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ORIGINAL ARTICLE

Predictors of attendance to an oncologist-referred exercise program for women with breast cancer

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Abstract

Purpose While exercise is associated with numerous benefits in women with breast cancer, adherence to exercise training concurrent to cancer treatment is challenging. We aimed to identify predictors of attendance to an oncologist-referred exercise program offered during and after adjuvant breast cancer treatment.

Methods Women with early-stage breast cancer receiving chemotherapy ($n = 68$) enrolled in the Nutrition and Exercise During Adjuvant Treatment (NExT) study. Supervised aerobic and resistance exercise was prescribed three times per week during treatment, then one to two times per week for 20 additional weeks. Predictors of attendance were identified using multivariate linear regression for three phases of the intervention, including during (1) adjuvant chemotherapy, (2) radiation, and (3) 20-weeks post-treatment.

Results Higher baseline quality of life (QoL) predicted higher attendance during chemotherapy ($\beta = 0.51\%$, 95 CI: 0.09, 0.93) and radiation ($\beta = 0.85\%$, 95 CI: 0.28, 1.41), and higher QoL, measured at the end of treatment, predicted higher attendance post-treatment ($\beta = 0.81\%$, 95 CI: 0.34, 1.28). Being employed pre-treatment ($\beta = 34.08\%$, 95 CI: 5.71, 62.45) and a personal annual income > $80,000 ($\beta = 32.70\%$, 95 CI: 0.85, 64.55) predicted higher attendance during radiation. Being divorced, separated or widowed ($\beta = -34.62\%$, 95 CI: −56.33, −12.90), or single ($\beta = -25.38\%$, 95 CI: −40.64, −10.13), relative to being married/common-law, and undergoing a second surgery ($\beta = -21.37\%$, 95 CI: −33.10, −9.65) predicted lower attendance post-treatment.

Conclusions Demographic variables, QoL, and receipt of a second surgery significantly predicted attendance throughout the NExT supervised exercise program. These results may help identify individuals with exercise adherence challenges and improve the design of future interventions, including optimizing the timing of program delivery.

Keywords Breast neoplasm · Adjuvant chemotherapy · Radiation · Exercise training · Resistance training

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Background

Exercise can be prescribed as an integrative therapy for breast cancer to mitigate treatment side effects and improve patient quality of life (QoL) and overall health [1, 2]. Furthermore, observational evidence suggests there is a positive association between higher physical activity levels or aerobic fitness and reduced risk of breast cancer recurrence, cancer-related death, and all-cause mortality [3, 4]. Thus, exercise training both during and following breast cancer treatment is recommended for long-term health [5]. Relative to home-based or unsupervised exercise interventions, supervised exercise has been shown to be superior in improving health and fitness outcomes, and QoL among women with breast cancer [6, 7].

However, the effectiveness of a supervised exercise program at the individual level largely depends on program adherence.

Adherence has been defined by the World Health Organization as the extent to which the behavior of the individual corresponds with recommendations [8]. Exercise adherence to a supervised program among women with breast cancer has been previously evaluated as the number of exercise sessions completed out of the total prescribed sessions (i.e., attendance) [9–11]. Unfortunately, breast cancer patients undergoing chemotherapy report unique exercise barriers, including treatment side effects [12]. Therefore, identification of modifiable and relevant predictors of exercise attendance is needed to improve the design and delivery of future exercise programs, particularly during breast cancer treatment, by determining which participants need additional support to meet recommended exercise targets.

Higher baseline physical fitness or physical activity levels [9, 10, 13], and greater perceived importance of exercise [14], have been previously identified as predictors of higher exercise attendance during chemotherapy for breast cancer. Exercise history or physical fitness, and exercise stage of change (theory of planned behavior), also significantly predict attendance to home-based and supervised exercise programs both during and after treatment in mixed cancer populations [15–17]. Although informative, information on additional predictors, including demographic, psychological, and medical variables, is needed to increase the potential reach of programming. Associations between such variables and exercise attendance are less consistent [15, 17], likely due to differences between intervention types and timing, patient populations, adherence definitions, and the availability of variables tested. Thus, further investigation of multifactorial barriers to exercise interventions delivered across the cancer treatment trajectory is needed to build upon this initial evidence.

Most published studies have evaluated predictors of exercise attendance in cancer populations within structured randomized controlled trials. While contributing important information regarding the effectiveness of exercise, findings from randomized trials with strict intervention adherence expectations may not directly translate into "real-world" settings. Therefore, we aimed to begin bridging this gap by evaluating predictors of attendance to an exercise program delivered within a clinical oncology setting. The purpose of the parent study, the Nutrition and Exercise During Adjuvant Treatment (NExT) study, was to assess the reach, effectiveness, maintenance, and implementation of an exercise and healthy eating program offered as a part of supportive care for women with breast cancer undergoing adjuvant chemotherapy. Findings from the primary paper demonstrated that the NExT program was safe, feasible, and associated with improvements in physical activity levels and maintained QoL [18]. The objective of this exploratory analysis was to determine whether demographic, QoL, medical, and fitness-related variables predicted supervised exercise program attendance during three phases of the NExT intervention, including during (1) adjuvant chemotherapy, (2) radiation, and (3) 20-weeks post-treatment.

Methods

Design and participants

The NExT study was a single-arm, oncologist-referred intervention program consisting of supervised and home-based exercise, and a single group-based nutrition information session. The program was offered to women with early-stage breast cancer undergoing adjuvant treatment at the British Columbia Cancer Agency in Vancouver, Canada. Eligibility criteria included female gender, age ≥ 19 years, referral within the first half of adjuvant chemotherapy treatment, body mass index (BMI) < 40 kg/m^2, deemed safe to exercise by their treating oncologist, and able to communicate in English.

Supervised exercise program

The NExT exercise and healthy eating program has been previously described in detail elsewhere [18, 19]. Briefly, the supervised exercise intervention included group-based aerobic and resistance training offered 3 days/week during adjuvant chemotherapy and radiation (if received), twice/week for 10-week post-treatment, and once/week for 10 additional weeks (20 total weeks post-treatment). Aerobic exercise was performed on the treadmill, cycle ergometer, or elliptical trainer starting at 20 min at 50–55% heart rate reserve (HRR) and progressed to 30 min at 70–75% HRR. Resistance exercise included two sets of 10–12 repetitions of seven exercises targeting major muscle groups starting at 50% estimated one- repetition maximum (1RM) and progressing to 75% of 1RM. Home-based aerobic exercise was introduced in week 3 to meet the recommended guidelines of 150 min/week of moderate-to-vigorous aerobic exercise throughout the study [20].

Assessment of predictors of attendance

Predictors of attendance examined included demographics, QoL, fitness, and medical variables, based on data collected for the parent study. Self-reported demographic data collected at baseline consisted of age, ethnicity, marital status, education, personal and spousal income, pre-treatment employment status, and primary caregiver. Travel distance (km) and time (min) to the exercise facility were estimated using Google maps [21]. Medical data extracted from patient medical records included past cancer diagnosis, disease stage, chemotherapy protocol, receipt of radiation, receipt of hormonal therapy, and receipt of Herceptin. Chemotherapy completion

rate variables were examined, including any treatment delay (> 5 days), cancelation, or reduction in prescribed dosage. Having a comorbid condition, individual types of comorbidities, total number of comorbidities, and the total number of prescribed medications for existing comorbidities were also evaluated. Medical and baseline demographics data were examined as predictors of attendance to each phase of the intervention, including during (1) chemotherapy, (2) radiation, and (3) 20-weeks post-treatment. Additionally, receipt of a second surgery following adjuvant treatment was examined as a predictor of attendance during the 20-week post-treatment phase only.

Self-reported physical activity levels over the previous 6 months were collected using a modified version of the Minnesota Leisure Time Physical Activity Questionnaire at baseline [22]. The compendium of physical activities [23] was used to assign a metabolic equivalent (MET) to each activity. Average MET hours/week and average hours/week of moderate-to-vigorous physical activity (MVPA) levels were calculated. The presence of an injury within the previous 12 months was also collected by questionnaire at baseline [24]. These three variables were examined as predictors of attendance for each phase of the intervention.

Other patient-reported and physical fitness outcomes were measured once at baseline to predict attendance during chemotherapy and radiation, and again at the end of adjuvant treatment (chemotherapy ± radiation, if applicable) to predict attendance during the 20-weeks post-treatment. In addition to absolute values, changes in these variables between baseline and end of adjuvant treatment were used to predict attendance during the 20-weeks post-treatment. Physical and mental component summaries and overall health-related QoL were collected using the Medical Outcomes Survey (RAND-36) [25] and cancer-related QoL using the Functional Assessment of Cancer Therapy–General (FACT-G) and breast cancer-specific version (FACT-B) questionnaires [26]. Physical fitness measures included aerobic fitness (estimated peak oxygen consumption (VO_{2peak}) calculated via a submaximal graded treadmill test), leg press 1RM (estimated from a submaximal leg press test), resting heart rate, systolic and diastolic blood pressure, and BMI.

Statistical analysis

This analysis was limited to women who attended at least one exercise session. Program attendance was defined as the percentage of sessions attended out of the total prescribed sessions during each phase of the program. Because of the variation in individual cancer treatment length, the number of exercise sessions offered differed between participants. Women who withdrew from the study were retained in the analysis. Women who moved following treatment and were unable to commute to the exercise facility had their attendance calculated based on the number of sessions offered up until the time they moved. Correlations between attendance rates for each phase of the study were calculated using Pearson's correlation coefficient (r). Univariate linear regression was first used to explore predictors of attendance for each phase of the intervention independently. Any variable with a $p < 0.25$ was considered a potential predictor of attendance, and these variables were tested within a multivariate model. Models were built in a forward-selection stepwise fashion, and variables were retained in the multivariate model if they were found to improve the overall fit of the model using the partial F test (for nested models) or AIC (for non-nested models). Multivariate models were built separately for during chemotherapy, radiation, and the 20-week post-treatment phases. All analyses were conducted using R version 3.2.2. (Vienna, Austria) [27].

Results

Participant demographics are reported in Table 1, and medical characteristics in Table 2. Altogether, 73 patients enrolled and underwent baseline testing [18] and 68 participants attended at least one exercise session. There were three women who moved upon treatment completion. Attendance during adjuvant chemotherapy, radiation, and post-treatment for the participants included in this analysis were 64 ± 25, 67 ± 36, and 54 ± 31%, respectively.

Overall, there was a positive correlation between attendance rates for each phase of the study. There was a strong correlation between attendance during chemotherapy and attendance during radiation ($r = 0.77$), a moderate correlation between attendance during chemotherapy and attendance during the 20-weeks post-treatment ($r = 0.56$), and a strong correlation between attendance during radiation and attendance during the 20-weeks post-treatment ($r = 0.62$).

Predictors of attendance during chemotherapy

Potential predictors of attendance during chemotherapy are summarized in Table 3. The univariate analysis revealed eight significant predictors of attendance during chemotherapy and 15 additional potential predictors that were further examined in the multivariate model. Univariate predictors of attendance included marital status, income, primary caregiver, pre-treatment employment status, chemotherapy dose disruption, total number of chemotherapy dose disruptions, and baseline mental component summary (RAND-36), and self-reported MVPA (MET hours/week).

In the multivariate analysis, higher baseline cancer-related QoL (FACT-G total score) significantly predicted higher attendance during chemotherapy ($\beta = 0.51\%$, 95 CI: 0.09, 0.93). There was also a large non-significant effect of full-time or

Table 1 Baseline demographics (n=67)*

Demographics	Mean ± SD
Age (years)	51.2±10.7
Commute to exercise facility	
Travel time (min)	17.9±10.8
Travel distance (km)	8.3±7.9
	n (%)
Marital Status	
Married/Common-law	47 (70%)
Divorced/Separated/Widowed	8 (12%)
Single	11 (16%)
Prefer not to answer	1 (1%)
Ethnicity	
White	42 (63%)
Asian	24 (36%)
Other	1 (1%)
Education	
High school diploma	5 (7%)
Technical/Community college	17 (25%)
Some university	8 (12%)
Bachelor's degree	16 (24%)
>Bachelor's degree	21 (31%)
Pre-treatment employment status	
Full-time/Part-time	56 (84%)
Not working/Unemployed/ Disability leave	3 (4%)
Homemaker/Retired	8 (12%)
Income	
<$20,000	11 (16%)
$30,000 - $49,999	20 (30%)
$50,000 - $79,999	11 (16%)
>$80,000	19 (28%)
Prefer not to answer	6 (9%)
Primary caregiver	
Spouse	39 (58%)
Relative/Child	12 (18%)
Friend	6 (9%)
Multiple caregivers	9 (13%)
No support	1 (1%)

*Demographics data missing for n=1 person who did not complete demographics questionnaire.

Table 2 Participant baseline medical characteristics (n=68)

Medical history	n (%)
Comorbidities	
Anxiety/Depression	11 (16%)
Hypertension	11 (16%)
Asthma/Lung disease	8 (13%)
Previous cancer	8 (13%)
Osteoporosis	5 (10%)
Arthritis	4 (6%)
Metabolic disease	3 (4%)
Thyroid disorder	3 (4%)
Neurological condition	3 (4%)
Cancer diagnosis and treatment	
Tumor stage	
I	17 (25%)
II	43 (63%)
III	7 (10%)
Chemotherapy protocol	
Doxorubicin, cyclophosphamide +/- paclitaxel[a]	47 (69%)
Docetaxel + cyclophosphamide	21 (31%)
Post-adjuvant treatment surgery	29 (43%)
Radiation therapy	60 (88%)
Herceptin	27 (40%)
Hormonal therapy	
Tamoxifen	38 (56%)
Letrozole	12 (18%)
Anastrozole	3 (4%)
None	15 (22%)

[a] n=5 received an experimental protocol on clinical trial consisting of four cycles of anthracyclines 2 or 3 weeks apart, followed by either trastuzumab and pertuzumab, or trastuzumab-emtansine and pertuzumab instead of paclitaxel.

part-time pre-treatment employment status on attendance during this phase ($\beta = 27.44\%$, 95 CI: − 1.35, 56.23).

Predictors of attendance during radiation

Potential predictors of attendance during radiation are summarized in Table 4. The univariate analysis revealed nine significant predictors of attendance during radiation and an additional 10 potential predictors. Univariate predictors of attendance during radiation included income, primary caregiver, pre-treatment employment status, a chemotherapy dose disruption, total number of chemotherapy dose disruptions, sustaining an injury within the previous 12 months, and baseline mental component summary (RAND-36) and cancer-related QoL (both FACT-G and FACT-B total scores).

In our multivariate analysis, significant predictors of higher attendance during radiation were higher cancer-related QoL (FACT-G total score) at baseline ($\beta = 0.85\%$, 95 CI: 0.28, 1.41), being employed full-time or part-time pre-treatment ($\beta = 34.08\%$, 95 CI: 5.71, 62.45), and falling into the highest personal annual income category (> $80,000) relative to the lowest income category (< $20,000) ($\beta = 32.70\%$, 95 CI: 0.85, 64.55).

Predictors of attendance post-treatment

Potential predictors of attendance during the 20-weeks post-treatment are summarized in Table 5. There were five

Table 3 Baseline predictors of attendance during chemotherapy (n=68)

Variable	Univariate Analysis		Multivariate Analysis	
	Estimate	CI (95%)	Estimate	CI (95%)
Age (years)	-0.36	(-0.93, 0.20)		
Marital Status				
Married/Common-law	REF			
Divorced/Separated/Widowed	-25.28	(-43.45, -7.10)**		
Single	-6.82	(-22.74, 9.10)		
Personal Income				
<$20,000	REF		REF	
$30,000 - $49,000	15.66	(-1.59, 32.90)	5.48	(-21.42, 32.38)
$50,000 - $79,000	3.46	(-16.13, 23.04)	-6.88	(-35.66, 21.89)
>$80,000	27.14	(9.74, 44.54)**	6.42	(-21.15, 33.99)
Caregiver				
Spouse	REF			
Relative/Child	-20.21	(-36.20, -4.21)*		
Friend	-8.71	(-29.95, 12.54)		
Multiple caregivers	-6.32	(-24.23, 11.60)		
No support	3.46	(-45.61, 52.53)		
Employment pre-treatment				
Not working	REF		REF	
Full-time/Part-time	23.69	(8.34, 39.04)**	27.44	(-1.35, 56.23)
Osteoporosis	-13.75	(-36.89, 9.39)		
Arthritis	19.41	(-6.10, 44.91)		
Total number of comorbid conditions	-6.12	(-15.34, 3.11)		
At least one comorbid condition	-8.41	(-20.71, 3.90)		
Chemotherapy dose disruption	-13.96	(-25.71, -2.21)*		
Total chemotherapy dose disruptions	-5.47	(-10.11, -0.84)*		
Second surgery	-11.86	(-23.87, 0.14)	-12.62	(-25.97, 0.74)
Systolic blood pressure	0.28	(-0.18, 0.75)		
RAND-36				
Mental component summary	0.45	(0.02, 0.88)*		
Physical component summary	0.60	(-0.10, 1.30)		
FACT-B total score	0.22	(-0.11, 0.54)		
FACT-G total score	0.35	(-0.05, 0.74)	0.51	(0.09, 0.93)*
MET hours per week of MVPA	0.42	(0.10, 0.73)*		
Hours per week of MVPA	1.44	(-0.46, 3.33)		
Aerobic capacity (VO_{2peak})	0.56	(-0.40, 1.52)	0.10	(-1.03, 1.22)
Injury (previous 12 months)	-8.03	(-21.64, 5.59)		
Travel distance (km)	0.73	(-0.03, 1.49)	0.25	(-0.83, 1.32)
Travel time (min)	0.45	(-0.12, 1.01)		

All variables shown for univariate analysis were identified as potential predictors ($p<0.25$) for multivariate analysis. REF=reference category; *($p\leq0.05$) **($p<0.01$)

significant predictors of attendance during the post-treatment phase following the univariate analysis, plus 20 additional potential predictors that were included in the multivariate analysis. Significant univariate predictors of attendance included cancer stage, baseline, and end of treatment BMI, as well as end of treatment and change in physical component summaries between baseline and end of treatment (RAND-36).

The multivariate analysis revealed five significant predictors of attendance during the 20-week post-treatment phase. Being divorced, separated or widowed ($\beta = -34.62\%$, 95 CI: −56.33, −12.90), or single ($\beta = -25.38\%$, 95 CI: −40.64, −10.13), significantly predicted lower attendance relative to being married or in a common-law partnership. Receipt of a second surgery after adjuvant treatment also significantly

Table 4 Baseline predictors of attendance during radiation (n=60)

Variable	Univariate Analysis		Multivariate Analysis	
	Estimate	CI (95%)	Estimate	CI (95%)
Marital status				
Married/Common-law	REF			
Divorced/Separated/Widowed	-24.71	(-50.94, 1.51)		
Single	-10.84	(-37.07, 15.39)		
Personal Income				
<$20,000	REF		REF	
$30,000 - $49,999	23.94	(-2.93, 50.81)	28.41	(-2.97, 59.80)
$50, 000 - $79,999	21.41	(-8.83, 51.65)	20.91	(-14.50, 56.31)
>$80, 000	43.05	(15.61, 70.49)**	32.70	(0.85, 64.55)*
Caregiver				
Spouse	REF			
Relative/Child	-28.11	(-50.52, -5.71)*		
Friend	-1.86	(-31.36, 27.63)		
Multiple caregivers	-20.41	(-46.59, 5.78)		
Employment pre-treatment				
Not working	REF		REF	
Full/Part-time	40.32	(16.06, 64.58)**	34.08	(5.71, 62.45)*
Osteoporosis	-29.04	(-61.37, 3.30)		
Anxiety/Depression	-17.74	(-41.01, 5.52)		
Chemotherapy dose disruption	-19.97	(-37.60, -2.35)*		
Total chemotherapy dose disruptions	-8.38	(-15.08, -1.68)*		
Herceptin	-11.49	(-30.12, 7.14)		
BMI	-1.37	(-2.93, 0.19)		
Injury (previous 12 months)	-22.34	(-41.24, -3.44)*		
RAND-36				
Mental component summary	0.87	(0.25, 1.50)**		
Physical component summary	0.76	(-0.32, 1.84)		
FACT-B total score	0.49	(0.03, 0.95)*		
FACT-G total score	0.69	(0.13, 1.24)*	0.85	(0.28, 1.41)**
MET hours per week of MVPA	0.43	(-0.03, 0.90)		
Hours per week of MVPA	2.04	(-0.69, 4.78)		
Travel distance (km)	1.06	(-0.03, 2.15)	0.13	(-1.33, 1.58)
Travel time (min)	0.51	(-0.32, 1.34)		

All variables shown for univariate analysis were identified as potential predictors ($p<0.25$) for multivariate analysis. REF=reference category; *($p\leq0.05$) **($p<0.01$)

predicted poorer attendance ($\beta=-21.37\%$, 95 CI: −33.10, −9.65). Finally, higher baseline cancer-related QoL (FACT-G total scores) significantly predicted lower attendance ($\beta=-0.66\%$, 95 CI: −1.14, −0.18), while higher end of treatment cancer-related QoL significantly predicted higher attendance ($\beta=0.81\%$, 95 CI: 0.34, 1.28).

Discussion

Despite widespread interest in incorporating exercise into supportive care for cancer patients undergoing treatment [28, 29], only a handful of studies have evaluated predictors of attendance to exercise programs delivered during chemotherapy for breast cancer [9, 10, 13, 14]. Several other studies have evaluated predictors of attendance to exercise interventions delivered post-breast cancer treatment [11, 30–33]. To our knowledge, this is the first study to evaluate predictors of attendance to an oncologist-referred supervised exercise program, with an intervention that spans three distinct phases along the breast cancer treatment continuum, including during chemotherapy, radiation, and 20-weeks post-treatment.

Our multivariate analysis confirmed that cancer-specific QoL significantly predicted attendance to each phase of the

Table 5 Predictors of attendance during the 20-weeks post-treatment (n=66)

Variable	Univariate Analysis		Multivariate Analysis	
	Estimate	CI (95%)	Estimate	CI (95%)
Age (years)	0.59	(-0.09, 1.27)		
Marital status				
Married/common-law	REF		REF	
Divorced/separated/widowed	-11.93	(-35.74, 11.88)	-34.62	(-56.33, -12.90)**
Single	-17.04	(-36.73, 2.66)	-25.38	(-40.64, -10.13)**
Pulmonary disease	15.22	(-7.31, 37.75)		
Anxiety/depression	-14.35	(-34.04, 5.35)		
Thyroid disorder	26.37	(-8.84, 61.57)		
Previous cancer	13.51	(-9.09, 36.11)		
Cancer stage				
Stage I	REF			
Stage II	-9.82	(-26.48, 6.85)		
Stage III	-35.45	(-63.08, -7.82)**		
Radiation therapy	20.38	(-3.32, 44.08)		
Chemotherapy protocol				
Doxorubicin, cyclophosphamide +/- paclitaxel	REF			
Docetaxel, cyclophosphamide	12.41	(-3.52, 28.34)		
Paclitaxel chemotherapy	-11.45	(-26.84, 3.95)		
Hormone therapy				
No hormone therapy	REF			
Tamoxifen	3.99	(-14.29, 22.27)		
Letrozole	22.60	(-0.43, 45.63)		
Anastrozole	10.60	(-27.01, 48.21)		
Baseline BMI	-1.33	(-2.53, -0.14)*		
End of treatment BMI	-1.43	(-2.62, -0.24)*		
Second surgery post-treatment	-13.52	(-28.24, 1.19)	-21.37	(-33.10, -9.65)**
End of treatment diastolic blood pressure	-0.52	(-1.18, 0.13)	-0.53	(-1.17, 0.12)
RAND-36				
Baseline mental component summary	0.47	(-0.06, 0.99)	-0.49	(-1.04, 0.07)
Change in mental component summary	-0.39	(-1.00, 0.22)		
End of treatment physical component summary	0.75	(0.10, 1.40)*		
Change in physical component summary	0.94	(0.28, 1.61)**		
FACT-B				
End of treatment total score	0.24	(-0.10, 0.59)		
FACT-G				
Baseline total score	0.31	(-0.18, 0.80)	-0.66	(-1.14, -0.18)**
End of treatment total score	0.35	(-0.08, 0.77)	0.81	(0.34, 1.28)**
Hours per week of MVPA	1.64	(-0.65, 3.93)		
Change in leg press 1RM (kg)	0.10	(-0.05, 0.25)	0.05	(-0.06, 0.17)
Travel distance (km)	0.69	(-0.22, 1.59)		

All variables shown for univariate analysis were identified as potential predictors ($p<0.25$) for multivariate analysis. REF=reference category; *($p\leq0.05$) **($p<0.01$)

supervised exercise intervention. Previous studies that have evaluated QoL did not find it significantly predicted attendance during cancer treatment [9, 10]; however, higher baseline FACT-B scores significantly predicted higher supervised exercise attendance among breast cancer survivors > 6 months post-treatment [30]. Exercise can significantly enhance QoL, mood, and physical function both during and after cancer treatment [7]. Our results demonstrate that QoL prior to participating in an exercise program may also predict exercise attendance, and thus influence the intervention's overall

effectiveness. Surprisingly, while higher baseline QoL significantly predicted higher attendance during chemotherapy and radiation, it predicted lower attendance during the 20-weeks post-treatment. Alternatively, we found that those with higher QoL measured at the end of adjuvant treatment had significantly higher attendance during the 20-weeks post-treatment. Greater health-related concerns experienced at the time of exercise program delivery may hinder participants' perceived ability or motivation to participate in exercise at different stages following a breast cancer diagnosis. Therefore, monitoring QoL at different time points is one possible strategy to identify participants at risk of low exercise attendance.

During radiation, our multivariate analysis revealed that employment status and personal annual income predicted higher exercise attendance. Attendance among employed participants was 34 percentage points higher compared to participants who were not working, including those who were unemployed, on leave, retired or homemakers, even after adjusting for age. A similar effect size that was not statistically significant was found between employment status and attendance during chemotherapy. A previous randomized control trial found that employed participants had increased adherence to the prescribed aerobic exercise intensity in a supervised intervention during chemotherapy for breast cancer [14]. These associations may be due to employed individuals being in better physical condition relative to those who are not working. Population-based evidence suggests that men and women who are unemployed have lower odds of participating in leisure-time physical activity and report lower physical well-being [34, 35]. Employed individuals may also have fewer socio-economic barriers. Positive associations between physical activity levels and income specifically in women with breast cancer have been previously reported [36, 37]. Similarly, we detected a significant effect of personal annual income on exercise attendance during adjuvant chemotherapy and radiation in our univariate analysis. Women reporting a personal annual income > $80,000, which is well above the provincial and national median income [38], had higher attendance relative to a low personal annual income (< $20,000). However, our multivariate analyses found that higher income predicted higher attendance during radiation only. Although our program was offered for free, socio-economic barriers extending beyond fees for exercise-related services may hinder exercise participation. Thus, participant financial barriers are likely an important consideration when developing future cancer exercise programs, even if programs are subsidized or included as a part of standard care.

During the 20-week post-treatment phase, the strongest predictor of attendance was marital status. Associations between marital status and exercise participation among cancer patients have been reported, demonstrating the important role of family and social support in reducing exercise barriers and promoting exercise adherence [39, 40]. During treatment, participants without a spouse may have received more social support from outside family members or friends, while upon treatment completion, their level of support may have decreased relative to women with a spouse. Women without spouses may also experience additional exercise barriers post-treatment, including greater family obligations, such as childcare, or earlier return to work dates. Next, our finding that receipt of a second surgery (e.g., re-excision of margins, mastectomy, or breast reconstruction) significantly predicted lower attendance during the post-treatment phase was unsurprising, given the restriction on exercise during recovery. A large proportion of our participants (n = 29, 43%) received at least one additional surgery following adjuvant treatment, suggesting attention to the timing of exercise program delivery around breast surgery schedules and anticipated recovery times is needed.

Altogether, our analysis offers distinct information regarding exercise attendance patterns in women with breast cancer. The NExT study aimed to model a program feasible for implementation into standard breast cancer care. The program was designed with the support of participants' treating medical oncologists and was offered in a group-based setting at a convenient location near the cancer treatment center. One paid lead exercise trainer coordinated the trial; however, student volunteers played a large role in assisting with exercise supervision to reduce the cost of program delivery. Inclusion criteria were potentially less strict for the NExT study relative to previous randomized trials, and participants were not actively discouraged to miss scheduled sessions for work or holidays. Results from the primary paper demonstrated that the NExT supportive care model was feasible, safe, and associated with important physical and psychosocial benefits [18]. Thus, understanding predictors of NExT supervised exercise program attendance is an important endeavor, given it may reveal aspects of attendance to an evidence-based intervention delivered under a setting attempting to resemble "real-world" conditions.

This was an exploratory analysis and some important predictors of attendance, such as psychosocial factors, including social connectedness given it was a group-based program, the presence of treatment toxicities, and the time between participants' primary surgery and program commencement, were not included as variables. Further, this analysis was limited to the assessment of predictors of attendance to the NExT supervised exercise program. We noticed a reduction in supervised program attendance following treatment and this may be due to participants replacing supervised exercise sessions with home-based exercise, which can be completed at more convenient times and locations. The NExT study intervention spanned approximately 11 months and factors that predicted attendance for each phase of this study may not mirror predictors of attendance to interventions offered during shorter and more discrete time points following a breast cancer diagnosis. Furthermore, two previous Canadian multi-center randomized

trials found that women undergoing chemotherapy for breast cancer who exercised at Vancouver sites had significantly higher attendance relative to women exercising in other Canadian cities [9, 10]. While attendance rates in the current trial were lower in comparison to these previous randomized trials, this suggests women in Vancouver may be more likely to adhere to an exercise intervention relative to women in other locations. Another consideration is that our participants lived in an urban setting and were mostly well educated and employed. As such, our results may not directly translate to a broader breast cancer population. Finally, our relatively small sample size limits our ability to add additional variables to the multivariate model as well as validate our findings using a bootstrapping approach.

Given the emphasis on prescribing exercise as a part of standard breast cancer care, there is an urgent need to recognize factors that either hinder or maximize the benefits of an exercise program tailored for this population. Specifically, determining who will "show up" upon committing to an exercise program is a key undertaking to identify individuals at risk of poor attendance and implement strategies to reduce attendance barriers. Future exercise programs could include specific approaches to improve attendance among participants with lower socio-economic status, who are single or living on their own, or have greater health-related concerns. Flexible workout schedules or multiple locations may help ease the burden for individuals who rely on public transport or have limited time due to work or family obligations. Importantly, distance or travel time to the facility did not independently predict attendance in the current study, suggesting that among those who enroll in a program based at a specific location, these variables may not be critical barriers when other individual needs are met. Further, comorbidities did not independently predict attendance in this study, yet large effects were detected for some comorbid conditions, such as anxiety and depression, in our univariate analysis. These conditions may form a basis for some of the associations we detected, including poorer QoL and recovery time following surgery, and subsequently act as exercise barriers. In general, those with greater health-related concerns likely require prescribed behavioral support throughout an exercise program to achieve desired attendance. Overall, it is important to recognize that exercise uptake and attendance differ not only between individuals but within individuals at various time points along the cancer continuum.

Conclusion

This analysis helps expand our current knowledge of exercise attendance in a supervised setting among women recently diagnosed with breast cancer. Given the positive influence of exercise on numerous physical and psychosocial outcomes in this population, understanding exercise attendance barriers is of interest to researchers and health providers alike. We observed a strong association between cancer-related QoL, employment status, income, marital status, and receipt of surgery post-treatment with exercise program attendance during and after adjuvant breast cancer treatment. Going forward, these findings may help inform exercise program design, including the timing of intervention delivery, and the necessary supportive interventions to promote attendance among breast cancer survivors.

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Compliance with ethical standards

Conflicts of interest The authors declare they have no conflicts of interest.

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