



Association of Body Esteem with Fitness and Body Fat Among Colorectal Cancer Survivors: Secondary Analyses from a Randomized Trial

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Abstract

Background Survival rates among cancer survivors have improved; however, treatments affect body esteem. Body esteem can significantly affect quality of life and depression following cancer treatment. The purpose of these secondary analyses was to examine the relationship between changes in fitness and body fat with changes in body esteem among colorectal cancer survivors who participated in a randomized controlled trial that tested the effects of a 12-week physical activity intervention.

Method Male and female colorectal cancer survivors (< 5 years since diagnosis) participated in a randomized controlled trial that tested a 12-week moderate-intensity physical activity intervention. Body esteem, fitness (estimated VO₂ peak), and body composition (bioelectrical impedance) were assessed at baseline and follow-up visits (3 months, 6 months, and 12 months).

Results Forty-six colorectal cancer survivors (57 years old, 57% female) completed the study. Improvements in fitness were associated with improvements in body esteem among males at 6-month and 12-month follow-up visits, while improvements in body fat were associated with increased body esteem at 12-month follow-up among females. Improvements in fitness and body fat among stage 0–2 survivors were associated with significant improvements in body esteem, with no significant changes among stage 3 survivors.

Conclusion Results from this study showed that improved fitness and body composition can improve body esteem among these survivors; however, differences exist among gender and disease stage.

Trial Registration <https://clinicaltrials.gov/ct2/show/NCT00230646?term=Pinto&cond=Colorectal+Cancer&rank=2>

Keywords Body esteem · Fitness · Body fat · Colorectal · Cancer survivor

Introduction

Currently, there are 15.5 million Americans living with a history of cancer [1]. Over the past two decades, cancer death

rates have dropped approximately 25% due to a reduction in smoking and improvements in early detection and treatment [1]. As survival rates continue to improve, cancer treatments present challenging physical and psychosocial burdens that reduce health-related quality of life [2] and body satisfaction [3, 4]. Body esteem refers to satisfaction of one's body or appearance [5] and plays a role in general self-esteem [6, 7]. Cancer treatments such as surgery and/or adjuvant treatment, result in worsening of overall quality of life [8] and increases in depression [9]. In addition, cancer survivors report an increase in dissatisfaction with the body's appearance and function following treatment. For example, physical changes such as hair loss and weight gain are common side effects among survivors receiving chemotherapy [10]. Surgical treatments, such as a stoma, may also reduce body esteem, thus increasing depression, anxiety, and distress in the individual [11]. Hence, identifying ways to improve body esteem (or offset its decrease) among cancer survivors is a worthwhile goal for their recovery.

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Evidence is conflicting in regard to whether physical activity (PA) can improve body esteem among adults. A recent meta-analysis reviewed stand-alone interventions, one of which included a physical fitness program, to improve body image among adults [12]. This meta-analysis did not specifically target cancer populations. Inconsistent results were found among studies with objective improvements in fitness (aerobic and anaerobic) relating to change in body image among adults [12]. Furthermore, an earlier meta-analysis identified 57 interventions which examined the effect of exercise on body image [13]. A small effect size was indicated among those participants who improved their body image following an exercise intervention as compared to controls [13]. While there are other interventions that can help an individual to improve their body satisfaction (e.g., cognitive behavioral therapy) [13], participating in a PA program can be low-cost and may appeal to people who do not want to receive psychotherapy. Therefore, more research is necessary to understand the possible association between participating in a PA intervention and improving body esteem, especially among special populations such as cancer survivors.

Depending on treatment stage, colorectal cancer survivors can experience radical, but lifesaving, surgical treatments such as a permanent colostomy, resulting in a stoma. Among colorectal cancer survivors, those patients who received a stoma had a higher body image disturbance compared to those who did not [11]. Similar findings were found among those colorectal cancer survivors who underwent stoma-forming surgery. Over time, colorectal cancer survivors with a stoma had a significant deterioration of body image [14]. Furthermore, at baseline, poor body image was a predictor of depression and anxiety [14]. In addition to surgical treatment, colorectal cancer survivors may complete chemotherapy as part of their treatment plan. In a case-control study, 90 breast cancer survivors were evaluated on their body image and compared to 77 women without breast cancer. Among those women who had breast cancer and were receiving chemotherapy, they were more dissatisfied with their body image as compared to those without breast cancer [3]. Consistent results have identified the association with body image and depression and anxiety; however, less is known on how to offset body image disturbance, specifically among colorectal cancer survivors. In a systematic review among colorectal cancer survivors, authors highlighted the need for more research describing the relationship between exercise intensity and patient-centered outcomes [15]. Specifically, among breast cancer survivors, those who exercised regularly reported better body esteem than their sedentary peers [16]. More research is necessary among colorectal cancer survivors to identify ways to improve their body esteem and possibly reduce distress.

This secondary analysis is based on a randomized controlled trial that tested the effects of a telephone-based PA

intervention among colorectal cancer survivors: the primary outcome was minutes of PA/week [17]. Other work from this study identified four classes of colorectal cancer survivors based on their sedentary behavior over time [18]. The purpose of this study was to investigate change in body esteem among colorectal cancer survivors after participating in a 12-week telephone-based PA intervention. The current study was a secondary analysis of a randomized controlled trial examining the effects of the PA intervention. We were interested in identifying variables (e.g., fitness and body composition) that may predict changes in body esteem. Specifically, we sought to answer the question: Are improvements in fitness and body fat (resulting from participating in a PA intervention) associated with an improvement in body esteem over time? We hypothesized that predictors of change in body esteem would differ between male and female survivors [19], consistent with the literature in which females focus on body appearance [20], more specifically weight and shape [21], while males tend to focus on their body functioning and physical fitness [20]. Further, we explored if there is a difference in body esteem following a PA intervention between cancer stages (stage 0–2 vs. stage 3). We hypothesized cancer stage would influence body esteem such that those with stage 0–2 disease would see greater improvements in body esteem with changes in body fat and fitness compared to those diagnosed with stage 3 disease. Stage 0–2 survivors would most likely not have experienced radical treatment (e.g., stoma, chemotherapy) as compared to stage 3 survivors, resulting in less fatigue and better physical function.

Methods

Within this randomized controlled trial, male and female patients diagnosed with colorectal cancer (stage 0–3) were recruited between 2005 and 2009. This study recruited participants from private clinical practices serving colorectal cancer survivors, colorectal cancer support groups, cancer survivorship events, and other community events. This trial was registered on [ClinicalTrials.gov](https://clinicaltrials.gov) (NCT00230646). The primary outcome for this study was minutes of moderate-intensity PA. Study methods and design were previously reported [17]; however, study methods are briefly described in the text.

Participants

Male and female colorectal cancer survivors were eligible for study participation if they were 18 years and older, completed primary and adjuvant treatments for colon or rectal cancer, and were less than 5 years since treatment completion. Furthermore, those who were able to walk unassisted and defined as sedentary (< 60 min/week of

moderate-intensity PA or <20 min of vigorous-intensity PA) over the past 6 months were invited to participate. Other eligibility criteria included reading/writing English and access to a telephone. Participants were ineligible for the study if they had a prior history of cancer and/or had a medical or current psychiatric illness that would limit study participation. Those patients with cardiovascular disease and/or diabetes were included only with physician approval. All interested participants completed a phone screen to determine initial eligibility.

The study was powered a priori such that 60 participants per group after attrition would provide 80% power [17]. Overall, 46 participants were randomized into either the physical activity group ($N = 20$) or the contact control group ($n = 26$). A detailed figure describing recruitment and participant flow throughout the study has been previously reported [17]. Briefly, at the 3-month assessment, one participant in the physical activity group (PA group) dropped from the study and two participants in the contact control group (CC group) dropped from the study. At the 6-month assessment, one participant in the CC group dropped from the study, while no participants dropped from the PA group. No additional participants dropped at the 12-month assessment. There was a 95% retention rate among PA group participants ($n = 19$) and an 88% retention rate among participants in the CC group ($n = 23$) at the 12-month assessment.

Randomization

Informed consent was obtained from all individual participants included in the study. Interested and eligible participants also provided medical clearance from their oncologist (and other physician(s) if they had cardiovascular disease or diabetes) prior to completing baseline assessments. The Institutional Review Boards at the Miriam Hospital and the Women and Infants Hospital approved the study. Participants were randomized into either (1) a 12-week, home-based moderate-intensity PA program (PA group) or (2) a contact control (CC group) by trained research staff. Patients were stratified for age (< 65 years vs. ≥ 65 years), cancer type (colon or rectal cancer), and gender.

Intervention

PA Group

At an in-person visit, research staff instructed participants on exercising at moderate intensity (64–76% of estimated maximal heart rate) [22] and on wearing a heart rate (HR) monitor and a pedometer (Digi-Walker; Yamax Corporation, Tokyo, Japan) during planned PA. Participants were asked to record details of their PA (e.g., type of activity, duration of activity, average HR, total steps, and rate of perceived exertion (RPE))

on an exercise log. Participants were asked to begin the program by exercising at least 2 times/week for 10 min, and the goals were progressively increased to 5 days/week for 30 min [23, 24]. Since one of the measurement tools used to measure intensity was a pedometer, participants were encouraged to participate in activities in which their steps could be recorded. Overall, walking was the main form of activity; however, participants also chose to be active using an elliptical or online walking videos.

During their 12-week PA intervention, each participant received a call from trained research staff. Calls were tailored to each participant's motivational readiness [25] and based on the transtheoretical model [26] and social cognitive theory [27]. Research staff focused each call on strengthening self-efficacy for exercise, setting PA goals, and using techniques such as self-monitoring and planning ahead. For those participants in the contemplation phase, research staff emphasized cognitive process of change, while research staff emphasized behavioral processes for participants in the preparation phase. During each call, research staff reviewed the PA sessions from the previous week, identified and helped the participant to problem-solve barriers to exercise, reviewed health status, and aided participants with PA goal setting for the upcoming week. During each weekly call, participants reported on their exercise sessions based on their exercise logs. If a health problem such as chest pain was reported, participants were immediately referred to their physician and asked to halt PA sessions.

CC Group

These participants received 12 weekly calls from the research staff during which the Symptom Questionnaire [28] was administered to monitor any health problems.

The duration of calls to the PA group was longer (mean 19.32 min, SD = 4.91) than calls to the control condition group (mean 10.84 min, SD = 19.32). The PA calls were longer due to the fact that the research staff discussed barriers to exercise, planned ahead for upcoming exercise sessions each week, and problem-solved with the participant. The calls with the control condition group were focused on assessing symptoms and did not discuss exercise, thus limiting the duration of the call. The study design aimed at controlling for the frequency of contact with the two groups (12 calls per group) and not at ensuring the duration of calls was similar for both groups.

Measures

At baseline, demographic and medical and treatment history was collected. Body weight and height were measured on a calibrated scale; BMI was subsequently calculated (kg/m^2). At baseline, bioelectrical impedance analysis (BIA)

was collected at visit 1 and the treadmill walk test was completed 1 week later (visit 2). All participants completed the same assessments at baseline, 3-month, 6-month, and 12-month follow-up visits and received small incentives for providing data. Staff completing assessments were blind to participants' group assignment. Assessments included the following:

- a. *Body Esteem Scale.* The Body Esteem Scale (BES) is a valid and reliable measure of body satisfaction among males and females [6]. This 35-item scale is broken into subscales depending on the gender of the individual. Males are asked to complete the physical attractiveness, upper body strength, and physical condition subscales, while female subscales include sexual attractiveness, weight concern, and physical condition. For this study, we only used the scores from the physical condition subscale (which included 13 items for males and 9 items for females) since this was the only scale common to male and female participants. On a 5-point Likert scale (1 = have strong negative feelings, 5 = have strong positive feelings), participants were asked to rate items such as physical stamina and physical coordination. All responses were summed with a higher score indicating positive body esteem.
- b. *Submaximal fitness test.* Physical fitness was assessed by the treadmill walk test. Participants self-selected the fastest pace to walk a mile on the treadmill. Once the pace was selected, it was held constant until the mile was completed. The treadmill walk test accounts for the time to walk a mile on a treadmill, thus providing an estimate of maximal oxygen uptake (VO_2 peak). This measure of fitness has been validated among young and fit adults [29] and older individuals [30].
- c. *Body composition.* Body composition was measured using BIA. BIA was performed with a single-frequency (50 kHz) electrical current produced by a BIA Quantum II RJL system analyzer (RJL Systems, Clinton Township, MI). Participants were placed in the supine position, with arms 30° from the body and legs not touching. The electrode sites were cleaned with alcohol prior to placement. Once the electrodes were placed on the participant, the analyzer was turned on and the participant was asked to remain still. Once the measurements stabilized, the resistance and reactance were recorded. The measure of body composition has been validated among male and female older adults [31].
- d. *Accelerometer data.* Moderate-to-vigorous physical activity (MVPA) was measured using the Computer Science and Applications, Inc., PA monitor (CSA model 7164). CSA monitors were worn around the waist, on the right hip. Participants were instructed to wear the monitors for 3 consecutive days (including one weekend day) during

all waking hours. The participant was asked to remove the monitor during periods when it might get wet such as bathing or swimming. CSA monitors have been validated among males and females [32]; in addition, PA intensities have been defined for this accelerometer [33].

During the follow-up assessments, participants were not informed of any change in their body composition (specifically body fat) or any potential improvements in their fitness level.

Statistical analyses

To estimate fat-free mass (FFM) from the BIA measurement, the following equation was used: (1) female FFM = $7.7435 + (0.4542 \times (\text{height})^2 / \text{resistance}) + (0.1190 \times \text{weight}) + (0.0455 \times \text{reactance})$ and (2) male FFM = $9.1536 + 0.4273 \times (\text{height})^2 / \text{resistance} + (0.1926 \times \text{weight}) + (0.0667 \times \text{reactance})$ [31]. Weight was measured in kilograms, and height was measured in centimeters. Adipose (or fat mass) was calculated by subtracting FFM from weight. To calculate fitness from the treadmill walk test, the following equation was used: $92.08 - 0.10 (\text{body weight in pounds}) - 0.34 (\text{age in years}) + 9.72 (\text{gender: male} = 1, \text{female} = 0) - 1.01 (\text{walk time in minutes and hundredths of a minute}) - 0.13 (\text{walk heart rate in beats per minute}) + 0.86 (\text{activity level})$ [30].

Baseline sociodemographic and medical history variables have been presented elsewhere [17]. Table 1 presents descriptive statistics by randomized group condition at baseline. Unadjusted mean values of the predictors (fitness and body fat), as well as outcome (body esteem), are presented over time and by group. *t* tests and chi-square tests were used to compare baseline values of predictors and outcomes between groups for continuous and categorical variables, respectively (in Table 1), and analysis of variance for between-groups differences in changes from baseline to follow-up in unadjusted mean outcomes (Table 2).

Using a series of generalized linear models, we examined whether changes in fitness and changes in body fat would predict changes in body esteem over time (baseline to 3 months, baseline to 6 months, baseline to 12 months), controlling for group assignment. Additionally, we explored whether these effects were similar for males and females and for participants with differing disease severity at baseline (stage 0–2 vs. stage 3). Gender and stage were chosen a priori as they showed positive correlations with both predictors and outcomes. Models used a likelihood-based approach to estimation and thus make use of all available data without directly imputing missing outcomes.

Table 1 Baseline demographic and medical history variables by condition ($N = 46$)

	Intervention, $N = 20$	Control, $N = 26$
Age, years	59.45 (11.22)	55.62 (8.25)
Gender, % female	60.0% (12)	53.8% (14)
Ethnicity, % non-Hispanic	100% (20)	100% (26)
Race		
White	100% (20)	96.2% (25)
Black	0% (0)	3.8% (1)
Marital status		
Single	10.0% (2)	19.2% (5)
Married	75.0% (15)	57.7% (15)
Living with partner	5.0% (1)	7.7% (2)
No longer married	10.0% (2)	15.4% (4)
Employment status*		
Full-time	35.0% (7)	65.4% (17)
Part-time	10.0% (2)	11.5% (3)
Retired	50.0% (10)	11.5% (3)
Homemaker	0% (0)	3.8% (1)
Disabled	0% (0)	7.7% (2)
Unemployed	5.0% (1)	0% (0)
Stage of cancer		
0	0% (0)	3.8% (1)
1	20.0% (4)	15.4% (4)
2	45.0% (9)	53.8% (14)
3	35.0% (7)	26.9% (7)
Time since diagnosis (months)	37.65 (19.45)	34.53 (20.08)
Treatment		
Chemotherapy	95.0% (19)	73.1% (19)
Radiation	55.0% (11)	34.6% (9)
Colostomy, ileostomy		
Did not have	52.6% (10)	69.2% (18)
Permanent colostomy	15.8% (3)	7.7% (2)
Temporary colostomy with reversal	5.3% (1)	0
Diverting ileostomy with reversal	26.3% (5)	23.1% (6)

Mean (SD) and % (N) are presented for continuous and categorical variables as appropriate

* $p < 0.05$ for between-groups difference

All analyses were conducted using SAS 9.3 with significance level set at 0.05.

Results

A full description of the study and study participants ($n = 46$) has been presented elsewhere [17]. Briefly, participants were randomized into a PA group ($N = 20$) or CC group ($n = 26$). At study completion (12 month assessment), there was a 95% retention rate among PA group participants ($n = 19$) and an 88% retention rate among participants in the CC group ($n = 23$). Participants were 57.28 years of age on average (SD = 9.73), predominantly female (56.5%), married/partnered

(71.7%), non-Hispanic (100%), and white (97.8%) with at least some college-level education (76.1%). Majority had received chemotherapy (82.6%), and 30.4% were diagnosed with stage 3 cancer. A complete description of the sample is presented in Table 1.

Given the final sample size ($n = 46$) and effect estimates, the post hoc power analysis provided 76% power to identify significant predictors in the given models. The body esteem scale has high internal consistency in this data set ($\alpha = 0.92$). Mean body esteem (physical condition subscale) at baseline was 31.50 (SD = 6.85) for the PA group and 30.84 (SD = 9.29) for the CC group ($p = 0.79$). Unadjusted mean body esteem over time by condition is presented in Fig. 1.

Table 2 Unadjusted predictors over time

	Baseline	3 months	6 months	12 months
Fitness (ml/kg/min)				
Intervention	21.90 (7.59)	26.44 (6.04) ^a	26.65 (6.28) ^b	24.57 (7.10) ^c
Control	23.80 (8.66)	26.18 (8.38)	25.10 (9.25)	24.65 (9.58)
Body fat (lb)				
Intervention	40.48 (5.66)	39.68 (4.66)	40.32 (5.35)	42.33 (6.14)
Control	40.18 (9.63)	38.87 (9.11)	39.10 (10.36)	39.39 (10.15)

Data are presented as mean (standard deviation)

ml milliliters, *kg* kilograms, *min* minutes, *lb* pounds

^a $p < 0.05$ for between-groups difference (based on analysis of variance) in change in fitness baseline to 3 months

^b $p < 0.05$ for between-groups difference in change in fitness baseline to 6 months

^c $p < 0.05$ for between-groups difference in change in fitness baseline to 12 months

Fitness as a predictor of body esteem

Unadjusted mean fitness (ml/kg/min) over time is presented in Table 2. Adjusted models suggest significant associations between fitness (estimated VO₂ peak) and body esteem during the intervention phase (12 weeks) such that changes in fitness, baseline to 3 months, were positively associated with changes in body esteem over the same time period (after adjusting for condition); $b = 0.68$, $SE = 0.35$, $p = 0.04$ (Table 3). Specifically, greater improvements in fitness during the intervention phase were associated with greater improvements in body esteem over the same time period (baseline to 3 months). There were no significant associations between changes in fitness and body esteem at 6 months or 12 months (Table 3).

As a subsequent step, we explored associations between changes in fitness and body esteem separately for males and females and cancer stage (stage 0–2 vs. stage 3). Results indicated that for male participants, changes in fitness from baseline to 6 months was positively associated with changes in body esteem from baseline to 6 months ($b = 6.50$, $SE = 3.18$, $p = 0.04$) and changes from baseline to 12 months in

fitness were associated with changes in body esteem over 12 months ($b = 1.36$, $SE = 0.66$, $p = 0.04$). There were no significant associations among females. For cancer stage, there was no significant difference in baseline body esteem between stage 0–2 and stage 3 survivors. However, models suggest significant associations between changes in fitness and body esteem among stage 0–2 colorectal cancer survivors only, such that greater improvements in fitness at 12 months were associated with greater improvements in body esteem at 12 months ($b = 0.84$, $SE = 0.36$, $p = 0.03$).

Body fat as a predictor of body esteem

Unadjusted mean body fat over time is presented in Table 2. As changes were small and the effect sizes were in the small-medium range ($f^2 = 0.08$), we considered the binary indicator of any improvement from baseline (i.e., reductions in body fat) as a predictor in subsequent analyses. Among the aggregated samples, there were no significant associations between improvements in body fat and changes in body esteem from baseline to 3 months, 6 months, or 12 months after

Fig. 1 Mean body esteem over time by condition. Time is defined as 0 = baseline, 3 = 3 month follow-up, 6 = 6 month follow-up, and 12 = 12 month follow-up. Mean body esteem is measured using the physical condition subscale of the BES

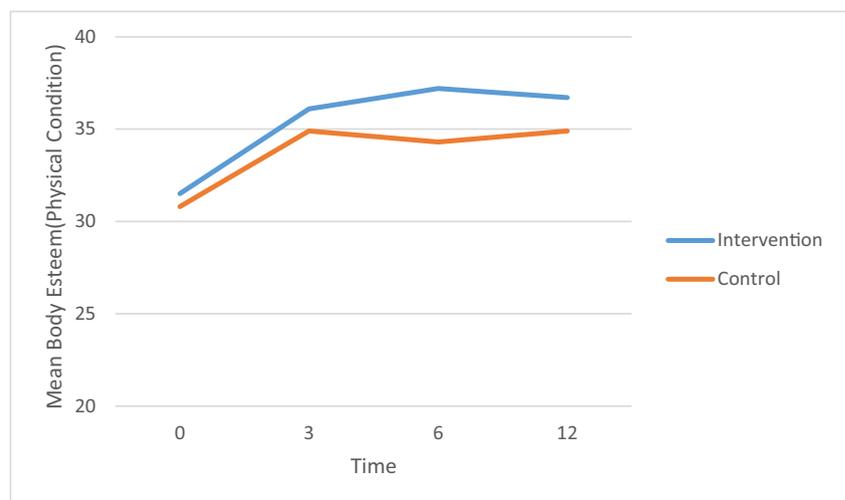


Table 3 Regression models to test association between changes in fitness, changes in body fat, and changes in body esteem

	Changes in body esteem at 3 months	Changes in body esteem at 6 months	Changes in body esteem at 12 months
Change in fitness	0.68 (0.35), $p = 0.04$	-0.04 (0.39), $p = 0.92$	0.33 (0.35), $p = 0.35$
Change in body fat	-0.04 (0.82), $p = 0.96$	-0.62 (0.63), $p = 0.33$	-0.67 (0.59), $p = 0.26$
Group	-1.18 (2.24), $p = 0.60$	3.38 (2.40), $p = 0.16$	2.10 (2.43), $p = 0.39$

Effects represent unstandardized regression coefficients (*b*) and standard error (SE), *p* value. Each column represents a separate generalized linear model. Models included intercept terms (not reported)

adjusting for condition (Table 4). However, among female participants, there were positive associations between reductions in body fat over 3 months and improvements in body esteem over 12 months ($b = 3.71$, $SE = 1.79$, $p = 0.05$). These effects were not found among male participants (Table 4). Furthermore, we examined improvements in body fat and changes in body esteem from baseline to 3 months, 6 months, and 12 months separately for stage 0–2 and stage 3 survivors. Stage 0–2 colorectal cancer survivors showed significant associations between reductions in body fat over 12 months and improvements in body esteem over 12 months ($b = 5.99$, $SE = 2.95$, $p = 0.05$), with no significant associations in stage 3 survivors.

We completed additional analyses to provide reasoning for the significant improvement in body esteem among stage 0–2 ($n = 32$) and not stage 3 ($n = 14$) survivors. We reviewed a variety of variables such as VO_2 peak, time on the treadmill (fitness test), time spent in moderate-to-vigorous PA in addition to having a colostomy, having surgery (e.g., colectomy), or receiving chemotherapy. The only significant difference between stages was chemotherapy ($p = 0.04$); 100% of stage 3 colorectal cancer survivors and 75% of stage 0–2 colorectal cancer survivors received chemotherapy.

Discussion

The primary objective of these secondary analyses was to determine if changes in either fitness or body fat following a 3-month PA intervention influenced body esteem among colorectal cancer survivors. In support of our hypotheses, we observed among male colorectal cancer survivors that an improvement in fitness was significantly associated with an improvement in body esteem at 6 month and 12 month follow-up visits. Secondly, a reduction in body fat at 3 months was significantly associated with an improvement in body esteem among female survivors at 12 months. Furthermore, those diagnosed with stage 0–2 colorectal cancer saw improvements in body esteem at 12 months with a reduction in body fat at 12 months and also with improvements in fitness at 12 months compared to stage 3 survivors.

Results previously showed those receiving the PA intervention significantly improved their fitness from baseline [17]. In this study, after controlling for group assignment, an improvement in fitness was significantly associated with higher body esteem at 3 months only. The first 3 months of the study consisted of weekly phone calls with research staff. During this weekly contact, participants may have been more

Table 4 Regression models to test association between improvements in body fat and changes in body esteem overall and by gender

	Changes in body esteem at 3 months	Changes in body esteem at 6 months	Changes in body esteem at 12 months
Model 1 (all)			
Improvement in BF	0.78 (2.14), $p = 0.72$	1.30 (2.04), $p = 0.53$	3.01 (2.29), $p = 0.19$
Condition	0.62 (2.09), $p = 0.77$	3.07 (2.04), $p = 0.13$	3.67 (2.23), $p = 0.11$
Model 2 (females)			
Improvement in BF	4.55 (3.30), $p = 0.19$	3.30 (2.77), $p = 0.25$	3.71 (1.79), $p = 0.05$
Condition	-1.06 (3.26), $p = 0.75$	1.98 (2.72), $p = 0.48$	1.74 (1.76), $p = 0.34$
Model 3 (males)			
Improvement in BF	-3.17 (2.52), $p = 0.23$	-0.60 (2.72), $p = 0.83$	2.45 (4.17), $p = 0.57$
Condition	1.67 (2.52), $p = 0.52$	5.60 (2.72), $p = 0.06$	6.55 (4.17), $p = 0.14$

Effects represent unstandardized regression coefficients (*b*) and standard error (SE), *p* value. Each column represents a separate generalized linear model. Models included intercept terms (not reported). Improvement in body fat (BF) and condition were predictors in each model

motivated and focused on a healthier lifestyle, thus improving their body esteem. Over time, contact with research staff lessened and the PA intervention novelty may have eroded, potentially weakening the improvement in body esteem as seen at the 3 month assessment. Previous research has shown gender differences with body esteem [20]; therefore, we elected to examine male and female participants separately. Among male participants only, improvements in fitness were associated with improvements in body esteem at 6 months and 12 months. These results are consistent with previous research among adults between the ages of 60 years and 80 years [20]. Among older adults, males valued the functioning of their body rather than appearance. Alternatively, women in the same study placed a higher value on their appearance [20].

Secondly, we explored changes in body fat as a predictor of body esteem changes. Among the study population (controlling for group assignment), there was no improvement in body esteem with a reduction in body fat. However, when analyzed separately for gender, females showed an improvement in body esteem with changes in body fat at follow-up (12 months), with no significant changes among male participants. This is consistent with other literatures that show that women tend to base their self-esteem on their appearance [34]. In an observational study among older women, women placed a higher value on their appearance as compared to their male counterpart [20]. Due to the small sample size in this study, we defined a reduction in body fat as any loss in body fat at follow-up visits from baseline. Therefore, there may not have been a large enough reduction in body fat to produce a significant change in body satisfaction among males. While these results should be taken with caution, it is interesting that over a 12 month trial, even a small reduction in body fat was associated with a significant change in body esteem among female colorectal cancer survivors.

In addition to examining changes in body esteem with improvements in fitness and body fat separately for sex, we also reviewed the potential difference in body esteem between early (stage 0–2) and late (stage 3) survivors. At baseline and follow-up visits, body esteem did not differ among stage 0–2 and stage 3 survivors. The lack of difference at baseline and consecutive follow-up visits is fairly consistent with recent data. Among male colorectal and head and neck cancer survivors (stage 0–3), there was no difference in body satisfaction for cancer stage, treatment type, or diagnosis at baseline or follow-up visits (6 months, 12 months, and 18 months) [35]. Raggio and colleagues [35] noted from their findings that clinical characteristics may have less of an influence on body esteem as compared to demographic characteristics (i.e., age and education). This remains perplexing, as clinical characteristics such as chemotherapy and surgical treatment can result in significant physical changes, especially among colorectal cancer survivors.

Interestingly, improvement in body esteem with increased fitness and a reduction in body fat were seen in stage 0–2 survivors and not stage 3. We explored potential explanations for this finding. There were no significant differences between estimated VO_2 peak values or time on the treadmill among stage 0–2 and stage 3 survivors at any time point. Additionally, there were no significant differences in MVPA participation (accelerometer data) among stage 0–2 and stage 3 survivors at baseline or follow-up visits. In regard to body fat, no significant differences were seen for body fat (at baseline or follow-up time points) among stage 0–2 and stage 3 survivors; however, only stage 0–2 survivors significantly improved body esteem with a reduction in body fat. Finally, there were no significant differences between stage 0–2 and stage 3 survivors in regard to colostomy type (i.e., permanent colostomy, temporary colostomy) or surgery type (i.e., abdominal-perineal resection, total colectomy). The only significant difference among stage 0–2 and stage 3 colorectal cancer survivors was treatment type; all stage 3 colorectal cancer survivors received chemotherapy. While chemotherapy use was the only significant difference between stage 0–2 and stage 3 survivors, the lack of significant improvement in body esteem among stage 3 survivors may be related to side effects of chemotherapy. A recent study examined body image and self-esteem among 90 breast cancer patients (24% received chemotherapy). Results showed those who received chemotherapy showed a significant reduction in body image scores, specifically for appearance and high self-esteem [3]. While this result cannot explain the lack of improved body esteem associated with increased fitness and reduced body fat among stage 3 colorectal cancer survivors, there is evidence to support the negative effects of chemotherapy on survivor's appearance and self-esteem, thus potentially lowering body esteem.

The study is not without its limitations. Due to challenges associated with participant recruitment, the overall sample size was small. The post hoc power analysis provided 76% power to identify significant predictors in the given model. We recruited participants from private clinical practices serving patients with colorectal cancer, colorectal cancer support groups, cancer survivorship events, and other community events. We were unable to use state tumor registries in RI due to legal restrictions. Such registries can be very helpful in participant recruitment. Because of the small sample size, we used only the physical condition subscale completed by both men and women. Unfortunately, body fat loss does not have a clinically significant definition. Therefore, for the purpose of this study, body fat loss was defined as any reduction in body fat from baseline. As there are no standards for clinically significant reductions in body fat, we chose to explore the effect of any reduction in body fat among the participants. These results should be taken with caution and require further exploration in future work. Furthermore, the sample was not a

representative sample as most participants were well educated and Caucasian. Strengths of the study include a submaximal measure of aerobic fitness, long-term follow-up (1 year), and a standardized assessment for body esteem. Finally, while the use of the BIA is not the strongest method of body composition, appropriate equations were used to estimate body fat.

In conclusion, improvements in fitness and body fat are associated with higher body esteem among male and female colorectal cancer survivors. Positive body esteem is an important psychosocial benefit of PA for cancer survivors. Future research should expand upon these results using a larger, more representative sample to examine whether the relationships we identified would apply and to examine whether improvements in body esteem (through an increase in fitness and/or body fat) are associated with a reduction in depression and anxiety among cancer survivors. Given the potential benefits of improved body esteem on quality of life and depression, these relationships merit further study.

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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 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. This article does not contain any studies with animals performed by any of the authors.

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