, easy swimming, popular and folk dancing) and what was the average duration?” Participants were provided space to write the average frequency (i.e., days per week), and average duration (i.e., minutes per session) for each. The GTLEQ has been used extensively in a cancer population and is a validated and reliable outcome of PA [19]. PA variable outcomes were assessed by the following calculations;

Light Aerobic Exercise = [frequency of light intensity aerobic exercise per week * duration per session]

Moderate Aerobic Exercise = [frequency of moderate intensity aerobic exercise per week * duration per session]

Vigorous Aerobic Exercise = [frequency of vigorous intensity aerobic exercise per week * duration per session]

Resistance Exercise = [frequency of resistance exercise per week * duration per session]

Total MVPA = [Moderate Aerobic Exercise + (Vigorous Aerobic Exercise x2)]

Total MVPA + Resistance = [Total MVPA + Resistance Exercise]

Quality of Life

QOL was assessed using the *Functional Assessment of Cancer Therapy-General (FACT-G)* questionnaire. The FACT-G is a quantitative, self-reported measure of QOL that involves answering 27 questions to evaluate physical, social, emotional and functional well-being. FACT-G scores range from 0 to 108, with higher subscale scores indicating better QOL in their respective domain and a higher total score representing better overall QOL. The FACT-G has been found to be a reliable and valid measure with a cancer population [20].

Self-Efficacy for Exercise

Self-efficacy for exercise was measured using a modified version of the *Exercise Self-Efficacy (ESE)* and *Barriers Specific Self-Efficacy Scale (BARSE)* questionnaires and were delivered online via REDCap. The ESE was used to determine an individual's perceived ability to exercise 3 times per week for the next 6 months and 12 months while two questions related to the next 3 and 6 months. Responses ranged from 0% ("not at all confident") to 100% ("highly confident") in 10% increments. The average of the two items was taken. The BARSE aims to determine an individual's perception of their ability to exercise in the face of commonly identified barriers to participation. The BARSE is a 13-item questionnaire, and for each item, participants indicate their confidence to exercise on a 100-point percentage scale comprised of 10-point increments, ranging from 0% ("not at all confident") to 100% ("highly confident"). Total score is calculated by summing the confidence ratings and dividing by the total number of items in the scale, resulting in a maximum possible self-efficacy score of 100. Both of these self-efficacy scales have been tested for reliability and validity in a variety of populations including middle-aged and older adults [21][22].

Physical Function

During the initial assessment participants self-reported height, weight & blood pressure, and Body Mass Index (BMI) was calculated by the assessor. Resting Heart Rate (HR) was collected manually with instructions from the assessor. Physical assessments were used to measure lower and upper body muscular endurance and balance. These included the 30 second Chair Sit to Stand (STS) test for lower body muscular endurance [23], the 30 second arm-curl test for upper body muscular endurance [24] & the Single Leg Balance (SLB) test to assess balance [25]. The chair sit to stand test involves participants beginning in a seated position with knees at a 90 degree angle and arms folded across their chest. On "Go" participants rise into a full stand, return to completely seated and complete this action for 30 seconds while the assessor timed and counted. The 30 second arm-curl tests required participants to stand on the middle of the 5lbs resistance band with flat shoes. On "Go" participants completed a single arm bicep curl through full range of motion for 30 seconds, before taking a rest and then repeating the process on the other arm while the assessor timed and counted. The single leg balance test involves participants balancing on one leg, with hands placed on their hips for as long as possible. The test ended when participants either touched the ground with their non-stance leg, removed a hand or hands from their hips or reached 60 seconds. The test was then repeated on the other leg. If participants balanced for equal to or greater than 30 seconds, they repeated the test on that same leg with their eyes closed. All tests were conducted using slides & visual demonstrations to ensure participant understanding prior to commencing the tests.

Program Details

Exercise Sessions

The program consisted of supervised group-based exercise sessions delivered once per week, via video conferencing software (i.e., Zoom). Sessions lasted 50-60 minutes each

throughout the 8-week program. All sessions were conducted in real-time on Zoom in a small group (4-6) setting. Sessions began with a group greeting and casual conversation before switching to a view that only allowed participants to see the instructor and not each other during exercise. Intensity of sessions was light-moderate, based on an RPE of 3-6 on a 1-10 scale [26] and a HRR of 30-59%. Participants were taught to self-monitor exercise intensity using RPE and FitBit Inspire 2 HR monitors. Sessions aimed to target key components of fitness including aerobic, muscular strength and endurance and flexibility. The exercise instructor would demonstrate the exercises including appropriate form, before the participants joined in. A qualified exercise physiologist monitored the participants throughout the entire session. The exercise sessions consisted of a warm-up, balance & core exercises, exercise circuits and a cool down with flexibility training. Following completion of the session, participants were emailed a private YouTube link containing a recording of the instructor throughout the session and encouraged to repeat it again that week.

Table 1. Example Exercise Session

Activity	**Example Exercises**	**Time**
Warm Up	Full body aerobic movements & dynamic stretches	5 minutes
Balance & Core Exercises	Single leg balance Seated core engagement Standing hip abductions	20-30 seconds per exercise, for 3 sets. - 7 minutes total
Circuit 1: Upper & lower body resistance and aerobic exercises	Sit to stands/squats Resistance band rows Marching on the spot	30 seconds per exercise, for 3 sets with 15 seconds rest. - 7 minutes total
Circuit 2: Upper & lower body resistance and aerobic exercises	Calf raises with support Resistance band chest fly Side steps	30 seconds per exercise, for 3 sets with 15 seconds rest. - 7 minutes total
Circuit 3: Upper & lower body resistance and aerobic exercises	Resistance band bicep curls Resistance band upright rows Stepping Jacks	30 seconds per exercise, for 3 sets with 15 seconds rest. - 7 minutes total
Cool Down	Full body static stretching	20-30 seconds per stretch - 5 minutes total

Discussion Sessions

In addition to the exercise sessions, the program included group-based PA behavior change discussion sessions targeting independent, long term PA. The discussion sessions were also conducted in real time via "Zoom", and held in weeks 3, 5 and 7. The discussion sessions

work through a participant workbook designed with a Cognitive Behavioral Theory approach [27]. Discussion session 1 included team building exercises & SMART Goal Setting, session 2 covered benefits of exercise for cancer survivors & appropriate FITT prescription. Session 3 covered strategies to overcome exercise barriers for independent exercise.

Table 2. Discussion Session Details

	Behavior Change Techniques	**Session Details**
Session 1	Social Support Action Planning Self-monitoring	Group introductions and motivation for joining the program Team name and goal setting Individual SMART Goal setting for short & long term goals Specify the frequency, duration, intensity, type and location/context of PA required to reach goals Instructions on how to use the Fitbit Inspire 2 to track activity Provided with written logs for activity tracking.
Session 2	Evidence based behavior Instruction on how to perform a behavior	Information about the benefits of exercise for cancer survivors, with references to peer-reviewed literature Information about aerobic and resistance exercise, and appropriate Frequency, Intensity, Time and Type.
Session 3	Review behavior goals Problem solving	Discuss original goals and modify as appropriate Discussion of barriers to exercise PA and ways to overcome them Provided with additional evidence-based techniques to overcome barriers & techniques for exercise maintenance.

Data Analyses

Statistical Analyses were conducted in IBM Statistical Package for Social Sciences (SPSS) Version 28.0.0.0. All variables were assessed for normal distribution using a Q-Q Plot and/or Histograms. Feasibility and acceptability data were analyzed using descriptive statistics

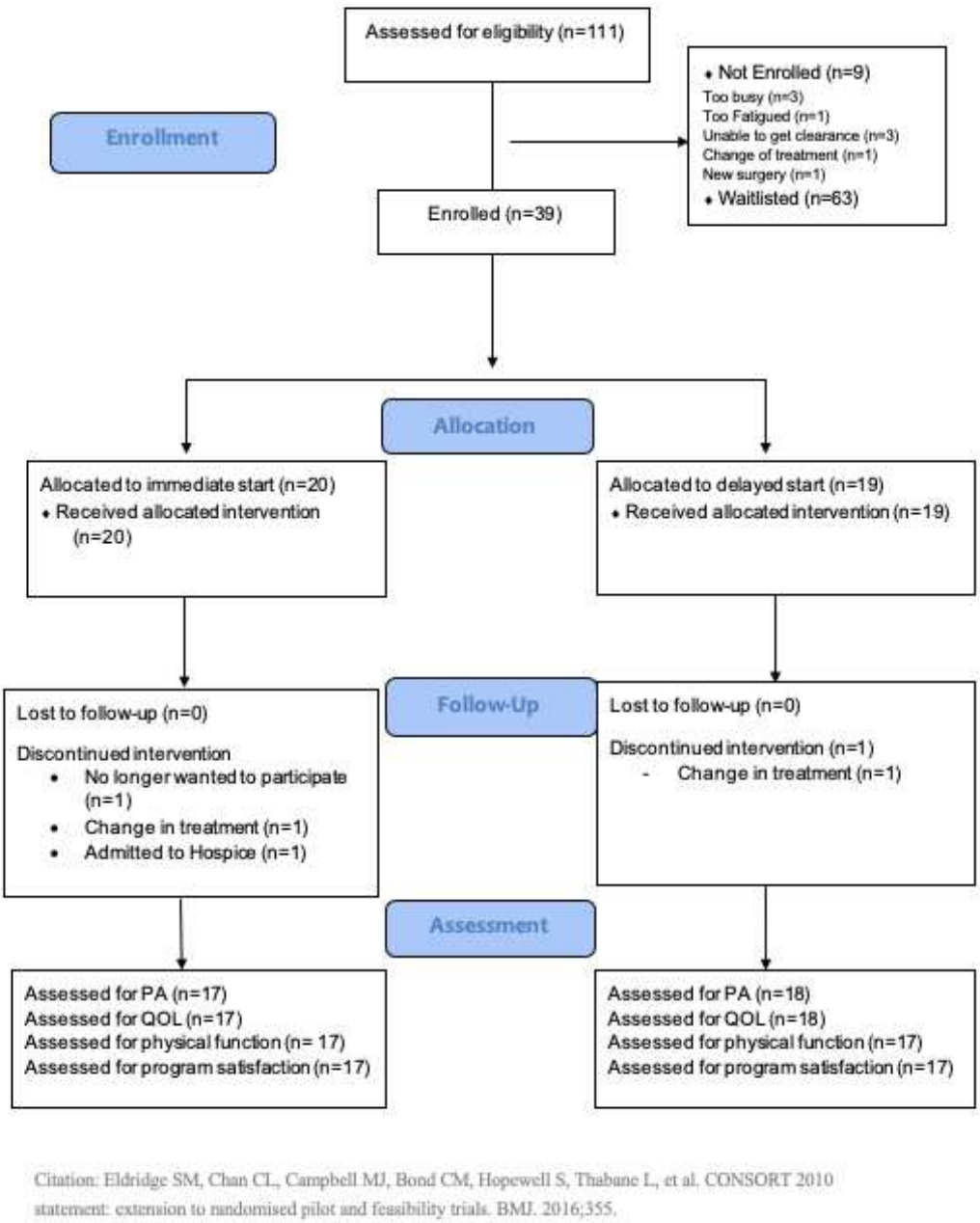
including means, standard deviations, percentages, median values and ranges. Preliminary effectiveness outcomes were assessed by comparing pre and post program means via one-tailed, paired sample t-tests, and calculating percent change. Percent change was calculate using the below formula; $\frac{pre\ value - post\ value}{pre\ value}\ x\ 100$.

Results

Participants in the program included 39 individuals. Age ranged from 23-76 with a mean age of 59.6 (Table 3). Participants were largely white (94.4%) female (97.2%) with a college education or higher (79.5%). Most prevalent cancer types were ovarian (58.3%) and breast (30.6%). Of the 39 participants, 12 with stage 3 or 4 cancer (33.3%) were still receiving chemotherapy treatment throughout the program. 24 participants (66.6%) were no longer receiving chemotherapy treatment. No participants were receiving radiation therapy.

Table 3. Participant Characteristics

	Mean (SD) or n (%)
Age	59.6 (10.3; range: 23-76)
Sex	
Female	35 (97.2%)
Male	1 (2.8%)
Race/Ethnicity	
White	34 (94.4%)
Black or African American	1 (2.8%)
Asian/Pacific Islander	1 (2.8%)
Education	
Completed High School	1 (2.8%)
AA degree/Technical Training	6 (16.7%)
Completed College	7 (19.4%)
Completed graduate school	22 (61.1%)
Combined Household Income	
$5,000-$19,999	4 (11.1%)
$20,000-$49,999	4 (11.1%)
$50,000-$99,999	13 (36.1%)
$100,000-$149,999	2 (5.6%)
More than $150,000	6 (16.7%)
Choose not to answer	7 (19.4%)
Cancer Type	
Ovarian	21 (58.3%)
Breast	11 (30.6%)
Colorectal	2 (5.6%)
Brain & Spinal Cord	1 (2.8%)
Prostate	1 (2.8%)
On/Off Treatment	
Receiving Chemotherapy	12 (33.3%)
Receiving Radiation Therapy	0 (0%)
Off Treatment	24 (66.6%)
Required Physician Clearance	
Yes	31 (86%)
No	5 (14%)



Citation: Eldridge SM, Chan CL, Campbell MJ, Bond CM, Hopewell S, Thabane L, et al. CONSORT 2010 statement: extension to randomised pilot and feasibility trials. BMJ. 2016;355.

Figure 1. CONSORT Flow Diagram

Feasibility

The study flow and recruitment diagram is presented in Figure 1. Recruitment took place from the beginning of December 2020 until mid-January 2021 (6-weeks). A total of 111 participants were screened for eligibility and 39 were enrolled (Table 4). Reasons for not enrolling can be seen in Figure 1. Of the 39 participants that enrolled in the program, *N*=35 completed post-program assessments resulting in a retention rate of 89.7%. Adherence rates were calculated from the number of sessions offered and the number attended. Of those who completed the program (*N*=35), adherence to exercise and discussion sessions were 88.2% and 87%, respectively. Accrual, retention and adherence are summarized in Table 4 and Figures 2 and Figure 3 show the frequency of exercise and discussion attendance.

Table 4. Accrual, retention & adherence rates.

Accrual Rate	91.1%
Recruitment Pace	39 enrolled in 6 weeks
Referral Sources	
Family/Friend	4 (10.3%)
Flyer/Brochure	2 (5.1%)
Support Group	26 (66.6%)
Oncologist	3 (7.7%)
Did not answer	4 (10.3%)
Retention Rate	89.7%
Adherence Rate	
Exercise Sessions	88.2%
Discussion Sessions	87%
Adverse Events	0

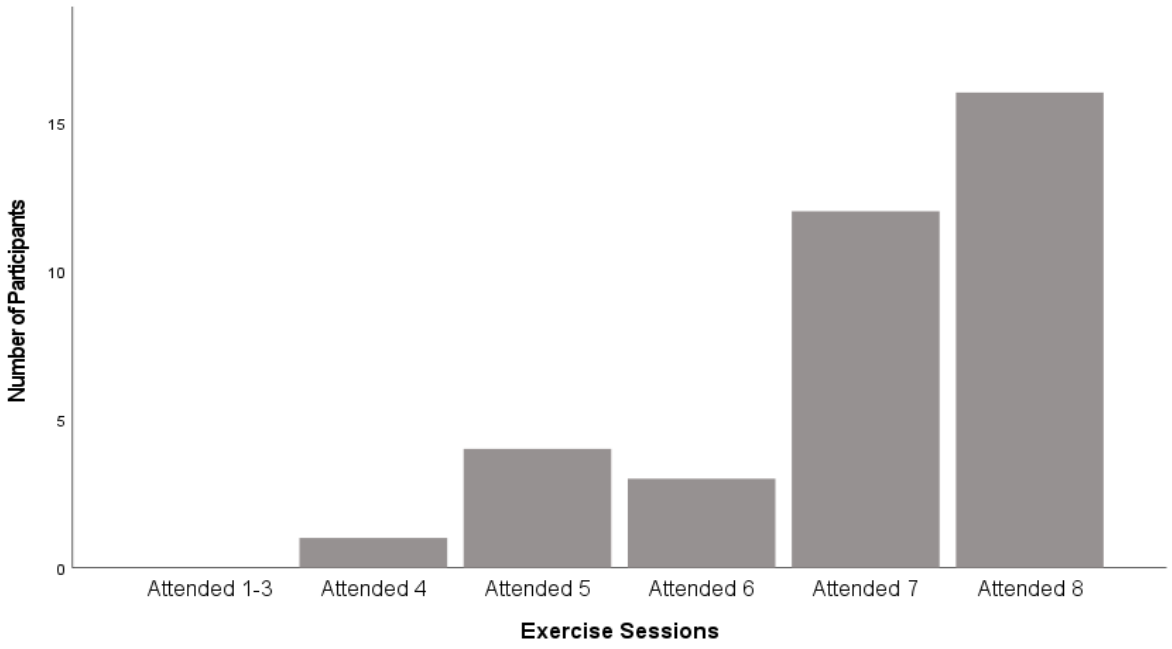


Figure 2. Exercise Session Adherence

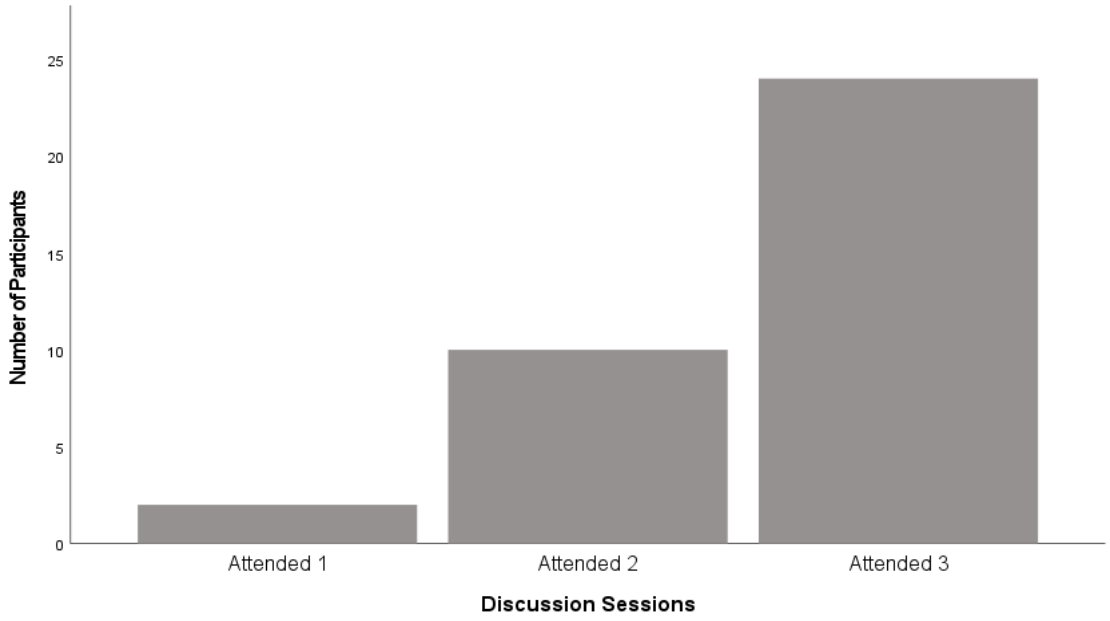


Figure 3. Discussion Session Adherence

Acceptability

In general, acceptability data were positive (Table 5). Figures 4 and 5 show the distribution of responses to each question.

Table 5. Participant satisfaction with the program and technology

Program Satisfaction (Likert scale response ranging from 1-Definitely no to 7 Definitely yes)	Median (range)
1. Did you enjoy participating in Fit Cancer?	7 (range; 5-7)
2. Do you feel physically stronger?	7 (range; 2-7)
3. Do you feel you can better perform your daily activities?	6 (range; 1-7)
4. Did you look forward to your exercise sessions?	7 (range; 5-7)
5. Did the staff and group environment provide you with a sense of community and support that you found beneficial?	7 (range; 5-7)
6. Would you recommend the Fit Cancer program to a fellow cancer patient/survivor?	7 (range; 4-7)
7. Did you find the discussion session(s) useful?	7 (range; 4-7)
Technology Satisfaction (Likert scale response ranging from 1-Not at all satisfied to 5-Completely satisfied)	**Median (range)**
1. The ease of using Zoom	5 (range; 2-5)
2. Your personal comfort with using Zoom	5 (range; 2-5)
3. The visual quality of exercise and discussion sessions	4 (range; 2-5)
4. The sound quality of exercise and discussion sessions	5 (range; 1-5)

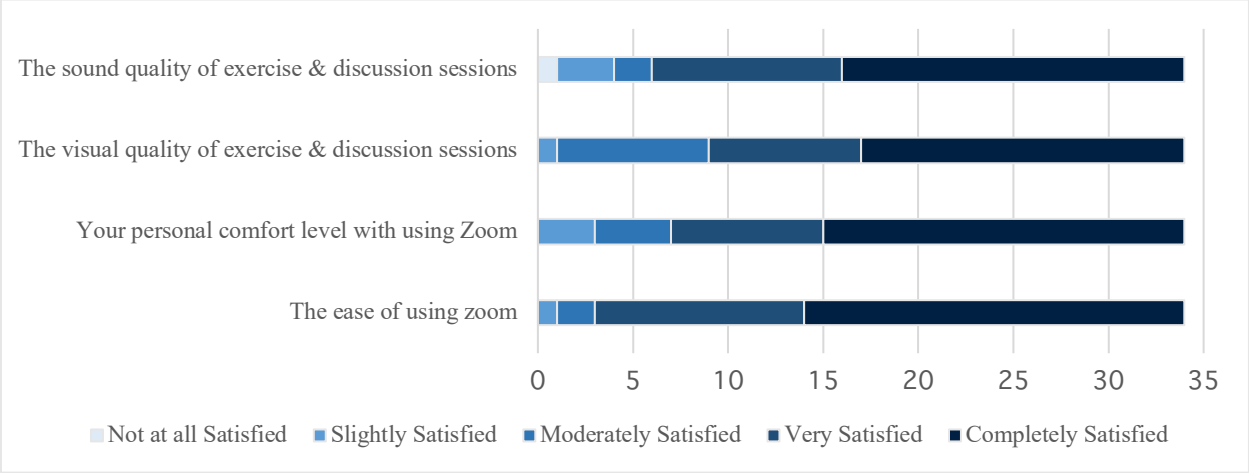


Figure 4. Post Program Technology Satisfaction Questionnaire Responses

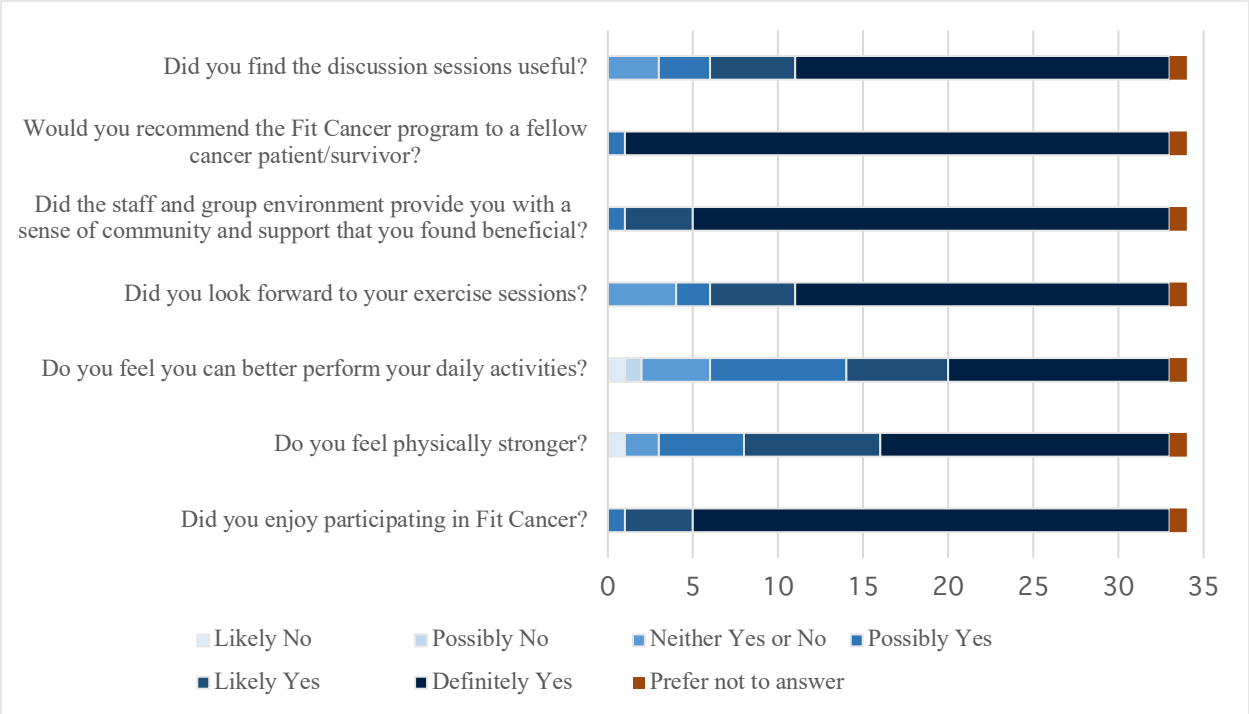


Figure 5. Post program satisfaction questionnaire responses

Effectiveness Outcomes

The 8-week virtual Fit Cancer program had a positive impact on the several effectiveness outcomes which are summarized in Table 6.

Physical Activity

There were significant increases in MVPA + Resistance ($M\Delta$=121±1781.1, p=0.001), total MVPA ($M\Delta$=82.7±164.2, p=0.003), moderate aerobic ($M\Delta$=50.8±136.3, p=0.017), vigorous aerobic ($M\Delta$=16±51, p=0.036), and resistance exercise ($M\Delta$=37.4±39.4, p=0.001). Figure 6 shows changes in Total MVPA + Resistance Exercise.

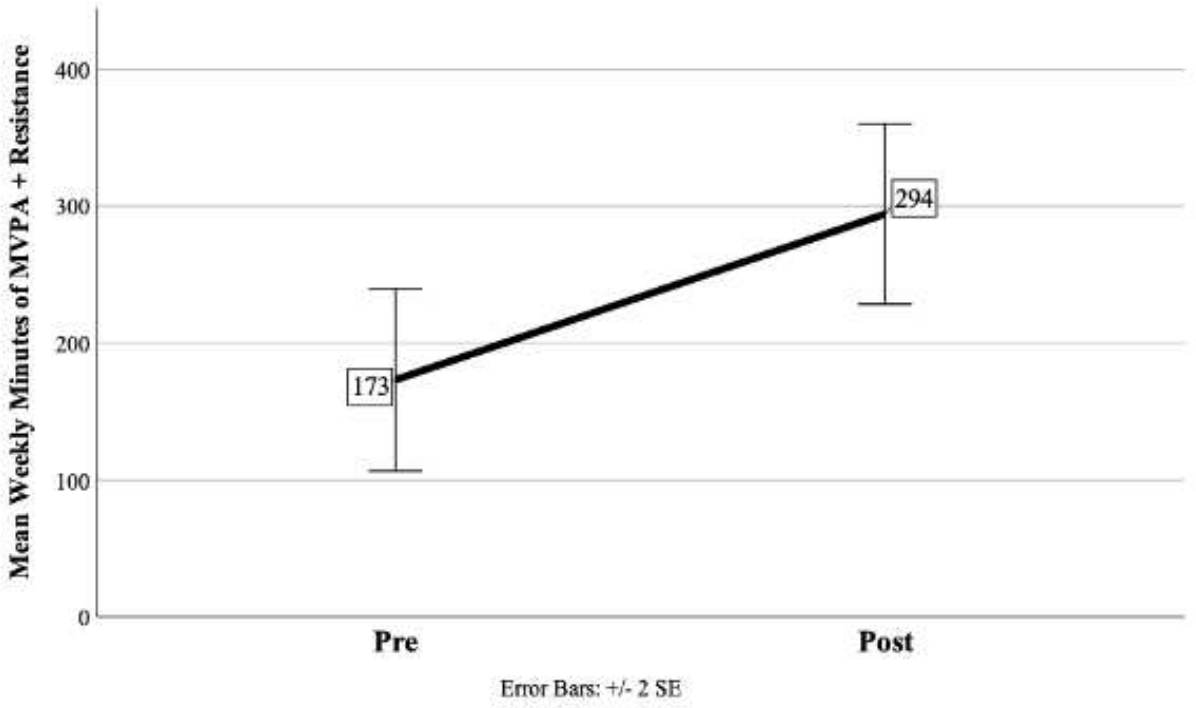


Figure 6. Change in weekly minutes of Total MVPA + Resistance Exercise.

Secondary Measures of Effectiveness

ESE decreased ($M\Delta$=-6.7±19.4, p=0.028). No significant change was seen in BARSE or QOL. Physical function measures increased including S2S ($M\Delta$=-1.2±3.9, p=0.015), Arm Curl left ($M\Delta$=4.4±5, p=0.001), and right ($M\Delta$=3.7±4.9, p=0.001). Both right and left leg eyes open and closed single leg balance scores all improved by a minimum of 10% with the left leg, eyes open produced a significant result (4.5, SD 16.4).

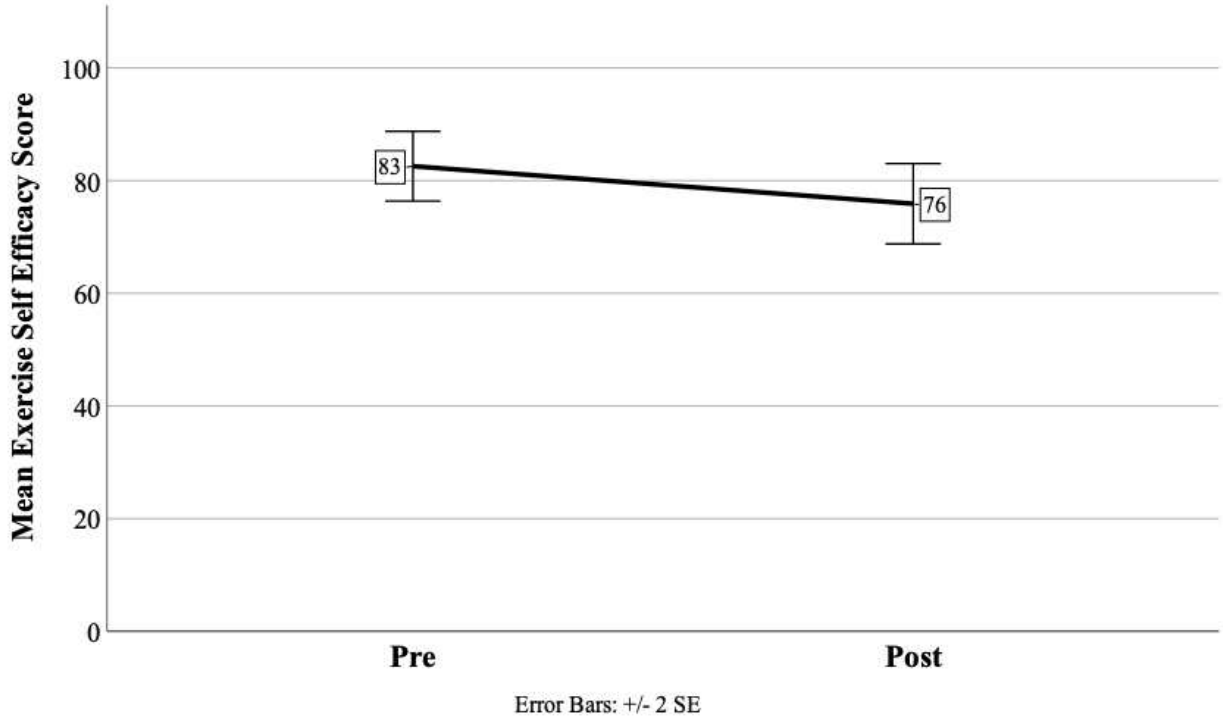


Figure 7. Change in Exercise Self Efficacy.

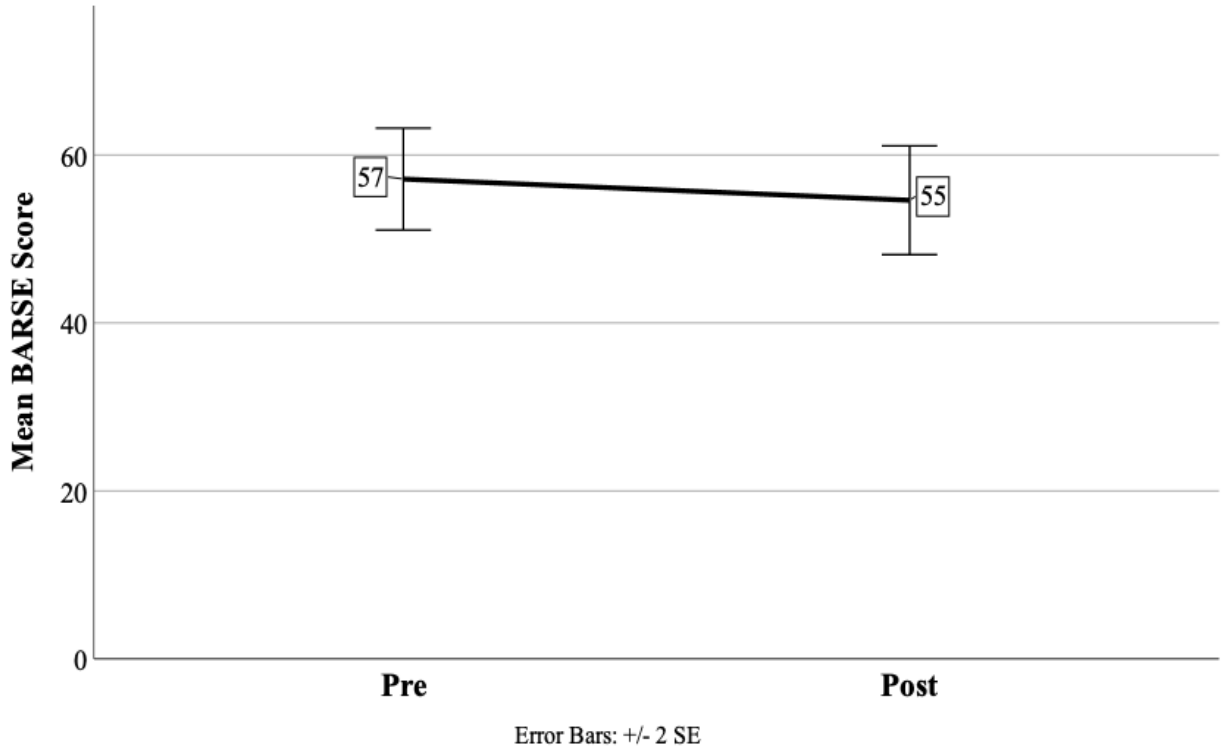


Figure 8. Change in Barrier Specific Self Efficacy.

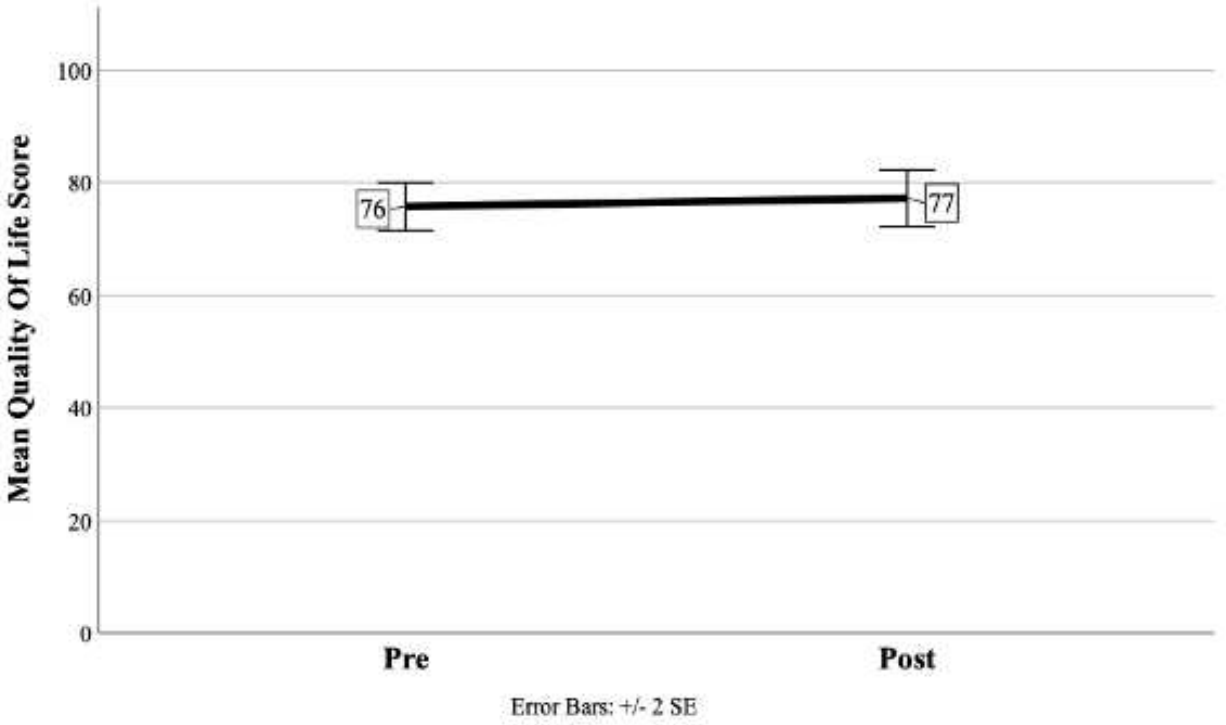


Figure 9. Change in Quality of Life score.

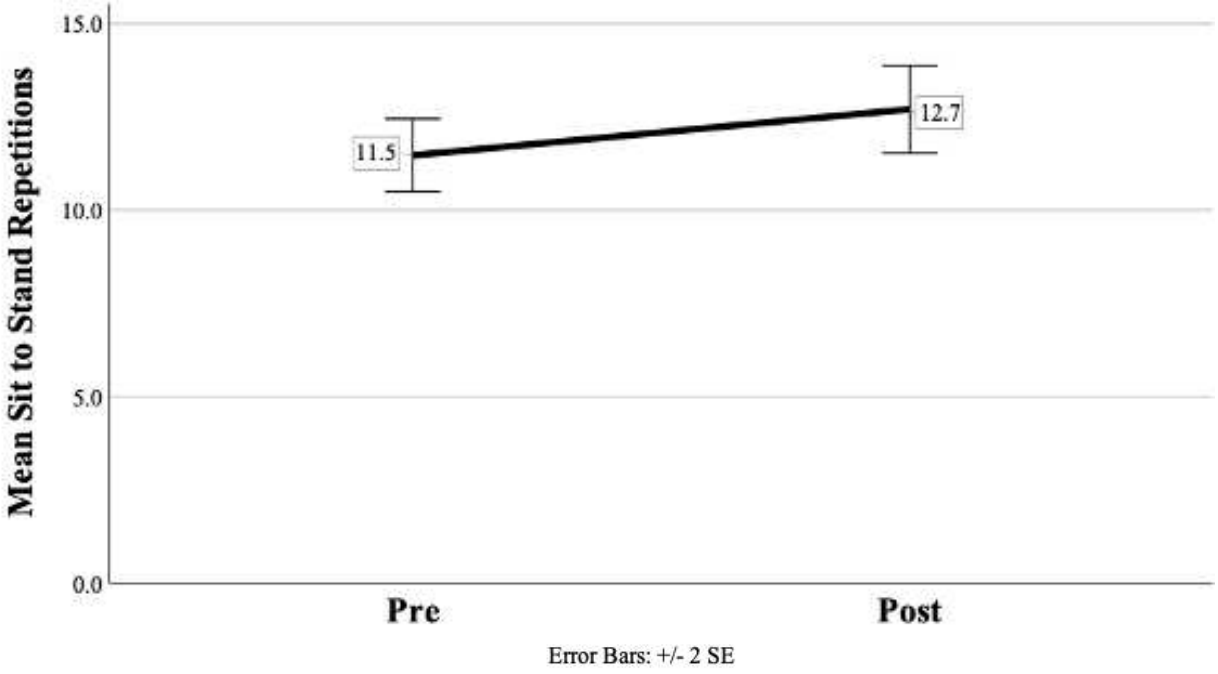


Figure 10. Change in Sit to Stand score.

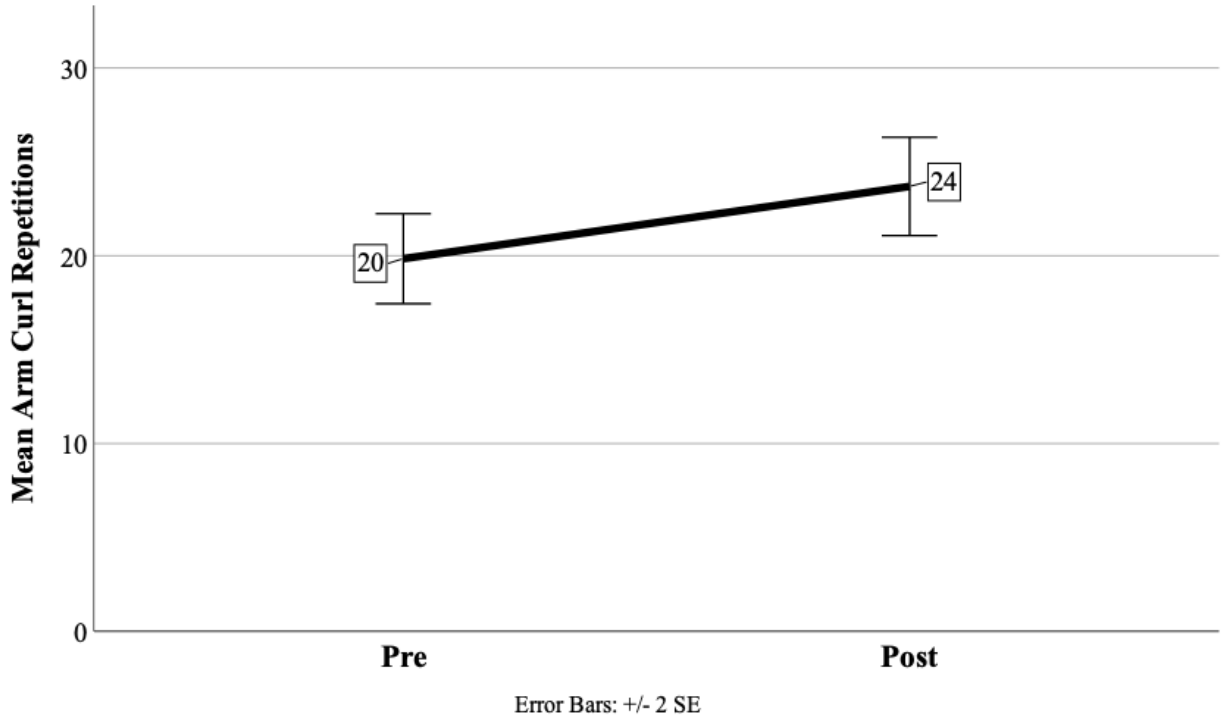


Figure 9. Change in Arm Curl score.

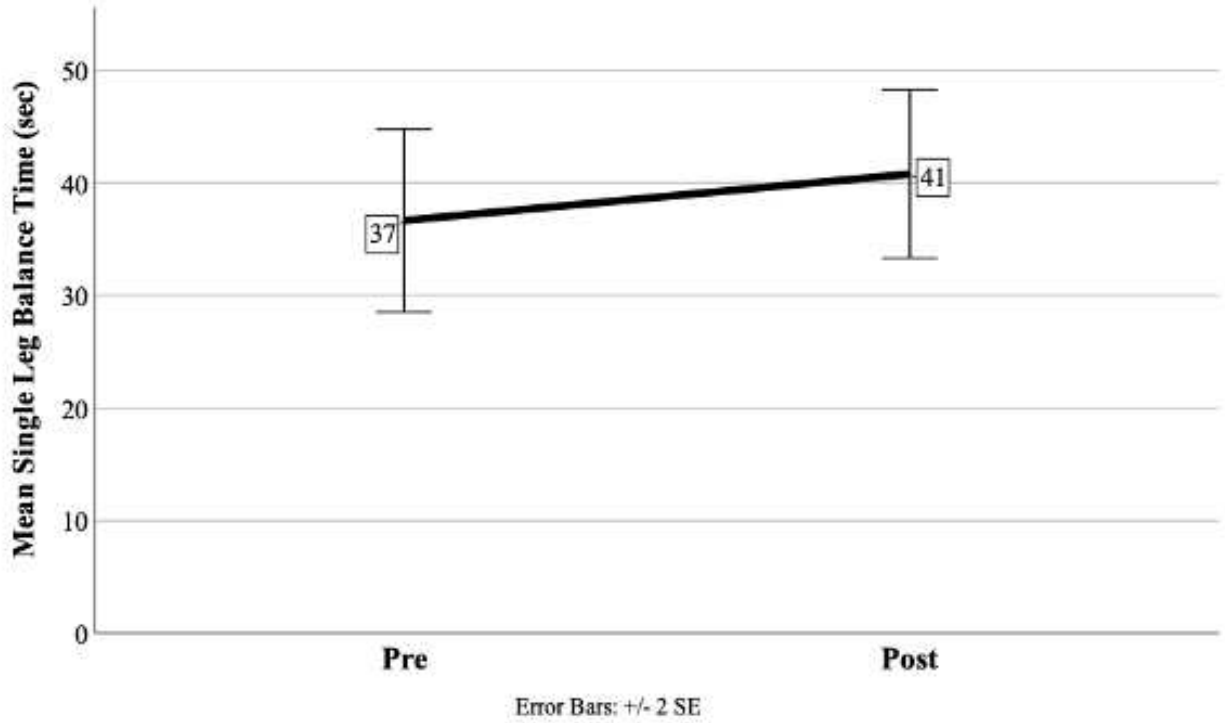


Figure 10. Change in Eyes Open Single Leg Balance score.

Table 6. Pre & Post Program Effectiveness Outcomes

	Pre-program Mean (SD)	Post-program Mean (SD)	Percent change	t-statistic, *p* value
Physical Activity (minutes per week)				
Total MVPA + Resistance	173.2 (194.1)	294.2 (192.2)	+69.9%	-3.963, <0.001**
Total MVPA	159.7 (194.8)	242.5 (192.8)	+51.8%	-2.983, 0.003**
Light Aerobic	120.9 (151.6)	114.1 (114.5)	-5.6%	0.398, 0.347
Moderate Aerobic	113.4 (134.6)	164.2 (132.3)	+44.8%	-2.204, 0.017*
Vigorous Aerobic	23.1 (56.8)	39.1 (60.7)	+69.3%	-1.855, 0.036*
Resistance	23.1 (43.8)	60.4 (53.2)	+161.5%	-5.615, <0.001**
Exercise Self efficacy	82.6 (17.8)	75.9 (20.5)	-8.1%	1.979, 0.028*
Barriers Self Efficacy	57.1 (17.9)	54.6 (19.2)	-4.4%	0.751, 0.229
Quality of Life	75.8 (12.2)	77.2 (14.4)	+1.8%	-1.178, 0.124
Sit to Stand	11.5 (2.9)	12.7 (3.4)	+10.4%	-2.257, 0.015*
Single Leg Balance				
Right Eyes Open	36.7 (24.8)	40.4 (23.3)	+10.1%	-1.271, 0.106
Left Eyes Open	36.5 (23.7)	41.1 (21.8)	+12.1%	-1.621, 0.057
Right Closed	6.8 (9.2)	8 (7.8)	+17.6%	-0.834, 0.208
Left Closed	5.1 (3.8)	6.1 (3.6)	+19.6%	-1.016, 0.162
Arm Curl				
Right	20.1 (7.4)	23.8 (7.9)	+18.4%	-4.450, <0.001**
Left	20.1 (7.2)	24.6 (7.7)	+22.4%	-5.138, <0.001**

* = <0.05 ** = <0.01

Discussion

The purpose of this study was to examine the feasibility, acceptability and preliminary effects of virtual Fit Cancer, a supervised group-based PA program for cancer survivors delivered via video conferencing. Based on accrual, retention and adherence rates, and acceptability, the program was feasible. Results also demonstrated increases in PA and improvements in physical function.

Feasibility

In this study, feasibility was assessed by recruitment pace, accrual, adherence, retention rates, and adverse events. Recruitment pace was highly successful when comparing to the in-person Fit Cancer program, which enrolled 50 participants in four years compared to the current videoconference delivered Fit Cancer program, which enrolled 39 participants in 6 weeks. The accrual rate of the current Fit Cancer program which was calculated by dividing the number of participants who enrolled by the screening form (PARQ+) was 91%, which is higher than the in-person Fit Cancer program which had an accrual rate of 50%. In addition, videoconference delivered Fit Cancer expanded the reach of the program from cancer survivors within Northern Colorado, to participants from 13 different states and two countries (USA & Canada). This evidence suggests recruitment for videoconferencing delivered physical activity programs in cancer survivors not only to be feasible but likely to be faster than in-person recruitment.

The videoconference-delivered Fit Cancer program had an exercise session adherence rate of 88%, which is comparable to the in-person Fit Cancer program (90%). The study by Wonders et al. that delivered personal training via videoconferencing software also similarly had

an exercise session adherence rate of 84% [14]. These results suggest adherence to exercise via videoconferencing to be feasible.

Program retention was 90%, which was higher than in-person Fit Cancer (70%). A systematic review by Fewtrell et al. of pre-post style interventions in healthy adults suggested that retention rates of 50-80% can be considered successful [32]. Of the 4 participants who did not complete the program, only 1 withdrew voluntarily. The remainder had changes in treatment status that did not allow them to continue the program. No adverse events occurred during exercise sessions. This evidence suggests retention of a video-conference delivered group-based program to be feasible and the mode of delivery to be safe, however caution should be taken with participants undergoing treatment. Any changes in treatment status or medication should require an updated medical clearance before continuing exercise.

Our study found fast recruitment pace, high accrual rates and high retention rates. Furthermore adherence to exercise sessions was high and participant safety was observed during exercise sessions. These results suggest video-conference delivered PA interventions to be feasible in a cancer population. These findings are supported by Wonders et al. [14] who found video-conference delivered personal training to be feasible in a cancer population. A systematic review by Bland et al. found mobile app/telehealth interventions to be feasible in a cancer population. Furthermore, the authors acknowledged the increasing need for remote based exercise programs to improve cancer patient outcomes before, during and after the COVID-19 pandemic [40].

Acceptability

Post program questionnaires demonstrate high acceptability of the program (Table 5), including 94% of participants who reported they enjoyed the program, which is similar to Wonders et al. which reported a 98% of participants enjoyed their videoconference delivered personal training study [14]. 91% of participants also reported being very satisfied or completely satisfied with the ease of using zoom for exercise and discussion sessions, supporting the acceptability of videoconferencing delivered exercise. Further research should focus on qualitative data to learn more about participant acceptability of video-conference delivered PA interventions.

Effectiveness Outcomes

Moderate Aerobic Exercise, Vigorous Aerobic Exercise, Total MVPA, Resistance Exercise and Total MVPA + Resistance all increased from pre-post program. On average, participants reported an additional 121 minutes of Total MVPA + Resistance per week at post-program, more than the weekly 60-minute exercise session, suggesting there was an additional increase in PA outside of the supervised group-based sessions. At the end of the program, average total MPVA exercise was 242.5 minutes per week and 60.4 minutes of Resistance Exercise at a frequency of 1.6 times per week suggesting many participants were achieving ACSM guidelines for cancer survivors [33]. We hypothesize that this increased PA to targeting environmental factors including providing access to exercise equipment and videos, cognitive factors including increasing knowledge on how to exercise safely & effectively and behavioral factors including confidence and practice targeted in discussion sessions [34]. Our measure of confidence to overcome barriers however, BARSE, did not increase, suggesting the increase in

PA to be more closely tied to environmental and cognitive factors of the social cognitive theory. The video-conference delivered sessions, versatile at home equipment provided and video recordings of the supervised sessions may have helped to overcome some of these barriers. On average, participants reported repeating the exercise session using the recording 1.6 times per week and rated the videos “Extremely Useful”.

Secondary Measures of Effectiveness

Contrary to our expectations, BARSE and QOL saw no change pre to post program and ESE significantly decreased despite PA significantly increasing. Exploratory analyses of individual data revealed that four participants who had large reductions in ESE had changes of treatment status at the end of the 8-week program which likely impacted their scores, and possibly driving the mean. When removing these four participants from analyses, average change in ESE and BARSE were positive (i.e., improved), but statistically non-significant. It is possible the COVID-19 pandemic impacted these results. At the time, gymnasiums and other PA opportunities were closed or posed a risk to participants, and thus could have reduced their perception of their ability to exercise moving forward. A meta-analysis by Ferrer et al. found interventions that had a significant improvement in QOL outcomes had an average intervention length of 12.6 weeks [35]. It is possible the statistically insignificant increase in QOL may be due to the length of our intervention. Furthermore, the COVID-19 pandemic could have impacted these results. In particular, the FACT-G which measures QOL has questions that relate to social support, feeling close to family and friends, satisfaction with life and worrying about dying. The lifestyle changes forced by the COVID-19 pandemic and the increased danger posed to cancer survivors could have impacted these questions and thus the QOL results.

For measures of physical function, results showed an improvement in lower body (+10.4%) and upper body muscular endurance (+22.4%) tests from pre-to-post program and are consistent with the in-person Fit Cancer program for lower body muscular endurance (1.2, SD 3.9). Tests of balance saw a >10% increase but results did not reach statistical significance. These results were expected given the high adherence to exercise sessions which included lower and upper body resistance training and balance exercises and increases in PA from pre- to post-program. Their results suggest that a videoconference delivered exercise program may help cancer survivors improve upper and lower body muscular endurance and balance.

Strengths and Limitations

One strength of this study is the novel use of videoconferencing software to conduct an exercise and PA behavior change program. To our knowledge, only one study exists to publish the feasibility and effects of an exercise intervention for cancer survivors that conducted all program components virtually, whilst still providing supervised exercise in real-time. This is a strength because video-conference delivered interventions have been touted in the field as a future direction due to their expanded reach and access [40]. The second strength is the group-based delivery. Group-based exercise is more cost-effective than 1:1 supervised exercise (based on the participant to instructor ratio) and the group-cohesion element can increase PA maintenance [11]. Last, the deliberate use of theory informed behavior change techniques is a strength of the program because of the strong evidence supporting it's impact on long term independent PA in cancer survivors [41].

Results from this study need to be interpreted while acknowledging limitations. First, this was a single-arm study with no control condition. It is possible participants enrolled were already

motivated to exercise, without a control we are unable to rule out this being a factor in results. Thus, effectiveness results should be considered preliminary. Second, participants were predominately female and racially/ethnically homogenous. The sex imbalance, resulting in a skewed female-male ratio should be noted as a potential limitation however, previous studies provide evidence supporting the generalization of our results, as males and females respond similarly to PA interventions despite potential differences in motivation to participate [36]. Conducting objective measures of physical function via Zoom is a further limitation, although one study showed reliability of similar tests of physical function in a cancer population when conducted by the same assessor, as we did [37]. Results from post program questionnaires reflect a high level of acceptability, however, it should be noted these results are only from those that completed the program. Finally, because of the timing of the study within the COVID-19 pandemic, psycho-social results (QOL, ESE & BARSE) are possibly not generalizable to post pandemic times.

Future Directions

It is well established that physical activity maintenance is a challenge following completion of physical activity interventions in cancer [38][39]. Future researchers should include long term follow up measures (6-12 months post intervention) of physical activity and psychological outcomes. Furthermore, a three-arm randomized trial with an in-person group, videoconference delivered group and control group would be highly impactful research to compare the effects on PA, QOL, and physical function.

Summary and Conclusions

This study provides important information on the feasibility, acceptability and impact of a videoconference delivered cancer rehabilitation intervention at a pivotal time. With the COVID-19 global pandemic posing an increased risk to cancer patients and survivors for the immanent future, alternative physical activity options are required for this population including videoconference delivered [40]. This study found videoconference delivered programs to be safe, feasible, enjoyable and preliminarily effective. High accrual, adherence and retention rates and a high level of acceptance by participants indicate this style of program could be replicated in the community with far reaching results.

References

[1] Siegel, R. L., Miller, K. D., Fuchs, H. E., & Jemal, A. (2021). Cancer Statistics, 2021. *CA: a cancer journal for clinicians*, *71*(1), 7–33. https://doi.org/10.3322/caac.21654

[2] Narod, S. A., Iqbal, J., & Miller, A. B. (2015). Why have breast cancer mortality rates

declined?. *Journal of Cancer Policy*, *5*, 8-17.

[3] Leach, C. R., Weaver, K. E., Aziz, N. M., Alfano, C. M., Bellizzi, K. M., Kent, E. E., ... & Rowland, J. H. (2015). The complex health profile of long-term cancer survivors: prevalence and predictors of comorbid conditions. *Journal of cancer survivorship*, *9*(2), 239-251.

[4] Campbell, K. L., Winters-Stone, K. M., Wiskemann, J., May, A. M., Schwartz, A. L., Courneya, K. S., ... & Schmitz, K. H. (2019). Exercise guidelines for cancer survivors: consensus statement from international multidisciplinary roundtable. *Medicine & Science in Sports & Exercise*, *51*(11), 2375-2390.

[5] Galvão, D. A., & Newton, R. U. (2005). Review of exercise intervention studies in cancer patients. *Journal of clinical oncology*, *23*(4), 899-909.

[6] Turner, R. R., Steed, L., Quirk, H., Greasley, R. U., Saxton, J. M., Taylor, S. J., ... & Bourke, L. (2018). Interventions for promoting habitual exercise in people living with and beyond cancer. *Cochrane Database of Systematic Reviews*, (9).

[7] Sweegers, M. G., Altenburg, T. M., Chinapaw, M. J., Kalter, J., Verdonck-de Leeuw, I. M., Courneya, K. S., ... & Buffart, L. M. (2018). Which exercise prescriptions improve quality of life and physical function in patients with cancer during and following treatment? A systematic review and meta-analysis of randomised controlled trials. *British journal of sports medicine*, *52*(8), 505-513.

[8] Finne, E., Glausch, M., Exner, A. K., Sauzet, O., Stoelzel, F., & Seidel, N. (2018). Behavior change techniques for increasing physical activity in cancer survivors: a systematic review and meta-analysis of randomized controlled trials. *Cancer management and research*, *10*, 5125.

[9] Stacey, F. G., James, E. L., Chapman, K., Courneya, K. S., & Lubans, D. R. (2015). A systematic review and meta-analysis of social cognitive theory-based physical activity and/or nutrition behavior change interventions for cancer survivors. *Journal of Cancer Survivorship*, *9*(2), 305-338.

[10] Rossi, A., Friel, C., Carter, L., & Garber, C. E. (2018). Effects of theory-based behavioral interventions on physical activity among overweight and obese female cancer survivors: A systematic review of randomized controlled trials. *Integrative cancer therapies*, *17*(2), 226-236.

[11] Leach, H. J., Mama, S. K., & Harden, S. M. (2019). Group-based exercise interventions for increasing physical activity in cancer survivors: a systematic review of face-to-face randomized and non-randomized trials. *Supportive Care in Cancer*, *27*(5), 1601-1612.

[12] Wonders, K. Y., Stout, B., & Ondreka, D. (2016). Group-based exercise improves fitness parameters in previously sedentary individuals with cancer. *Int J Innovative Med Health Sci*, *7*, 12-16.

[13] Covington KR, Leach HJ, Marshall T, Hidde MC, Crisafio ME, Pergolotti M. Novel application of standards to evaluate a cancer-specific community exercise program. Translational Journal of ACSM – Under review

[14] Wonders, K. Y., Gnau, K., & Schmitz, K. H. (2021). Measuring the Feasibility and Effectiveness of an Individualized Exercise Program Delivered Virtually to Cancer Survivors. *Current Sports Medicine Reports*, *20*(5), 271-276.

[15] Warburton, D. E., Jamnik, V. K., Bredin, S. S., & Gledhill, N. (2011). The physical activity readiness questionnaire for everyone (PAR-Q+) and electronic physical activity readiness medical examination (ePARmed-X+). *The Health & Fitness Journal of Canada*, *4*(2), 3-17.

[16] Patridge, E. F., & Bardyn, T. P. (2018). Research electronic data capture (REDCap). *Journal of the Medical Library Association: JMLA*, *106*(1), 142.

[17] Nemoto, T., & Beglar, D. (2014). Likert-scale questionnaires. In *JALT 2013 conference proceedings* (pp. 1-8).

[18] Godin, G., & Shephard, R. J. (1985). A simple method to assess exercise behavior in the community. *Can J Appl Sport Sci*, *10*(3), 141-146.

[19] Amireault S, Godin G, Lacombe J, Sabiston CM. The use of the Godin-Shephard Leisure Time Physical Activity Questionnaire in oncology research: a systematic review. *BMC Med Res Methodol.* 2015;15:60.

[20] Cella DF, Tulsky DS, Gray G, et al. The Functional Assessment of Cancer Therapy scale: development and validation of the general measure. *J Clin Oncol.* 1993;11(3):570-579.

[21] Resnick, B., & Jenkins, L. S. (2000). Testing the reliability and validity of the self-efficacy for exercise scale. *Nursing research*, *49*(3), 154-159.

[22] McAuley E. Self-efficacy and the maintenance of exercise participation in older adults. *J Behav Med.* 1993;16(1):103-113.

[23] Jones, C. J., Rikli, R. E., & Beam, W. C. (1999). A 30-s chair-stand test as a measure of lower body strength in community-residing older adults. *Research quarterly for exercise and sport*, *70*(2), 113-119.

[24] James, T. W. (1999). *The 30-second arm curl test as an indicator of upper body strength in older adults*. California State University, Fullerton.

[25] Jones J, Rikli RE. Measuring functional fitness of older adults. *The Journal on Active Aging* 2002(March-April):24-30.

[26] Borg, G. (1998). *Borg's perceived exertion and pain scales*. Human kinetics.

[27] Rothbaum, B. O., Meadows, E. A., Resick, P., & Foy, D. W. (2000). Cognitive-behavioral therapy.

[28] George, D., & Mallery, P. (2019). *IBM SPSS statistics 26 step by step: A simple guide and reference*. Routledge.

[29] MacDonald, A. M., Chafranskaia, A., Lopez, C. J., Maganti, M., Bernstein, L. J., Chang, E., ... & Jones, J. M. (2020). CaRE@ Home: Pilot Study of an Online Multidimensional Cancer Rehabilitation and Exercise Program for Cancer Survivors. *Journal of Clinical Medicine*, *9*(10), 3092.

[30] Gell, N. M., Grover, K. W., Humble, M., Sexton, M., & Dittus, K. (2017). Efficacy, feasibility, and acceptability of a novel technology-based intervention to support physical activity in cancer survivors. *Supportive Care in Cancer*, *25*(4), 1291-1300.

[31] Spector, D., Deal, A. M., Amos, K. D., Yang, H., & Battaglini, C. L. (2014). A pilot study of a home-based motivational exercise program for African American breast cancer survivors: clinical and quality-of-life outcomes. *Integrative cancer therapies*, *13*(2), 121-132.

[32] Fewtrell, M. S., Kennedy, K., Singhal, A., Martin, R. M., Ness, A., Hadders-Algra, M., ... & Lucas, A. (2008). How much loss to follow-up is acceptable in long-term randomised trials and prospective studies?. *Archives of disease in childhood*, *93*(6), 458-461.

[33] Campbell, K. L., Winters-Stone, K. M., Wiskemann, J., May, A. M., Schwartz, A. L., Courneya, K. S., ... & Schmitz, K. H. (2019). Exercise guidelines for cancer survivors: consensus statement from international multidisciplinary roundtable. *Medicine & Science in Sports & Exercise*, *51*(11), 2375-2390.

[34] Blaney, J. M., Lowe-Strong, A., Rankin-Watt, J., Campbell, A., & Gracey, J. H. (2013). Cancer survivors' exercise barriers, facilitators and preferences in the context of fatigue, quality of life and physical activity participation: a questionnaire–survey. *Psycho-oncology*, *22*(1), 186-194.

[35] Ferrer, R. A., Huedo-Medina, T. B., Johnson, B. T., Ryan, S., & Pescatello, L. S. (2011). Exercise interventions for cancer survivors: a meta-analysis of quality of life outcomes. *Annals of behavioral medicine*, *41*(1), 32-47.

[36] Richard, M., Christina, M. F., Deborah, L. S., Rubio, N., & Kennon, M. S. (1997). Intrinsic motivation and exercise adherence. *Int J Sport Psychol*, *28*(4), 335-354.

[37] Winters-Stone, K., Lipps, C., Guidarelli, C., & Herrera-Fuentes, P. (2020). Converting Physical Function Testing to the Remote Setting: Adapting Our Research Protocol During COVID-19. *Innovation in Aging*, *4*(Supplement_1), 936-937.

[38] Schmidt, M. E., Wiskemann, J., Ulrich, C. M., Schneeweiss, A., & Steindorf, K. (2017). Self-reported physical activity behavior of breast cancer survivors during and after adjuvant therapy: 12 months follow-up of two randomized exercise intervention trials. *Acta Oncologica*, *56*(4), 618-627.

[39] Grimmett, C., Corbett, T., Brunet, J., Shepherd, J., Pinto, B. M., May, C. R., & Foster, C. (2019). Systematic review and meta-analysis of maintenance of physical activity behaviour change in cancer survivors. *International Journal of Behavioral Nutrition and Physical Activity*, *16*(1), 1-20.

[40] Bland, K. A., Bigaran, A., Campbell, K. L., Trevaskis, M., & Zopf, E. M. (2020). Exercising in isolation? The role of telehealth in exercise oncology during the COVID-19 pandemic and beyond. *Physical Therapy*, *100*(10), 1713-1716.