Living Well After Cancer

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A feasibility study on how this community-based program impacts physical and metabolic health

In Brief

Though survivors of cancer frequently experience residual physiological and psychological symptoms post-treatment, cancer programs and practices often lack the resources to effectively address these conditions. *Living Well After Cancer* is a community-based wellness program offered to patients outside the clinical setting, allowing survivors of all cancer types the opportunity to mitigate these symptoms. This study examined the feasibility of the program and its impact on multiple factors, including metabolic measures, body composition, and physical fitness, which were assessed at baseline and at week 13. Study participants were recruited at a *Living Well After Cancer* orientation. A total of 88 participants consented, with 79 individuals (90 percent) presenting for baseline assessments and 65 individuals (82 percent) returning for post-program testing. Participation in *Living Well After Cancer* was associated with a significant decrease in several metabolic measures and an increase in physical fitness in cancer survivors.

Currently, there are more than 15 million cancer survivors in the United States and over 20 million are expected by 2026.[1] Due to early detection and treatments, the number of cancer survivors continues to grow exponentially each year. However, after active anti-cancer treatment, many of these survivors experience increased physical and psychological symptoms related to their chemotherapy regimen, radiation, and other types of treatment. Though many symptoms dissipate following the completion of treatment, some persist in the long term. These long-term symptoms, also known as "collateral damage,"[2] include pain, neuropathy, fatigue, weight gain, depression, anxiety, and cognitive decline. Though increased survivorship signals positive advancements in cancer care, it also places growing demands on the cancer programs and practices that provide active treatment to patients. After successful therapies, patients often look to these same institutions for survivorship care, including symptom management. However, these institutions are frequently overwhelmed by the number of patients on active treatment and cannot fully attend to the needs of cancer survivors due to lack of resources. Additionally, the programs that are available are often cancer and/or stage specific (i.e., metastatic breast cancer survivorship programs) and thus do not meet the needs of many cancer survivors.[3-6]

Program Description

The Claremont Club's *Living Well After Cancer* program in Claremont, Calif., uses a community-based approach to meet patients' needs outside the clinical setting. Certified trainers, a

dietitian, and other professionals help cancer survivors manage and mitigate long-term symptoms. Open to all survivors of cancer, the program was founded in 2005 and has reached approximately 1,340 individuals over the course of 15 years. Each program lasts 13 weeks and participants attend one-hour exercise classes at The Claremont Club twice weekly, alternating between aerobic exercise, strength training, and specialty classes (e.g., yoga, water aerobics).

In addition to the structured exercise regimen the program provides, participants are afforded the social support of their peers in the community. Cohorts, separated by gender, attend the same weekly meetings and develop a support system throughout the 13-week program. Evidence demonstrates that social support and social integration may be associated with reduced overall mortality.[7] Specifically, members of a shared social network may encourage one another to engage in healthy lifestyle modifications, such as increased physical activity, improved nutrition, and regular attendance of follow-up visits.[8] Not only does the *Living Well After Cancer* program facilitate social support through this cohort model, but the program also encourages participants to enroll with a companion, typically a family member or other close individual, thus enhancing opportunities for increased social connectedness and accountability. Through its 13-week structure, the *Living Well After Cancer* program aims to demonstrate to survivors the relationship between exercise, quality of life, and metabolic measures.

Thus far, the data supporting the program's success have been anecdotal. A partnership between The Claremont Club, City of Hope, and Claremont Graduate University provided evidence-based data for *Living Well After Cancer*'s success in improving metabolic health, function, and quality of life. The purpose of this study was to determine the feasibility of conducting pre- and post-intervention testing with program participants. It also examined the effect of the wellness program on body measurements, fasting glucose, hemoglobin A1c (HbA1c), cholesterol, lipids, chronic inflammation, blood pressure, and physical fitness.

Study Methods

Using a quasi-experimental design, the pilot study assessed the feasibility of conducting pre- and post-intervention testing of *Living Well After Cancer* participants. During testing, participants were asked to fill out questionnaires, agree to a body composition assessment, and give drops of blood from finger pricks for metabolic measures before and after program completion. City of Hope's institutional review board approved the protocol and informed consent. Furthermore, all methods were performed in accordance with relevant guidelines and regulations for research involving human subjects. End points were assessed at baseline and post-program (week 13).

Participants and Recruitment

Eligible participants consisted of cancer survivors (all disease types and stages at diagnosis) who were enrolled in The Claremont Club's *Living Well After Cancer* program. Recruitment occurred between Sept. 19, 2017, and Feb. 26, 2019, at the program's orientation sessions that were held at the beginning of the four cohorts (September 2017, February 2018, September 2018, and February 2019). All participants provided written, informed consent.

Outcome Measures

Feasibility and Adherence

To assess feasibility, researchers monitored the number of people who consented and the number of people who attended their baseline testing. To evaluate adherence to the data collection and wellness program protocols, researchers monitored the number of participants who attended their post-testing and the number of program sessions each individual attended.

Body Measurements

Weight, body mass index, and body fat percentage were measured using the InBody270, a body composition analyzer. Participants' chest circumference was measured to the nearest 0.5 cm around the widest portion of their chest, and their waist circumference was measured to the nearest 0.5 cm around their umbilicus. Arm circumference was also measured to the nearest 0.5 cm at the midpoint between participants' olecranon process and acromion, and thigh circumference was measured to the nearest 0.5 cm at the point where participants' fourth digit lies on the thigh while standing with their hands along their sides. Lastly, participants' ankle circumference was measured to the nearest 0.5 cm at the point directly above their lateral malleolus.

Fasting Glucose and Hemoglobin A1c

Clinical research assistants obtained participants' fasting blood from finger pricks and analyzed them immediately using the Contour® Next EZ blood glucose monitoring system (fasting glucose) and A1CNow+ multi-test A1c system (hemoglobin A1c).

Cholesterol and Lipids

Clinical research assistants used the fasting blood from the finger prick to measure total cholesterol, high-density lipoprotein cholesterol, and triglycerides, using the CardioChek® cholesterol analyzer kit. Participants' low-density lipoprotein (LDL) cholesterol was calculated using the results from the previous three measures.

Blood Pressure

Participants' blood pressure was measured at baseline and post-program (13 weeks) using the Omron® BP785.

Physical Fitness

Participants' level of physical fitness was assessed at baseline and post-program (13 weeks) using a hand dynamometer, which measures an individual's isometric grip force/hand grip strength.

Inflammation

Clinical research assistants obtained participants' fasting blood for a micro-erythrocyte sedimentation rate assay designed to serve as a surrogate marker for chronic inflammation. The micro-erythrocyte sedimentation rate method was adapted from papers that developed and used this method previously.[9,10] Briefly, for each patient sample, a 1:4 dilution of 3.8 percent sodium citrate

blood sample was drawn up using a microhematocrit heparin capillary tube and allowed to stand un-disturbed on a sealant rack for 20 minutes. Readings of the sedimented erythrocytes derived from this method were then converted to the Westergren erythrocyte sedimentation rate equivalent using the following formula: $x = 2.819 \times y + 1.346$ (where x = sedimentation per hour, and y = 20-minute reading of clear plasma level using micro-erythrocyte sedimentation rate).

Covariate Measures

Physical Activity and Dietary Assessments

Participants' physical activity history was assessed at baseline and post-program using a validated questionnaire. Three-day dietary records—two weekdays and one weekend day—were completed at baseline using a self-reporting form. Dietary records were also completed at baseline and post-program within 24 hours of participants' testing session via a self-reported form.

Medical History

Participants self-reported their cancer-related information, including the type of cancer, age at diagnosis, disease stage, histologic grade, treatments and symptoms, and diagnosed chronic conditions, using a questionnaire that was given at baseline and post-program.

Exercise Intervention

All participants completed the same 13-week supervised exercise program. Participants committed to meeting for one hour at The Claremont Club every Tuesday and Thursday. Tuesday sessions focused primarily on cardio and strength training, and Thursday sessions consisted of specialty classes like yoga or aquatics. All sessions were led by a certified (American College of Sports Medicine, National Strength and Conditioning Association, or National Council on Strength & Fitness) exercise trainer. Attendance at these sessions was monitored to determine adherence. Participants in the program were given free memberships to The Claremont Club to use for themselves and their immediate family.

Statistical Analyses

Researchers computed percent change relative to baseline for all fitness, body measurement, and metabolic measurement variables. Means are expressed with a standard deviation. Changes from baseline to post-program were evaluated using paired t tests. Analyses were run on participants who had both pre- and post-measurements. The level of significance in all statistical analyses was set at $p < 0.05$. Post-hoc analyses included stratification by cancer diagnosis, sex, and program adherence. Data analyses were performed using SPSS software (version 25, SPSS, Inc., Chicago, Ill.).

Study Results

At each orientation session, researchers gave a brief introduction to the study and explained that 20 participants would be enrolled. Eighty-eight participants provided written informed consent (Figure 1, below). Of those, 79 participants attended baseline testing (90 percent) and 65 participants returned for their post-program testing session (82 percent).

Table 1, page 46, depicts the baseline characteristics of the program's participants. Of the 79 participants who attended baseline testing, 14 participants did not complete the program. Most participants were non-Hispanic/Latino (n = 58; 73.42 percent), and the primary diagnosis was breast cancer (n = 50, 63.29 percent). On average, participants were 58 years of age or older, and a majority were college-educated, married/partnered, and did not have children under 18 years of age at home. Of the

Figure 1. Flowchart of Enrollment, Drop Out, and Completion.

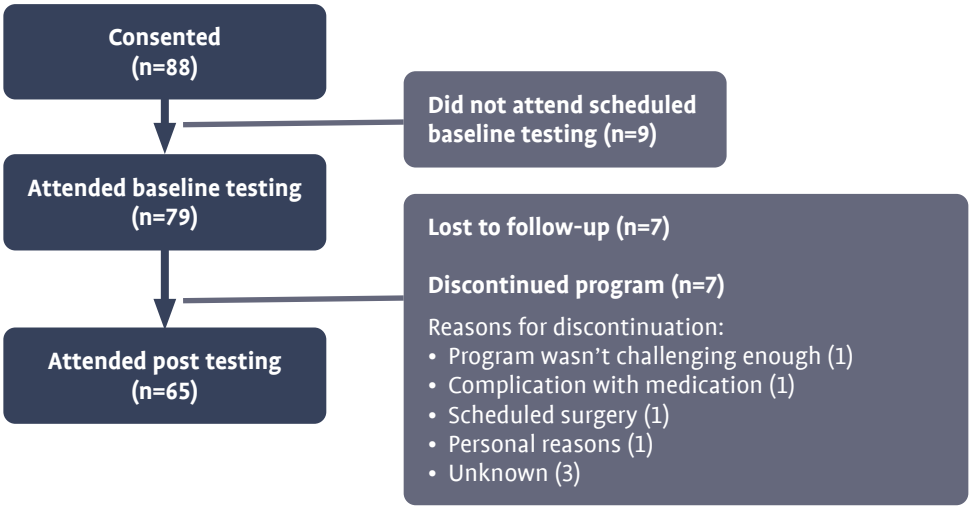

Table 1. Baseline Characteristics of the Sample (n = 79)

Variable	Mean	SD
Age (mean years)	58*	10.82
Variable	**Size (n)**	**%**
Gender		
• Female	65	82.28
• Male	14	17.72
Ethnicity		
• Hispanic/Latino	16	20.25
• Not Hispanic/Latino	58	73.42
• I'd rather not say	2	2.53
• Not reported	1	1.27
Race		
• White/Caucasian	55	69.62
• Black/African American	2	2.53
• Asian/East Indian	4	5.06
• American Indian or Alaska Native	1	1.27
• Multi-racial	8	10.13
• Other	3	3.80
• I'd rather not say	5	6.33
• Not reported	1	1.27
Education		
• High school or less	5	6.33
• Vocational, some college, or 2-year associate's degree	29	36.71
• 4-year college	16	20.25
• Graduate/professional school	26	32.91
• I'd rather not say	2	2.53
• Not reported	1	1.27
Marital Status		
• Never married	8	10.13
• Married, in a civil union, domestic partnership, or living as married	53	67.09
• Divorced/separated	12	15.19
• Widowed	5	6.33
• Not reported	1	1.27
Primary Cancer Diagnosis		
• Breast	50	63.29
• Others	28	35.44
• Not reported	1	1.27

*Calculated for the 78 participants who returned the demographic baseline questionnaire.

65 participants who completed the program, 60 percent maintained an 80 percent or higher adherence rate to the program throughout the 13 weeks. No difference in demographics was observed between the cohort that completed the program (n = 65) and the full cohort enrolled at baseline (n = 79).

Table 2, right, lists the baseline and post-program follow-up changes in metabolic measures. Total cholesterol decreased significantly at post-program follow-up compared to baseline, with a mean difference of –15.03 mg/dL (p = 0.006). Compared to baseline, LDL cholesterol and triglyceride levels displayed downward trends at post-program follow-up. However, when stratifying by sex, among males (n = 12), triglycerides decreased significantly compared to baseline, with a mean difference of –26.58 mg/dL (p = 0.025). When stratifying by adherence levels, those who adhered 80 percent or more to the program protocol demonstrated a significant decrease in LDL cholesterol, with a mean difference of –15.62 mg/dL (p = 0.040).

Table 3, right, lists the baseline and post-program follow-up changes in fasting glucose and HbA1c, stratified by clinical classification (fasting glucose: normal = less than 100 mg/dL, pre-diabetes = 100 mg/dL-125 mg/dL, and diabetes = greater than 126 mg/dL; HbA1c: normal = less than 5.7 percent, pre-diabetes = 5.7 percent to 6.4 percent, and diabetes = greater than 6.5 percent). Fasting glucose did not demonstrate any significant increases or decreases for any of the strata. However, when examining HbA1c levels, those in the normal range at baseline demonstrated a significant increase (M_{diff} = 0.28 percent; p < 0.001). However, from a clinical standpoint, this increase did not move the normal range group to a pre-diabetic range. Both the pre-diabetic and diabetic at baseline groups did not demonstrate any significant changes in HbA1c values. Similarly, when stratifying by sex, among females, HbA1c decreased significantly compared to baseline, with a mean difference of –0.21 percent (p = 0.018; data not shown).

As shown in Table 4, page 48, erythrocyte sedimentation rate levels for the group (third and fourth cohorts only) decreased significantly compared to baseline, with a mean difference of –2.82 (p = 0.020). When stratifying by age, the erythrocyte sedimentation rate for the younger group (less than 50 years of age, n = 5) decreased dramatically and significantly compared to baseline, with a mean difference of –7.05 (p = 0.030). Additionally, the calculated erythrocyte sedimentation rate values were used as a surrogate marker for assessing chronic inflammation in 29 participants. Participants who had erythrocyte sedimentation rate values higher than the normal range for their age and gender were categorized as having chronic inflammation. Normal range was defined as:

- Females younger than 50 years old = 0 mm/hr to 20 mm/hr
- Females 50 years of age or older = 0 mm/hr to 30 mm/hr
- Males younger than 50 years old = 0 mm/hr to 15 mm/hr
- Males 50 years of age or older = 0 mm/hr to 20 mm/hr

Overall, seven participants were categorized with chronic inflammation at baseline, of which five showed a dramatic reduction in erythrocyte sedimentation rate back to the normal range at

Table 2. Changes in Participants' Metabolic Measures

Outcome Variable	*n*	Baseline Mean (SD)	Post-Program Mean (SD)	Mean Difference	*p* Value
Systolic blood pressure	65	121.86 (16.32)	123.06 (14.98)	1.20	0.377
Diastolic blood pressure	65	79.55 (8.31)	79.68 (8.33)	0.12	0.850
Total cholesterol (mg/dL)	65	194.89 (41.19)	179.86 (44.59)	−15.03	0.006
HDL (mg/dL)	65	60.06 (17.33)	58.11 (19.19)	−1.95	0.392
Triglycerides (mg/dL)	65	135.49 (68.15)	121.38 (63.94)	−14.11	0.058
LDL (mg/dL)	65	107.87 (36.28)	98.49 (42.42)	−9.37	0.073

HDL = high-density lipoprotein; LDL = low-density lipoprotein; mg/dL = milligrams per decilitre; SD = standard deviation

Table 3. Changes in Participants' Glucose and HbA1c

Outcome Variable		*n*	Baseline Mean (SD)	Post-Program Mean (SD)	Mean Difference	*p* Value
Glucose	Normal range at baseline	32	90.31 (6.96)	90.47 (12.88)	0.16	0.940
	Pre-diabetic range at baseline	31	108.97 (6.86)	105.84 (18.15)	−3.13	0.312
	Diabetic range	2	169.00 (28.28)	174.50 (26.16)	5.5	0.170
HbA1c	Normal range at baseline	56	5.04 (0.46)	5.32 (0.41)	0.28	<0.001
	Pre-diabetic range at baseline	3	6.17 (0.23)	5.87 (0.45)	−0.30	0.423
	Diabetic range	1	7.10	6.50	−0.60	—-

HbA1c = hemoglobin A1c; SD = standard deviation

post-program follow-up. Only one participant who was categorized in the normal range at baseline presented as having chronic inflammation at post-program follow-up.

Table 5, page 49, lists body composition and physical fitness measures at baseline and post-program follow-up. At follow-up, participants displayed a significant increase of right hand grip strength, with a mean difference of 4.04 lb ($p = 0.001$). In addition, participants displayed a significant increase of left hand grip strength, with a mean difference of 2.64 lb ($p = 0.025$). Although not significant, waist circumference (cm) and weight (lb) displayed slight downward trends at post-program follow-up compared to baseline. When stratifying by gender, among females ($n = 53$), right arm measurements decreased significantly compared to baseline, with a mean difference of –0.36 cm ($p = 0.023$).

Study Discussion

This study aimed to examine the feasibility of conducting pre- and post-testing of a 13-week, supervised, community-based exercise program on metabolic measures, body composition, and physical fitness in a population of cancer survivors. Overall, feasibility was observed among 82 percent of the 79 participants who returned for their post-testing. Furthermore, researchers found preliminary evidence for the efficacy of the *Living Well After Cancer* program on metabolic measures and physical fitness. Namely, erythrocyte sedimentation rate (inflammation), total cholesterol, and grip strength (left and right hands) all demonstrated significant improvements at the post-program testing session. Conversely, the program was not associated with a

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Table 4. Changes in Participants' ESR Levels Post-Intervention (*n* = 29)

Total *n*	Baseline-Intervention Mean (SD)	Post-Intervention Mean (SD)	Mean Difference	*p* Value
29	16.07 (8.80)	13.25 (7.30)	-2.82	0.020
Participant	**Age**	**Gender**	**Baseline ESR**	**Post-Intervention ESR**
1	29	F	6.98	5.57
2*	42	M	**19.67**	8.39
3	45	F	12.62	6.98
4*	46	M	**25.31**	12.62
5	47	F	8.39	4.17
6*	50	F	**23.90**	15.44
7	52	F	22.49	15.44
8	52	F	19.67	6.98
9	53	F	12.62	5.57
10	53	F	19.67	**30.95**
11	54	F	8.39	8.39
12	55	F	23.90	19.67
13	55	F	6.98	9.80
14	58	F	11.21	11.21
15	58	F	9.80	12.62
16	58	M	5.57	5.57
17	58	F	16.85	15.44
18	61	M	12.62	9.80
19	62	M	**30.95**	**28.13**
20	63	M	**21.08**	**21.08**
21	65	F	8.39	12.62
22	66	F	6.98	8.39
23	67	M	8.39	6.98
24	69	F	16.85	15.44
25	71	F	9.80	11.21
26	72	F	21.08	18.26
27*	72	F	***39.40***	19.67
28	74	F	5.57	8.39
29*	76	F	**30.95**	29.54

Values in bold indicate ESR value higher than normal for the participant's age/gender category.
Normal range defined as: females <50 years = 0 mm/hr-20 mm/hr, females >50 years = 0-30 mm/hr, males <50 years = 0 mm/hr-15 mm/hr, and males >50 years = 0 mm/hr-20 mm/hr. ESR = erythrocyte sedimentation rate; SD = standard deviation

Table 5. Changes in Participants' Body Composition and Physical Fitness

Outcome Variable	*n*	Baseline Mean (SD)	Post-Program Mean (SD)	Mean Difference	*p* Value
Right hand grip strength (lb)	63	57.56 (17.40)	61.60 (17.68)	−4.04	0.001
Left hand grip strength (lb)	64	54.81 (18.00)	57.45 (17.11)	−2.64	0.025
Chest (cm)	65	99.30 (12.50)	99.14 (12.86)	0.16	0.664
Waist (cm)	65	95.45 (14.63)	95.09 (15.55)	0.36	0.561
Right arm (cm)	65	26.30 (3.88)	26.09 (3.58)	0.21	0.152
Left arm (cm)	65	26.18 (4.05)	26.09 (3.63)	0.08	0.576
Right thigh (cm)	65	52.91 (7.41)	52.17 (7.26)	0.74	0.214
Left thigh (cm)	65	52.70 (7.47)	52.69 (6.78)	0.02	0.954
Right ankle (cm)	65	19.77 (2.15)	19.77 (2.10)	0.00	1.000
Left ankle (cm)	65	19.92 (2.19)	19.85 (2.07)	0.08	0.486
Weight (lb)	65	170.83 (44.33)	170.37 (44.19)	0.46	0.535
Body mass index	65	28.00 (6.23)	27.76 (6.08)	0.24	0.226
Body fat (%)	65	37.12 (9.16)	36.73 (8.81)	0.39	0.275

cm = centimeters; lb = pounds; SD = standard deviation

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significant impact on body composition. However, when examining these results by gender, right arm measurements and triglycerides decreased significantly for females and males, respectively, after 13 weeks.

The results observed here parallel the results of several other studies that examine the effects of similar exercise programs on metabolic measures and body composition. In a pilot study by Nuri and colleagues, a 15-week combination exercise training program significantly improved metabolic measures among 29 post-menopausal survivors of breast cancer.[11] Similarly, Dieli-Conwright and colleagues found that a 16-week resistance and aerobic exercise program attenuated metabolic variables among 100 survivors of breast cancer.[12] However, both studies found significant changes in body composition variables, such as body weight, body mass index, and waist to hip ratio, whereas this study did not.

The lack of significant findings regarding body composition could be attributed to several reasons. First, the *Living Well After Cancer* program lasted a total of 13 weeks, compared to the 15- and 16-week durations of the other studies' interventions. Second, our program afforded participants two weekly supervised exercise sessions, whereas others offered three to four days of supervised sessions, which is more closely aligned with the American College of Sports Medicine and American Cancer Society exercise guidelines for survivors of cancer.[13] Lastly, Nuri et al. and Dieli-Conwright et al. utilized randomized control trial designs,[11,12] as opposed to the single-arm, quasi-experimental design used in this study. Taken together, these procedural and design differences could be the reason for the lack of significant changes in body composition that was observed in this study. However, despite these differences, our study observed significant differences in several outcome variables, demonstrating that even moderate amounts of exercise can impact metabolic measures whether significant changes in body composition are observed or not.

Given that significant improvements in several metabolic outcome variables were observed, it is important to note several strengths of this study. First, previous studies, including the two trials cited above, typically conduct exercise interventions in a controlled lab setting. In comparison, the framework used by the *Living Well After Cancer* program allows participants to be in the community and engage in healthy lifestyle behaviors in a setting that is familiar to them—a local health and wellness center. This setting change increases the likelihood that participants will feel more comfortable continuing their efforts beyond the program's duration. Though several recent studies aimed to address

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the physical and psychosocial needs of cancer survivors in a community-based setting like the *Living Well After Cancer* program, many failed to include metabolic measures as indicators of a successful survivorship program.[4-6,14-16] This study found that measures of metabolic changes can yield significant results even when assessments of body composition and physical fitness do not. Therefore, it is important to include metabolic measures in studies when examining the impact of community-based wellness programs utilized by cancer survivors to fully assess how these programs can mitigate the sequalae associated with treatment.

Second, this study used instruments that do not require a laboratory for specimen processing. All instruments were purchased online and are accessible to the public. In addition to this convenience, study staff could quickly process participants' blood from finger pricks and receive immediate results, allowing for time efficiency. The community-based setting and instrument accessibility allow similar studies to be conducted outside the controlled environment of a lab, as seen in other studies.

Though these findings provide support for the *Living Well After Cancer* program, there are a few limitations that warrant discussion. First, this study lacked active recruitment, thus resulting in possible selection bias. In other words, individuals who self-select for a program that requires a twice-weekly exercise commitment might be more inclined to adhere to healthy lifestyle behaviors than those who do not self-select. Second, the single-arm, quasi-experimental design used in this study did not include a control group. For this reason, it is difficult to determine whether the observed improvements were due to participation in the program or the cancer survivorship trajectory in general.

Lastly, though this study used hand grip strength as an indicator of physical fitness, it did not include a six-minute walk test to assess cardiorespiratory fitness in this population—a measure frequently used by other studies in this research area.[4,14,15] By including this measure in the program, future sessions would be better equipped to assess its impact on multiple areas of physical fitness. Therefore, to address these limitations, future studies should implement a randomized controlled trial design and include the addition of the walking test. Other items for future studies to consider include having a control group to identify a program's impact more fully on markers of cancer survivorship and implementing a third timepoint. Because the *Living Well After Cancer* program encourages long-term lifestyle changes, there is a need to follow up with participants after the post-program testing session (e.g., three months post-program completion) to determine whether the program's results continue beyond 13 weeks.

Overall, these findings provide preliminary evidence for the *Living Well After Cancer* program as an effective strategy to mitigate the long-term symptoms cancer survivors develop after treatment. As a community-based program, it removes the burden of having to offer these services in the clinical setting and increases access to community resources that may lead to improved survivors' health and well-being. Future trials are needed to explore more fully participants' changes in metabolic measures and body composition. Ultimately, a randomized intervention trial is needed to determine the *Living Well After Cancer* program's impact on the cancer survivorship trajectory. OI

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Disclosure of Interest

The authors have no conflicts of interest or competing interests to declare.

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