



Published in final edited form as:

Support Care Cancer. ; 32(2): 122. doi:10.1007/s00520-024-08310-y.

Evaluating the Relationship Between Physical Activity and Quality of Life in a Racially Diverse Sample of Breast Cancer Survivors

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Abstract

Purpose: Physical activity (PA) has been shown to improve QoL in predominantly White cancer survivors. Very few studies have examined the association between PA and QoL among Black breast cancer survivors (BCS). We investigated the association between PA and multiple QoL domains and the effects of race on the proposed association in a racially diverse group of BCS.

Methods: This was an exploratory study using secondary data from a completed 12-month randomized controlled trial (RCT). Mixed effects models were tested on a subset of participants in the control and exercise groups of the RCT. The primary outcomes were changes in the QoL domains (baseline to 12 months post baseline).

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Disclosure of potential conflicts of interest: The authors declare that there is no conflict of interest.

Ethical approval: The WISER Survivor trial was approved by the IRB of the University of Pennsylvania. The current study was approved by the IRB of the Pennsylvania State University College of Medicine (STUDY00014712).

Code availability: The SAS code will not be made available.

Informed consent: The study participants provided signed informed consent and a written clearance from their doctors to participate in the WISER Survivor trial. Informed consent was not obtained in the current study because the research involves no more than minimal risk to subjects and no procedures for which written consent is normally required outside of the research context.

Disclaimer: Research reported in this publication was supported by the National Cancer Institute of the National Institutes of Health under Award Number F99CA253762 and U54155850. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Results: There were 173 participants included in this analysis, averaging 59 years of age; about 33% of the participants were Black women. There were no significant differences in the QoL outcomes between the control and exercise groups at 12 months post baseline. Race was not a significant moderator. Exercise improved emotional/mental wellbeing and body image as it relates to social barriers at 12 months post baseline in Black and White BCS, but the changes in these outcomes were only statistically significant in White BCS ($p < 0.05$).

Conclusions: Results show that exercise can improve multiple QoL domains over time in Black BCS. However, the significance of the effect on QoL was isolated to White BCS. The small sample size in Black women could constrain the statistical significance of observed effects. Future studies are warranted to assess associations between exercise and QoL in larger samples of Black women.

Keywords

cancer survivor; physical activity; exercise; quality of life; breast cancer; African American

Introduction

Breast cancer is the primary type of new invasive cancer cases and the second leading cause of cancer deaths in women in the United States (US). (1, 2, 3) The number of living breast cancer survivors (BCS) will increase from 3.8 to 4.9 million by 2030. (4) Despite the increase in the number of living BCS, there remain clear racial disparities in five-year breast cancer survival and mortality rates between Black and White women. The five-year breast cancer survival rate is significantly lower in Black women (82%) compared with White women (91%). (3) Furthermore, Black women are more likely to die from breast cancer than White women (e.g., 27.8 vs 19.3 deaths per 100,000 women). (5)

In addition to racial disparities in breast cancer outcomes, Black women in comparison with White Women are more likely to experience poorer quality of life (QoL) and adverse cancer treatment effects (e.g., pain and swelling from breast-cancer related lymphedema [BCRL]). (6, 7, 8, 9, 10, 11, 12) QoL is a multidimensional and subjective concept that “encompasses a broad range of domains, including physical, functional, emotional, and social well-being,” (12, 13, 14) whereas health-related QoL is defined by the Centers for Disease Control and Prevention as “an individual’s or a group’s perceived physical and mental health over time.” (15) Black BCS are more likely to have multiple QoL issues including lower sexual function, negative feelings or perceptions about their bodies, poorer sleep quality, poorer physical/functional wellbeing, greater fatigue, and unmet needs (e.g., emotional support). (8, 9, 12, 13, 16, 17) Based on previous research, the prevalence of lymphedema (abnormal swelling in the arms due to damaged or removed lymph nodes after breast cancer therapy) in BCS has ranged from 0% to 56%. (6, 7, 18, 19) Specifically, the prevalence of lymphedema has been shown to be higher in Black than White BCS (28% vs 21%). (6, 7) BCS with arm symptoms or diagnosed with lymphedema have reported lower HRQoL (physical and mental health) than BCS without lymphedema or arm symptoms. (18)

Physical activity (PA) has been documented to improve breast cancer outcomes. (20, 21, 22, 23, 24) PA is defined as any bodily movement, while exercise is the subset of PA

defined by planned activities for the purpose of improving health and fitness. (25) Exercise prescriptions or regimens consists of the following four major components: *frequency* (the number of days of activity per week), *intensity* (e.g., moderate activity), *time* (number of minutes or hours per session of exercise) and *type* (e.g., weightlifting) (FITT). (26) Research consistently reports PA as a protective factor against breast cancer incidence and mortality. (20, 21) Aerobic exercise (e.g., resistance training) has been shown to reduce the risk of breast cancer-related lymphedema (BCRL). (27)

Previous research has examined the link between PA and QoL among cancer survivors. Two studies reported positive and significant associations between PA and different aspects of QoL (e.g., social wellbeing) in predominantly Black cancer survivors. (28, 29) Another group of researchers observed direct and indirect statistically significant associations between PA and global QoL (e.g., mental wellbeing) in predominantly Black BCS. (30) Other relevant studies have included predominantly or only White cancer survivors and demonstrated similar results. (31, 32) For example, Smith and colleagues (2009) found positive and significant associations between PA and QoL (e.g., social functioning) in Black and White women. (31) Specifically, Black and White women who met the PA recommendations (at least 150 minutes of moderate to vigorous PA each week) reported better QoL. (31) Another study found similar results among predominantly White cancer survivors. (32) However, the results were not stratified by race and gender. (32) Therefore, researchers cannot determine whether there are potential underlying differences in QoL across race and gender. Very few studies have examined the longitudinal association between PA and multiple QoL domains among BCS, specifically Black women. (28)

Previous meta-analyses investigated the effects of exercise on QoL as well as the moderating effects of various factors in cancer survivors. (33, 34) The results showed that exercise significantly improved QoL (e.g., social functioning) in cancer survivors. In addition, the evidence suggested no significant moderating effects of clinical factors (e.g., body mass index), demographic factors (e.g., age), and exercise specific intervention components (e.g., exercise frequency) on the association between PA and QoL in cancer survivors. Potential moderators such as race were not examined in previous studies. Taken together, these studies demonstrate that PA alone improves multiple QoL domains in survivors of breast cancer. However, the effects of PA on multiple QoL domains in Black BCS remains unclear. These observations justified the examination of the independent effects of PA on QoL among subgroups of BCS in a completed randomized controlled trial.

This study will address some gaps in the literature. We will expand the literature on the study of PA and QoL in BCS and determine the effects of PA on QoL among an underrepresented group, specifically Black women. The aim of this paper was to investigate the association between PA and multiple QoL domains and to explore the effects of race on the proposed association among a racially diverse group of BCS in a completed 12-month randomized controlled trial. The hypotheses were as follows: (1) the exercise group will show significant improvements in the QoL outcomes compared with the control group and (2) the effect of exercise on the QoL outcomes will significantly differ between Black and White BCS. One possible reason for this hypothesis is that White BCS are more likely to meet the PA recommendations than Black BCS. (35) The findings will help researchers

and healthcare professionals to better understand the proposed association and the benefits of behavioral medicine (e.g., PA) on QoL among Black BCS who disproportionately have worse breast cancer-related outcomes.

Methods

This was an exploratory study investigating the association between PA and QoL and the effects of race on the proposed association in Black and White BCS who were enrolled in a 12-month randomized controlled trial (Women in Steady Exercise Research [WISER] Survivor). This analysis focuses specifically on the participants in the exercise and control groups. Participants were recruited in Philadelphia, Pennsylvania through local hospitals and tumor registries. (36) The study was conducted between 2011–2016. The study participants provided signed informed consent and a written clearance from their doctors to participate in the WISER Survivor trial. In the WISER Survivor trial, 351 participants were recruited and randomly assigned: (1) exercise (in person and home-based exercises); (2) weight loss (using Nutrisystem); (3) combined exercise and weight loss; or (4) control group (referral to physician and health organization for health behavior resources such as diet or exercise). The study participants received 52 weeks of exercise, diet, or exercise plus diet. The exercise treatment plan consisted of nine resistance exercises (e.g., chest press) twice per week and moderate exercise (walking) consistent with the American College of Sports Medicine (ACSM) guidelines. (37, 38, 39) Participants were asked to increase their weekly minutes of walking from 90 to 180 minutes (30 minutes on most days of the week). (38) About 74% of the survivors in the exercise and combined groups in the WISER Survivor trial engaged in an average of 133 minutes of moderate exercise each week. (37) The original study was approved by the Institutional Review Board (IRB) of the University of Pennsylvania. The study is registered on [ClinicalTrials.gov](https://clinicaltrials.gov) as [NCT01515124](https://clinicaltrials.gov/ct2/show/study/NCT01515124). The study methods are described in detail elsewhere. (38) Ethical approval was required for analysis of secondary data. Informed consent was not obtained in the current study because the research involves no more than minimal risk to subjects and no procedures for which written consent is normally required outside of the research context. The current study was approved by the IRB of the Pennsylvania State University College of Medicine (STUDY00014712).

Study Population

The inclusion criteria for the WISER Survivor trial were as follows: (1) personal history of breast cancer; (2) completed treatment at least six months prior to randomization; (3) 80 years or younger; (4) body mass index of $\leq 25 \text{ kg/m}^2$; (5) diagnosed with breast cancer-related lymphedema; (6) female; (7) sedentary (engaging in less than 3 or more times weekly aerobic activity of moderate intensity); and (8) free of cancer (no evidence of cancer or recurrence at the time or during the study). (38) Of the 351 participants, 35% identified as a Black woman. (38) The current analysis included both Black and White women. Women who did not identify as White or Black (N=4) were removed from this analysis because further evaluation of women who did not identify as Black or White was not possible due to a smaller number of participants. In addition, White BCS were the comparison group since most women identified in this group.

Measures

Primary outcomes—The primary outcomes were changes in multiple QoL domains. The major QoL domains were social functioning, social wellbeing, emotional/mental wellbeing, and body image. The body image subdomains were strength and health, social barriers, and appearance and sexuality. Very few studies have assessed these specific domains in relation to PA among Black BCS. (29–31)

QoL was assessed at baseline, 6 months post baseline, and 12 months post baseline using multiple valid and reliable questionnaires such as the Short Form Health Survey (SF-36), Body Image and Relationships Survey (BIRS), and Specific Quality of Life Scale for Upper Limb Lymphedema (ULL-27). (38, 40, 41, 44) The SF-36 survey has been used extensively in BCS. (42) The internal consistency reliability estimates for the SF-36 scales have been shown to range from 0.76 to 0.93 among diverse groups (e.g., Black patients). (43) The SF-36 survey consists of 36 questions about eight major health domains (e.g., emotional/mental wellbeing) with each domain score ranging from 0 to 100 (higher score indicates better QoL). One specific SF-36 survey question was “*During the past 4 weeks, have you been a happy person?*”? Participants then rated their QoL on a 5 or 6 point Likert scale (e.g., 1=all of the time, 6=none of the time), depending on the QoL domain. The BIRS survey has been shown to have internal consistency and test-retest reliability ranging from 0.41 to 0.80. (40) It consists of three subscale scores and one summary score with higher scores indicating higher impairment: strength and health (ranging from 12 to 60), social barriers (ranging from 9 to 45), and appearance and sexuality (ranging from 11 to 55), and total (32–160). For the BIRS, one example item was “*I felt confident I could make myself stronger.*” Using a 5 point Likert scale (1=strongly disagree, 5=strongly agree), participants then rated their attitudes about health, strength, appearance, sexuality, and social barriers. The ULL-27 survey includes 27 questions and measures three major QoL domains (e.g., social wellbeing) with each domain score ranging from 0 to 6 (higher score indicates lower QoL). This scale has been shown to be precise, sensitive, and accurate. (44) One specific ULL-27 survey question was “*Are you disturbed by difficulty in social life?*”? Participants then rated their QoL on a 6 point Likert scale (1=never, 6=constantly).

PA measure—PA levels were assessed with the Modifiable Physical Activity Questionnaire at baseline and 12 months. (38) This survey captures leisure-time, occupational, and sedentary time in the past year. The leisure activity section of this survey has been validated through comparisons with accelerometry ($\rho = 0.62$). (45)

Other measures—A general survey with questions about demographics and a medical history survey were administered to the study participants. (38) Clinical characteristics (e.g., cancer stage) were obtained from pathology reports and other medical records. Anthropometric measurements were assessed at different time points: body weight (baseline to 12 months) and height (baseline). (38) Body weight and height were measured on a calibrated scale and stadiometer. (37, 38)

Statistical Analysis

The WISER Survivor trial was powered to detect a change in the primary outcome (breast cancer-related lymphedema interlimb volume difference). The primary outcomes in the current study consisted of the changes in the QoL outcomes (baseline to 12 months post baseline). The baseline and 12 month timepoints were used in the primary analysis. The effects of race, time, intervention condition (e.g., exercise group), and their interactions (e.g., group X time X race) were examined. Race was examined as a potential moderator. After data extraction and cleaning (including variable construction), descriptive statistics were used to summarize categorical (e.g., frequencies) and continuous variables (e.g., means) in the secondary data analysis. The primary outcomes were emotional/mental wellbeing, social wellbeing, social functioning, body image, and the BIRS subscale scores (e.g., strength and health). Demographic and clinical characteristics were compared at baseline across the intervention conditions and race. The means and SDs for each of the primary outcomes were compared across the intervention conditions and race at baseline. Comparisons across the intervention conditions and race were performed using chi-square tests or Fisher's exact test (categorical variables) and F-tests or unpaired t-tests (continuous variables).

Multiple imputation (MI) was used for handling missing data where necessary at baseline and 12 months. (46–48) This method for analyzing missing data assumes that the data are missing at random and similar methods were used in the main results manuscript for the WISER Survivor trial. (37, 47) The total number of imputations consisted of 10 replicates. Mixed effects models with multiple imputation were used to examine associations between the predictor and outcomes. The covariates included marital status, age, mode of transportation, cancer treatments (e.g., immunotherapy), cancer stage, leisure time, retirement, and body mass index (BMI). A mixed effects model is more efficient for handling missing data and multiple imputation in SAS and appropriate for analyses of repeated measures. (49) A moderation analysis was conducted. The moderating effect of race was tested by examining interactions. The mixed effects models included the group X time and group X time X race interaction terms for the subgroup analyses. In addition, the data were analyzed with and without imputation using mixed effects models to examine the consistency of the findings for the primary outcomes. There were differences in the BIRS scores (e.g., strength and health) for imputed versus not imputed analyses. The probability (p values) did not include adjustment for multiplicity. Therefore, the findings should be interpreted carefully. All analyses and models were conducted using SAS version 9.4 software (SAS Institute Inc., Cary, NC, USA). A significance value of 0.05 for the analyses was used.

Results

Characteristics of Study Participants

The baseline characteristics of the study sample and the differences in the baseline characteristics by race can be found in Table I. This sample consisted of 173 Black women (N=57) and White women (N=116). The average age of the participants was 59 years (SD=8.27). More than half of the women were White (67%), married or living with a partner (68%), and postmenopausal (66%). About 33% of the participants were Black

women. Over half of the participants (81%) had at least some college education. The average time since diagnosis was about 8 years ($SD=5.23$). More than half of the participants received chemotherapy (79%) and radiation (82%), while 17% of the participants received immunotherapy.

Overall, there were significant differences in the baseline characteristics (including marital status, mode of transportation, and social wellbeing) by race (Table I). White women were more likely to be married or living with a partner compared with Black women (77% vs 50%; $p=0.004$). Black women were less likely to have personal transportation (e.g., private vehicle) than White women (61% vs 91%; $p<.0001$). At baseline, the average social wellbeing scores ($p=0.035$) were significantly worse in White women (mean=1.38, $SD=1.29$) than Black women (mean=0.95, $SD=1.13$).

Table II displays the participants' characteristics by intervention condition at baseline. Overall, there was a significant difference in one of the sociodemographic variables at baseline between the intervention conditions. There was a significant difference in race between the intervention conditions ($p=0.013$). There were significantly more Black women in the exercise group (42%) compared with the control group (24%) due to the small sample sizes in the current study.

Effects of Intervention Condition on QoL

The group X time interaction effect on social functioning ($p=0.164$), emotional/mental wellbeing ($p=0.756$), social wellbeing ($p=0.092$), and BIRS total ($p=0.138$) along with the subscale scores including BIRS strength and health ($p=0.634$), BIRS appearance and sexuality ($p=0.939$), and BIRS social barriers ($p=0.174$) scores was not significant. After further analysis, there were no significant changes in the QoL scores between the intervention conditions at 12 months post baseline (Table III).

Effects of Exercise Intervention on QoL by race

The group X time X race interaction effect on social functioning ($p=0.274$), emotional/mental wellbeing ($p=0.527$), social wellbeing ($p=0.057$), and BIRS total ($p=0.702$) along with subscale scores including BIRS strength and health ($p=0.654$), BIRS appearance and sexuality ($p=0.800$), and BIRS social barriers ($p=0.777$) was not significant. Race was not a significant moderator. Although the main effect of the three-way interaction was not significant, we explored the proposed association further and found some significant within group differences in the QoL scores by race from baseline to 12 months (Table IV).

Emotional/mental wellbeing—The exercise intervention had a significant effect on emotional/mental wellbeing in White women (Table IV). There were significant improvements in the emotional/mental wellbeing scores ($p=0.036$) in White women at 12 months post baseline. On the other hand, there was no significant effect of the exercise intervention on emotional/mental wellbeing ($p=0.166$) in Black women at 12 months post baseline.

Social wellbeing—The exercise intervention had a significant effect on social wellbeing in White women (Table IV). There were significant improvements in the social wellbeing scores ($p=0.004$) in White women at 12 months post baseline. In contrast, the social wellbeing scores of Black women did not significantly improve from baseline to 12 months.

BIRS total—The BIRS total scores for White women ($p=0.205$) and Black women ($p=0.252$) in the exercise intervention were reduced (i.e., lower impairment) at 12 months post baseline, but the results were not statistically significant (Table IV).

BIRS strength and health—There were no significant improvements in the strength and health scores at 12 months post baseline in White women ($p=0.364$) and Black women ($p=0.928$) (Table IV). At 12 months post baseline, there was a lower impairment in Black women, whereas a higher impairment was observed in White women.

BIRS appearance and sexuality—The BIRS appearance and sexuality scores for White women ($p=0.517$) and Black women ($p=0.361$) increased (i.e., higher impairment) at 12 months post baseline (Table IV).

BIRS social barriers—The exercise intervention had a significant effect on body image as it relates to social barriers in White women (Table IV). There were significant improvements in the social barriers scores in White women ($p=0.001$) at 12 months post baseline. Black women in the exercise intervention demonstrated improvements in the social barriers scores ($p=0.059$) at 12 months post baseline, although the result was marginally significant.

Social functioning—The social functioning scores for Black women ($p=0.597$) and White women ($p=0.415$) improved at 12 months post baseline, but the results were not statistically significant (Table IV).

Discussion

In this study, we investigated the association between exercise and multiple QoL domains and the effects of race on the proposed association in a racially diverse group of BCS. We found that exercise did not significantly improve the QoL outcomes. Furthermore, race did not moderate the associations between exercise and the QoL outcomes. The current study findings do not support the study hypotheses. Although these associations were not significant, exercise improved most of the QoL outcomes (emotional/mental wellbeing, social wellbeing, body image, body image as it relates to strength and health, and social barriers). In addition, the mean differences across multiple QoL outcomes were similar for Black and White women in the exercise group. This indicates that exercise can be used to improve multiple QoL domains among Black and White women.

Previous studies have demonstrated the association between PA and QoL among cancer survivors. For instance, Diggins and colleagues (2017) found a significant and positive association between PA and social/family wellbeing at time 2 (immediately post 10-week intervention) in Black BCS ($N=114$) in a randomized controlled trial. (29) Survivors who

engaged in any level of PA had significantly better social/family wellbeing but not emotional wellbeing at time 2. Emotional/mental wellbeing and social wellbeing were not found to be significantly associated with PA in the current sample of Black BCS, which is not consistent with the previous results. Another group of researchers showed that mental and emotional wellbeing improved significantly in White BCS after participating in a community based exercise intervention, which is consistent with our study findings. (50) A previous study consisting of a diverse group of BCS showed a significant and positive association between PA and mental health. (16) The sample included 118 Black women. Black and White BCS who met the PA recommendations had significantly better mental health than those who did not meet the PA recommendations, which is consistent with the current study findings in White BCS. (16) The inconsistent findings could be explained by the sample sizes. Compared to the previous study, the current study included a small sample of Black women (N=57). Statistically significant effects are more likely to be observed in larger sample sizes.

Beebe-Dimmer et al. conducted a prospective cohort study among Black cancer survivors (including breast) and found a positive and significant association between PA, social, mental, and emotional wellbeing at the first study follow up (2020). (28) This sample consisted of 852 Black women. Black cancer survivors who met the PA recommendations had significantly better social, mental, and emotional wellbeing. Increasing the level of moderate to vigorous PA was positively associated with improvements in social, mental, and emotional wellbeing. No significant associations between PA and QoL were observed in Black BCS in the current sample. The sample sizes could account for variations in the study results. There was a significant difference in the sample sizes of Black women in the current study compared to the previous study. Larger sample sizes are more likely to yield statistically significant effects.

Two previous meta-analyses were conducted to examine the effect of exercise on QoL among cancer survivors. Mishra and colleagues (2012) found no significant difference in body image between the exercise and control groups, (33) which is consistent with the current results. No significant effects of exercise on mental wellbeing (depression) and emotional wellbeing in BCS were observed from baseline to follow-up, which is consistent with the current study findings. Additionally, the same group of researchers found a significant effect of exercise on social functioning from baseline to 12 weeks, which is not consistent with the current study results. Differences in the exercise frequency, intensity, and type may explain the inconsistent results. For example, the level of exercise frequency, intensity, and type prescribed in the WISER Survivor trial may not have been adequate to yield significant improvements in QoL.

A meta-analysis of 34 randomized controlled trials showed that exercise, specifically supervised exercise, significantly improved the QoL of cancer survivors. (34) Potential moderator effects were identified and tested. The researchers found that the effect of exercise on QoL did not significantly differ by participant demographics (e.g., age), clinical factors (e.g., body mass index), intervention timing and duration, and exercise FITT factors (e.g., time). However, the previous meta-analysis did not examine race as a potential moderator. The current study tested the moderating effect of race on the longitudinal association between PA and QoL in BCS but did not observe a significant interaction.

The WISER Survivor trial was not powered to identify and test moderator effects (e.g., race). It is important for future studies to be designed to test moderator effects and include larger samples of Black women in PA studies. Specifically, observational (prospective or retrospective) and experimental studies (e.g., randomized controlled trial) are needed to test these effects and proposed associations. This will help to determine the specific exercise prescription (including FITT) needed to achieve the optimal QoL for Black BCS.

Strengths and Limitations

This study contributes to the literature by helping researchers and public health professionals to better understand the association between exercise and QoL among a diverse group of BCS, specifically Black women. Experimental studies can be less prone to biases compared to observational studies. However, the available secondary data may embed confounding, information bias, and selection bias (loss to follow-up). All models consisted of multiple adjusters to control confounding variables. The original study design and use of randomization reduces selection bias and theoretically balances the study groups on confounding variables. However, when the study samples are small, randomization may not always work to balance the study groups on confounding variables. In the WISER Survivor trial, the control group had a moderate to high loss to follow-up rate (24%) compared with the other groups. (37) After examining the baseline characteristics (age, race, education, and marital status), the results demonstrated no significant differences between participants who completed the study and participants who were lost to follow up. Also, there was some level of missingness in the WISER Survivor trial. Multiple imputation was used to address data loss. In addition, the results from the BIRS were not robust and the findings changed after imputation. Therefore, these preliminary findings should be interpreted with caution.

Furthermore, most of the self-reported measures in this study (e.g., SF-36 survey) have been tested and validated among White cancer survivors. Therefore, the self-reported surveys might not include all the appropriate information to understand and predict behavior among Black cancer survivors. Future studies should develop and validate these study instruments among primarily Black cancer survivors. Additionally, all the participants were diagnosed with breast cancer-related lymphedema, and most were relatively well-educated. Therefore, the findings may not be generalizable to other cancer types, races, socioeconomic groups, and cancer survivors who do not have breast cancer-related lymphedema. On the other hand, targeting an underrepresented group who have worse breast cancer outcomes should be a priority of public health concern. This research may help to encourage other investigators to increase the representation of Blacks in studies focusing on health behavior change, behavioral medicine, exercise oncology, supportive care, and cancer survivorship.

Conclusions

Results show that exercise can improve multiple QoL domains over time among subgroups of BCS after their active treatment. However, the significance of the effect on QoL was isolated to White women. The small sample size in Black women could constrain the statistical significance of observed effects. Future studies are warranted to examine the associations between exercise and multiple QoL domains in larger samples of Black women. PA could play a crucial role in attaining an optimal QoL in Black women.

Acknowledgements:

Natasha Burse has moved to the University of North Carolina at Chapel Hill since completing the research. This work is part of the first author's dissertation. The authors would like to give special thanks to the Penn State Clinical and Translational Science Institute for their assistance with this project.

Funding:

Natasha Burse was funded by the National Cancer Institute of the National Institutes of Health under Award Number F99CA253762. The WISER Survivor trial was funded by the National Cancer Institute of the National Institutes of Health under Award Number U54155850.

Availability of data and material:

The data and materials will not be made available.

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Table 1.

Baseline characteristics of the study participants by race

Variables	Total (n=173)	Blacks (n=57)	Whites (n=116)	P-value
Marital status				0.004*
Never married	17 (10%)	8 (14%)	9 (8%)	
Currently married or living with partner	116 (68%)	28 (50%)	88 (77%)	
Divorced or separated	30 (17%)	17 (31%)	13 (11%)	
Widowed or widower	8 (5%)	3 (5%)	5 (4%)	
Education				0.771
Less than college	34 (19%)	12 (21%)	22 (19%)	
Some college (junior or technical college)	55 (32%)	20 (35%)	35 (30%)	
4 -year college grad	48 (28%)	13 (23%)	35 (30%)	
Graduate degree	36 (21%)	12 (21%)	24 (21%)	
Ethnicity				0.330
Hispanic or Latino	2 (1%)	0 (0%)	2 (2%)	
Not Hispanic or Latino	167 (99%)	54 (100%)	113 (98%)	
Retirement status				0.250
Not retired	125 (72%)	38 (67%)	87 (75%)	
Retired	48 (28%)	19 (33%)	29 (25%)	
Mode of Transportation				<.0001*
Personal car	140 (81%)	35 (61%)	105 (91%)	
Public transportation	27 (16%)	18 (32%)	9 (8%)	
Other	5 (3%)	4 (7%)	1 (1%)	
Leisure time (MET hr/week)				0.282
Mean (SD)	7.16 (7.78)	6.32 (6.45)	7.57 (8.35)	
Body Mass Index				0.200
Mean (SD)	34.25 (6.44)	35.15 (5.80)	33.81 (6.71)	
Cancer stage				0.167
0-<1	16 (12%)	6 (15%)	10 (11%)	
1-<2	37 (28%)	9 (23%)	28 (31%)	
2-<3	45 (35%)	12 (30%)	33 (36%)	
3-<4	26 (20%)	8 (20%)	18 (20%)	
4	7 (5%)	5 (12%)	2 (2%)	
Chemotherapy				0.732
No chemotherapy	36 (21%)	11 (19%)	25 (22%)	
Chemotherapy	137 (79%)	46 (81%)	91 (78%)	
Radiation				0.076
No radiation	31 (18%)	6 (11%)	25 (22%)	
Radiation	142 (82%)	51 (89%)	91 (78%)	

Variables	Total (n=173)	Blacks (n=57)	Whites (n=116)	P-value
Immunotherapy				0.237
No immunotherapy	126 (83%)	40 (78%)	86 (86%)	
Immunotherapy	25 (17%)	11 (22%)	14 (14%)	
Hormonal therapy				0.080
No hormonal therapy	108 (65%)	39 (75%)	69 (61%)	
Hormonal therapy	57 (35%)	13 (25%)	44 (39%)	
Social Functioning Score				0.626
Mean (SD)	79.91 (22.34)	78.73 (22.16)	80.50 (22.50)	
Emotional/Mental Wellbeing Score				0.135
Mean (SD)	75.72 (15.11)	78.18 (14.36)	74.52 (15.38)	
Social Wellbeing Score				0.035*
Mean (SD)	1.24 (1.25)	0.95 (1.13)	1.38 (1.29)	
Body Image and Relationships-Total Score				0.780
Mean (SD)	92.68 (9.75)	92.98 (9.37)	92.54 (9.97)	
Body Image and Relationships-Social Barriers Subscale Score				0.780
Mean (SD)	22.30 (8.35)	22.01 (8.44)	22.46 (8.35)	
Body Image and Relationships-Strength and Health Subscale Score				0.230
Mean (SD)	36.00 (4.40)	36.57 (4.76)	35.72 (4.21)	
Body Image and Relationships-Appearance and Sexuality Subscale Score				0.069
Mean (SD)	33.40 (4.64)	34.37 (4.70)	32.90 (4.55)	

* p value < 0.05 indicated statistical significance

Table II.

Baseline characteristics of the study participants by intervention condition

Variables	Control (N=87)	Exercise (N=86)	P-value
Marital status			0.133
Never married	9 (11%)	8 (9%)	
Currently married or living with partner	62 (73%)	54 (63%)	
Divorced or separated	13 (15%)	17 (20%)	
Widowed or widower	1 (1%)	7 (8%)	
Education			0.421
Less than college	19 (22%)	15 (17%)	
Some college (junior or technical college)	27 (31%)	28 (33%)	
4 -year college grad	20 (23%)	28 (33%)	
Graduate degree	21 (24%)	15 (17%)	
Ethnicity			0.497
Hispanic or Latino	2 (2%)	0 (0%)	
Not Hispanic or Latino	83 (98%)	84 (100%)	
Race			0.013*
Black or African American	21 (24%)	36 (42%)	
White or Caucasian	66 (76%)	50 (58%)	
Retirement status			0.468
Not retired	65 (75%)	60 (70%)	
Retired	22 (25%)	26 (30%)	
Mode of Transportation			0.795
Personal car	71 (83%)	69 (80%)	
Public transportation	12 (14%)	15 (18%)	
Other	3 (3%)	2 (2%)	
Leisure time (MET hr/week)			0.725
Mean (SD)	7.37 (7.77)	6.95 (7.83)	
Body mass index			0.785
Mean (SD)	34.38 (6.73)	34.12 (6.16)	
Cancer stage			0.286
0-<1	10 (15%)	6 (9%)	
1-<2	15 (23%)	22 (33%)	
2-<3	22 (34%)	23 (35%)	
3-<4	16 (25%)	10 (15%)	
4	2 (3%)	5 (8%)	
Chemotherapy			0.245
No chemotherapy	15 (17%)	21 (24%)	
Chemotherapy	72 (83%)	65 (76%)	

Variables	Control (N=87)	Exercise (N=86)	P-value
Radiation			0.576
No radiation	17 (20%)	14 (16%)	
Radiation	70 (80%)	72 (84%)	
Immunotherapy			0.912
No immunotherapy	62 (84%)	64 (83%)	
Immunotherapy	12 (16%)	13 (17%)	
Hormonal therapy			0.664
No hormonal therapy	53 (64%)	55 (67%)	
Hormonal therapy	30 (36%)	27 (33%)	
Social Functioning Score			0.360
Mean (SD)	81.47 (23.41)	78.34 (21.22)	
Emotional/Mental Wellbeing Score			0.872
Mean (SD)	75.91 (15.82)	75.53 (14.43)	
Social Wellbeing Score			0.458
Mean (SD)	1.17 (1.21)	1.31 (1.29)	
Body Image and Relationships-Total Score			0.148
Mean (SD)	91.62 (9.47)	93.78 (9.97)	
Body Image and Relationships-Social Barriers Subscale Score			0.011
Mean (SD)	20.42 (8.32)	24.25 (7.99)	
Body Image and Relationships-Strength and Health Subscale Score			0.780
Mean (SD)	35.91 (4.39)	36.09 (4.44)	
Body Image and Relationships-Appearance and Sexuality Subscale Score			0.693
Mean (SD)	33.55 (4.45)	33.25 (4.86)	

* p value < 0.05 indicated statistical significance

Table III.

Between treatment group changes in the quality of life outcomes from baseline to 12 months

Outcomes	Randomized group	Baseline	Change at 12 months	
		Mean (95% CI)	Mean (95% CI)	P-value
Emotional/Mental Wellbeing Score (Range: 0–100, higher is better)	Control	72.21 (65.68, 78.73)	Reference	Reference
	Exercise	70.64 (64.24, 77.04)	1.45 (–3.81, 6.72)	0.585
Social Wellbeing Score (Range: 0–6, higher is worse)	Control	1.02 (0.51, 1.52)	Reference	Reference
	Exercise	1.36 (0.86, 1.85)	–0.04 (–0.36, 0.27)	0.787
Body Image and Relationships-Total Score (Range: 32–160, higher is worse)	Control	93.34 (88.95, 97.73)	Reference	Reference
	Exercise	95.46 (91.19, 99.72)	–1.56 (–6.54, 3.42)	0.532
Social Functioning Score (Range: 0–100, higher is better)	Control	77.87 (69.11, 86.64)	Reference	Reference
	Exercise	71.83 (63.30, 80.36)	–0.01 (–7.80, 7.79)	0.999
Body Image and Relationships-Strength and Health Subscale Score (Range: 12–60, higher is worse)	Control	37.10 (35.15, 39.06)	Reference	Reference
	Exercise	36.64 (34.73, 38.54)	–0.16 (–2.13, 1.81)	0.875
Body Image and Relationships-Appearance and Sexuality Subscale Score (Range: 11–55, higher is worse)	Control	34.37 (32.32, 36.42)	Reference	Reference
	Exercise	33.84 (31.86, 35.83)	1.45 (–0.53, 3.42)	0.151
Body Image and Relationships-Social Barriers Subscale Score (Range: 9–45, higher is worse)	Control	21.00 (17.61, 24.40)	Reference	Reference
	Exercise	24.36 (21.06, 27.65)	–2.83 (–5.80, 0.13)	0.061

* p value < 0.05 indicated statistical significance

Table IV.

Within treatment group changes in the quality of life outcomes by race from baseline to 12 months

Outcomes	Randomized group	Race	Baseline	Change at 12 months	
			Mean (95% CI)	Mean (95% CI)	P-value
Emotional/Mental Wellbeing Score (Range: 0–100, higher is better)	Exercise	Black	73.13 (66.10, 80.15)	3.32 (–1.38, 8.02)	0.166
		White	68.15 (60.56, 75.74)	4.69 (0.32, 9.06)	0.036*
Social Wellbeing Score (Range: 0–6, higher is worse)	Exercise	Black	1.19 (0.65, 1.73)	0.21 (–0.16, 0.57)	0.260
		White	1.52 (0.93, 2.11)	–0.41 (–0.68, –0.13)	0.004*
Body Image and Relationships-Total Score (Range: 32–160, higher is worse)	Exercise	Black	94.96 (90.25, 99.67)	–2.44 (–6.62, 1.74)	0.252
		White	95.96 (90.96, 100.95)	–2.29 (–5.85, 1.26)	0.205
Social Functioning Score (Range: 0–100, higher is better)	Exercise	Black	68.05 (58.76, 77.33)	2.20 (–6.00, 10.39)	0.597
		White	75.61 (65.39, 85.83)	2.58 (–3.63, 8.80)	0.415
Body Image and Relationships-Strength and Health Subscale Score (Range: 12–60, higher is worse)	Exercise	Black	36.32 (34.28, 38.37)	–0.10 (–2.20, 2.01)	0.928
		White	36.95 (34.69, 39.22)	0.71 (–0.83, 2.26)	0.364
Body Image and Relationships-Appearance and Sexuality Subscale Score (Range: 11–55, higher is worse)	Exercise	Black	34.40 (32.24, 36.57)	0.89 (–1.02, 2.79)	0.361
		White	33.28 (30.87, 35.69)	0.66 (–1.38, 2.71)	0.517
Body Image and Relationships-Social Barriers Subscale Score (Range: 9–45, higher is worse)	Exercise	Black	23.92 (20.24, 27.61)	–3.06 (–6.24, 0.12)	0.059
		White	24.79 (20.99, 28.59)	–3.97 (–6.31, –1.63)	0.001*

* p value < 0.05 indicated statistical significance