Associations between Exercise and Quality of Life in Bladder Cancer Survivors: A Population-Based Study

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Abstract

Background: **Exercise has been shown to improve quality of life (QoL) in some cancer survivor groups, but it is unknown if the unique QoL issues faced by bladder cancer survivors are also amenable to an exercise intervention. This study provides the first data examining the association between exercise and QoL in bladder cancer survivors.**
Methods: **Bladder cancer survivors identified through a provincial cancer registry were mailed a survey that included the Godin Leisure Time Exercise Questionnaire, the Functional Assessment of Cancer Therapy-Bladder (FACT-Bl) scale, and the Fatigue Symptom Inventory.**
Results: **Of the 525 bladder cancer survivors (51% response rate) that completed the survey, 22.3% were meeting public health exercise guidelines in the past month, 16.0% were insufficiently active (i.e., some exercise but less than the guidelines), and 61.7% were completely sedentary. ANOVA indicated a general linear association between meeting guidelines and QoL, with those meeting guidelines reporting more favorable scores than completely sedentary survivors on the FACT-Bl (mean difference, 7.6; 95% confidence interval, 3.6-11.7; $P < 0.001$), the FACT ($P = 0.001$), the trial outcome index ($P < 0.001$), functional well-being ($P < 0.001$), additional concerns ($P = 0.001$), sexual functioning ($P < 0.001$), erectile function ($P < 0.001$), body image ($P < 0.001$), and various fatigue indicators ($P < 0.05$). Adjusting for key medical and demographic factors slightly attenuated the magnitude of the associations but did not alter the substantive conclusions.**
Conclusions: **Exercise is positively associated with QoL in bladder cancer survivors, although few are meeting public health exercise guidelines. Studies testing the causal effects of exercise on QoL issues unique to this population are warranted.** (Cancer Epidemiol Biomarkers Prev 2007;16(5): 984–90)

Introduction

In Canada, ~6,400 new cases of bladder cancer were diagnosed in 2006, making it the sixth most common cancer (1). The 5-, 10-, and 15-year survival rates are 82%, 76%, and 70.3%, respectively, indicating that most bladder cancer survivors can expect to live for many years after their diagnosis and treatments (2). Bladder cancer survivors undergo various treatments that improve survival including, the most common, surgery (3). For superficial tumors, adjuvant therapy commonly involves the insertion of cytotoxic agents directly into the bladder (4). For metastatic and locally advanced disease, systemic chemotherapy is frequently used as an adjuvant treatment. Radiation therapy is less commonly used as a single modality treatment in North America (5).

Bladder cancer survivors experience a number of side effects that may affect quality of life (QoL; ref. 6). Urinary dysfunction and sexual difficulties are the primary side effects from treatment and may have acute and chronic effects (7). Urinary dysfunction has been reported in up to 84% of superficial bladder cancer patients on treatment and up to 40% off treatment (6). Over 50% of bladder cancer survivors report sexual dysfunction (8, 9). Thus, poor physical and emotional functioning, body image disturbance, and mood state disturbances are common QoL issues faced by bladder cancer survivors (6).

Recent systematic reviews (10, 11) have indicated that exercise improves a variety of QoL and health outcomes in various cancer survivor groups both during and after adjuvant therapies, including aerobic fitness, muscular strength, fatigue, depression, anxiety, self-esteem, body image, functional ability, and overall QoL. These findings have been based on the results of randomized controlled trials of primarily breast and prostate cancer survivors (12, 13) and observational studies in other cancer groups such as endometrial (14), non–Hodgkin's lymphoma (15), and multiple myeloma (16) survivors. No studies to date, however, have examined exercise and QoL in bladder cancer survivors. Bladder cancer survivors experience a number of unique QoL issues, such as urinary complications (7) and sexual dysfunction (6), that may be less amenable to an exercise intervention and may also make it more difficult to exercise.

The purpose of the present study was to examine the association between exercise and QoL in bladder cancer survivors and, in the process, document the prevalence rate of exercise in this population. Secondarily, we explored the moderating effects of several demographic and medical variables on these potential associations. We hypothesized that exercise prevalence rates would be lower in bladder cancer survivors than in the general population or in other cancer survivor groups. We also hypothesized that exercise would be positively associated with QoL, particularly the physical and functional domains.

Materials and Methods

Protocol and Research Participants. Details about the methods of the study have been reported elsewhere (17). In brief, the Alberta Cancer Board Research Ethics Board and the University of Alberta Health Research Ethics Board gave approval to conduct the study. Information on all bladder cancer

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survivors diagnosed between January 1989 and December 2003 in Alberta, Canada was provided by the Alberta Cancer Registry. The study design was prospective for the additional purpose of collecting data on the determinants of exercise (data not presented here). Eligibility for the study included (*a*) 18 years old or older, (*b*) able to provide written consent in English, (*c*) approval for contact from a family physician or primary oncologist (required by our ethics boards), and (*d*) confirmed diagnosis of bladder cancer in the past 15 years.

Measures

Demographic and Medical Information. Demographic and medical information were collected from the registry and by self-administered questionnaire. Specifically, marital status, annual income, employment status, education level, ethnicity, height, weight, presence of an ostomy appliance, cystectomy, recurrence, and current cancer status were collected exclusively by self-report. Age, sex, time since diagnosis, tumor grade, tumor invasiveness (i.e., superficial or invasive), and treatment(s) received were collected from both the registry and self-report. For the medical variables, we first used information from the registry and supplemented it with self-report in the case of missing data.

Exercise Behavior. A modified version of the Leisure Score Index from the Godin Leisure Time Exercise Questionnaire (18) was used to assess exercise behavior. Participants were asked to recall their average frequency and duration of mild (minimal effort, no perspiration), moderate (not exhausting, light perspiration), and strenuous (heart beats rapidly, sweating) exercise behavior for three separate time periods: (*a*) in the months before diagnosis, (*b*) during adjuvant therapy (if applicable), and (*c*) in the past month. We calculated weekly exercise minutes for mild, moderate, and strenuous activities plus combined scores for moderate plus strenuous exercise minutes. For analyses, participants were categorized as (*a*) completely sedentary (i.e., 0 min of moderate or strenuous exercise per week), (*b*) insufficiently active (i.e., some moderate to strenuous minutes of activity but not enough to meet public health exercise guidelines), or (*c*) meeting public health exercise guidelines (i.e., ≥60 min of strenuous exercise per week or 150 min of moderate plus strenuous exercise per week) as defined by the American College of Sports Medicine and the Centers for Disease Control (19). The Leisure Score Index has been found to be valid and reliable in comparison with nine other self-report measures of exercise (20). The Leisure Score Index has a 1-month test-retest reliability of 0.62 and concurrent validity coefficients of 0.32 with an accelerometer and 0.56 with maximal oxygen consumption.

QoL. QoL was assessed by the Functional Assessment of Cancer Therapy-Bladder (FACT-Bl) scale (21). The FACT-Bl consists of five subscales: physical well-being (PWB; 7 items), functional well-being (FWB; 7 items), emotional well-being (EWB; 6 items), social well-being (SWB; 7 items), and an additional concerns scale specific to bladder cancer (13 items). The additional concerns scale assesses urinary function (3 items), bowel function (2 items), sexual function (2 items), body image (1 item), weight loss/appetite (2 items), and issues concerning an ostomy appliance (2 items). The PWB, FWB, EWB, and SWB subscales can be summed to form the FACT-General (FACT-G) score. The PWB, FWB, and additional concern subscales can be summed to form the Trial Outcome Index (TOI). A 5-point Likert scale ranging from 0 (''not at all'') to 4 (''very much'') was used to rate all FACT items. Higher scores indicate higher QoL. The FACT scales have been found to have acceptable internal consistency, test-retest reliability, and convergent and discriminant validity and to be easy to administer and brief (22).

Fatigue. Fatigue was assessed using the Fatigue Symptom Inventory (23). The Fatigue Symptom Inventory is a 13-item scale designed to capture multidimensional aspects of fatigue in cancer survivors. The Fatigue Symptom Inventory consists of four ratings of intensity of fatigue over the past week (most fatigue, least fatigue, average fatigue, current fatigue), two ratings of duration of fatigue in the past week (number of days fatigued, time spent per day fatigued), and a fatigue interference subscale (7 items). The Fatigue Symptom Inventory has been found reliable and valid in a sample of women with breast cancer (23) and in a sample of men and women with mixed cancers (24).

Statistical Analyses. Changes in exercise behavior across the three cancer-related time periods were analyzed with a one-way repeated-measures ANOVA and dependent *t* tests. Differences in QoL based on the exercise categories were tested using ANOVA followed by independent *t* tests. We repeated these analyses using analysis of covariance to control for demographic and medical variables that had statistically significant associations with the FACT-Bl or any of its subscales in our data set. Our analytic strategy was to first test for differences in the largest aggregate scale (i.e., FACT-Bl) and, if significant, continue with tests of the smaller aggregate scales (i.e., FACT-G and the TOI) followed by the subscales (i.e., PWB, FWB, SWB, EWB, and additional concerns). We also had an interest in several aspects of the additional concern subscale that were analyzed separately (i.e., urinary function, bowel functioning, sexual function, and body image). For

Table 1. Demographic profile of bladder cancer survivors (*N* = 525)

Demographic variable	Mean ± SD or %
Age (*N* = 525), y	70.2 ± 11.2
<65	30.9
≥65	69.1
Sex (*N* = 525)	
Male	74.7
Female	25.3
Marital status (*N* = 525)	
Married/common law	79.8
Divorced/separated	6.1
Widowed	11.8
Never married	2.3
Education (*N* = 525)	
Some elementary school	5.5
Completed elementary school	8.2
Some high school	27.8
Completed high school	24.0
Some university/college	14.3
Completed university/college	16.2
Some graduate school	1.1
Completed graduate school	2.9
Annual family income (data missing: *N* = 424), US$	
<20,000	13.7
20,000-39,000	36.3
40,000-59,000	21.7
60,000-79,999	12.5
80,000-99,999	5.9
>100,000	9.9
Employment status (*N* = 525)	
Retired	70.9
Disability	4.4
Employed full/part-time	23.2
Temporarily unemployed	1.5
Ethnicity (*N* = 525)	
Caucasian	98.1
Native/Metis	1.3
Asian	0.6
Smoking status (*N* = 525)	
Never smoked	23.4
Ex smoker	59.2
Occasional smoker	6.8
Regular smoker	10.6

Table 2. Medical profile of bladder cancer survivors (*N* = 525)

Medical variable	Mean ± SD or %
Body mass index (*N* = 525)	27.3 ± 4.1
<25.0	4.6
25.0-29.9	56.2
30.0-34.9	14.5
≥35.0	4.8
Months since diagnosis (*N* = 525)	72.4 ± 42.2
<60	48.6
≥60	51.4
Tumor grade (*N* = 525)	
1	22.3
2	38.5
3	14.9
4	11.0
Unknown	13.3
Degree of invasiveness (*N* = 525)	
Superficial	65.0
Invasive	35.0
Surgery (*N* = 525)	
Yes	97.9
No	2.1
Cystectomy (*N* = 525)	
Yes	20.2
No	79.8
Immunotherapy (*N* = 525)	
Yes	57.7
No	42.3
Chemotherapy (*N* = 525)	
Yes	11.8
No	88.2
Radiation (*N* = 525)	
Yes	6.7
No	93.3
Any adjuvant therapy (*N* = 525)	
Yes	64.8
No	35.2
Ostomy appliance (*N* = 525)	
Yes	11.8
No	88.2
Recurrence (*N* = 525)	
Yes	37.9
No	62.1
Current status (*N* = 525)	
Cancer-free	89.5
Still has bladder cancer	10.5

fatigue, we used similar analyses (ANOVA and analysis of covariance followed by *t* tests) for each of the seven fatigue variables (i.e., most, least, average, current, interference, days spent fatigued, and time fatigued). Covariates for the analysis of covariance were demographic and medical variables that had significant associations with any of the fatigue indicators.

We tested several demographic and medical variables as potential moderators of the associations between exercise and QoL/fatigue. For these analyses, we conducted ANOVA with age (<65 versus ≥65 years), sex, body mass index (nonobese versus obese), presence of an ostomy appliance, tumor invasiveness (superficial versus invasive), adjuvant therapy (yes versus no), and current cancer status as potential moderators. We used a strategy similar to the main effects analysis by first testing the FACT-Bl as the dependent measure followed by the FACT-G and the TOI and finally the subscales. For fatigue, all seven fatigue dimensions were tested. These analyses were repeated using ANCOVA with the same covariates as the main-effects analyses.

Results

A detailed report of the flow of participants through the study is presented elsewhere (17). Briefly, we received a total of 525 completed questionnaires from the 1,287 bladder cancer survivors who were mailed the baseline questionnaire. Based on the subtraction of 200 surveys that were returned unopened and 60 that were ineligible or could not respond, we estimate our response rate to be 51% (525 of 1,027; ref. 25). Demographic and medical variables of the participants are displayed in Tables 1 and 2. Descriptive statistics of exercise, QoL, and fatigue variables are displayed in Table 3.

Exercise Behavior across the Three Cancer-Related Time Periods. Based on the entire sample (n = 525), dependent t tests showed that exercise levels for moderate and strenuous exercise were significantly higher pre-diagnosis (mean, 89.6 min/wk) compared with the past month (mean, 74.5 min/wk; $P < 0.001$). For those who had received adjuvant treatment (n = 340), results of the one-way repeated-measures ANOVA found a significant effect for time [Wilks' Lambda = 0.86, $F_{(2,338)} = 27.96$, $P = 0.001$]. Follow-up dependent t tests showed that exercise levels dropped significantly ($P < 0.001$) from pre-diagnosis (mean, 80.3 min/wk) to during treatment (mean, 42.2 min/wk) and then increased significantly ($P < 0.001$) from during treatment to the past month (mean, 68.5 min/wk) but did not return to pre-diagnosis levels ($P < 0.001$).

Exercise Patterns across the Cancer Experience. We categorized participants into eight exercise patterns based on their exercise participation during each of the time points of the cancer trajectory (i.e., pre-diagnosis, treatment, and past month; Table 4). At each time point, participants were identified as ''active'' (i.e., meeting public health exercise guidelines) or ''inactive'' (not meeting public health exercise

Table 3. Exercise behavior and quality of life in bladder cancer survivors (*N* = 525)

Variable	Mean ± SD
Weekly exercise Pre-diagnosis (*N* = 525)	
Mild minutes	165.5 ± 288.5
Moderate minutes	64.5 ± 110.2
Strenuous minutes	25.1 ± 77.7
Strenuous plus moderate minutes	89.6 ± 145.7
% Meeting public health guidelines	27.8
Weekly exercise during adjuvant treatment (*n* = 340)	
Mild minutes	122.2 ± 221.3
Moderate minutes	32.7 ± 83.6
Strenuous minutes	9.4 ± 51.3
Strenuous plus moderate minutes	42.2 ± 101.8
% Meeting public health guidelines	17.4
Weekly exercise in the past month (*N* = 525)	
Mild minutes	162.7 ± 282.3
Moderate minutes	56.1 ± 108.6
Strenuous minutes	18.5 ± 68.4
Strenuous plus moderate minutes	74.5 ± 133.4
% Meeting public health guidelines	22.3
QoL (*N* = 525)	
FACT-Bl (0-152)	123.6 ± 19.2
FACT-G (0-108)	88.2 ± 14.5
TOI (0-104)	82.9 ± 14.2
PWB (0-28)	25.4 ± 4.1
FWB (0-28)	22.0 ± 5.9
EWB (0-24)	21.0 ± 3.6
SWB (0-28)	19.7 ± 5.2
Additional concerns (0-48)	35.5 ± 7.1
Urinary function (0-12)	9.7 ± 2.8
Bowel function (0-8)	6.9 ± 1.6
Sexual interest (0-4)	1.8 ± 1.4
Erectile dysfunction, *n* = 392 (0-4)	1.4 ± 1.4
Body image (0-4)	2.5 ± 1.2
Fatigue (*N* = 525)	
Most fatigue (0-10)	4.0 ± 2.8
Least fatigue (0-10)	2.0 ± 2.1
Average fatigue (0-10)	2.9 ± 2.4
Fatigue now (0-10)	2.4 ± 2.6
No. days (0-7)	2.8 ± 2.4
Time fatigued per day (0-10)	2.6 ± 2.5
Interference scale (0-10)	1.7 ± 2.0

Table 4. Exercise patterns of bladder cancer survivors across the cancer experience (*n* = 340)

Exercise pattern	Major cancer-related time points			*n* (%)
	Before	During	After	
1. Maintainers	Active	Active	Active	42 (12)
2.	Active	Active	Inactive	7 (2)
3. Temporary relapsers	Active	Inactive	Active	15 (4)
4. Permanent relapsers	Active	Inactive	Inactive	30 (9)
5.	Inactive	Active	Active	10 (3)
6.	Inactive	Active	Inactive	0 (0)
7.	Inactive	Inactive	Active	6 (2)
8. Nonexercisers	Inactive	Inactive	Inactive	230 (68)
Total				340 (100)

guidelines). Based on this criterion, we found that 93% of participants fell into four exercise patterns: (*a*) Maintainers (active at all three time points; 12%), (*b*) Temporary Relapsers (active at pre-diagnosis, inactive during treatment, active in the past month; 4%), (*c*) Permanent Relapsers (active at pre-diagnosis, inactive during treatment and during the past month; 9%), and (*d*) Nonexercisers (inactive at all three time points; 68%).

QoL Differences Based on Exercise Behavior. The ANOVA for the FACT-Bl [$F_{(2,522)} = 7.5$, $P = 0.001$], FACT-G [$F_{(2,522)} = 6.2$, $P = 0.002$], TOI [$F_{(2,522)} = 8.9$, $P < 0.001$], PWB [$F_{(2,522)} = 6.3$, $P = 0.002$], FWB [$F_{(2,522)} = 7.4$, $P = 0.001$], additional concerns [$F_{(2,522)} = 5.6$, $P = 0.004$], sexual interest [$F_{(2,522)} = 12.1$, $P < 0.001$], body image [$F_{(2,522)} = 12.3$, $P < 0.001$], and erectile function [$F_{(2,389)} = 6.3$, $P = 0.002$] were statistically significant. In the follow-up independent *t* tests, we found significantly higher scores for the meeting guidelines group compared with the completely sedentary group on FACT-Bl ($P < 0.001$, $d = 0.40$), FACT-G ($P = 0.001$, $d = 0.35$), TOI ($P < 0.001$, $d = 0.44$), FWB ($P < 0.001$, $d = 0.41$), additional concerns ($P = 0.001$, $d = 0.36$), PWB ($P = 0.009$, $d = 0.29$), sexual interest ($P < 0.001$, $d = 0.54$), erectile dysfunction ($P < 0.001$, $d = 0.44$), and body image ($P < 0.001$, $d = 0.44$; Table 5). Additionally, the insufficiently active group reported significantly higher scores than the completely sedentary group on FACT-Bl ($P = 0.046$, $d = 0.26$), FACT-G ($P = 0.043$, $d = 0.26$), TOI ($P = 0.024$, $d = 0.31$), PWB ($P = 0.004$, $d = 0.43$), and sexual interest ($P = 0.013$, $d = 0.31$; Table 5). After covarying for prognostic factors for QoL (i.e., current cancer status, presence of an ostomy appliance, tumor invasiveness, and age), most of the associations between exercise and QoL were reduced, although the comparisons between the meeting guidelines group and the completely sedentary group remained meaningful and statistically significant, whereas the comparisons between the insufficiently active and completely sedentary group became trivial and statistically nonsignificant (Table 5).

Differences in Fatigue Based on Exercise Level. The ANOVA for least fatigue [$F_{(2,522)} = 4.5$, $P = 0.012$], current fatigue [$F_{(2,522)} = 3.8$, $P = 0.023$], average fatigue [$F_{(2,522)} = 4.0$, $P = 0.019$], average amount of time fatigued [$F_{(2,522)} = 3.7$, $P = 0.025$], and fatigue interference [$F_{(2,522)} = 3.0$, $P = 0.049$] were statistically significant. In the follow-up independent *t* tests, the meeting guidelines group reported significantly lower scores compared with the completely sedentary group for least fatigue ($P = 0.003$, $d = 0.35$), average fatigue ($P = 0.014$, $d = 0.27$), current fatigue ($P = 0.009$, $d = 0.28$), average amount of time fatigued ($P = 0.010$, $d = 0.30$), and fatigue interference ($P = 0.017$, $d = 0.26$; Table 6). Additionally, the meeting guidelines group reported significantly lower scores compared with the insufficiently active group on most fatigue ($P = 0.027$, $d = 0.33$), average fatigue ($P = 0.012$, $d = 0.36$), and current fatigue ($P = 0.026$, $d = 0.33$; Table 6). After controlling for prognostic factors for fatigue (i.e., body mass index, current cancer status, presence of an ostomy appliance, degree of invasiveness, and age), most of the associations were reduced, but they remained meaningful and statistically significant (Table 6).

Moderators of the Associations between Exercise and QoL/Fatigue. There were no significant interactions between exercise category and any of the demographic or medical variables. Adjusting for current cancer status, presence of an ostomy appliance, tumor invasiveness, and age did not alter these results.

Table 5. Differences in quality of life in bladder cancer survivors based on exercise category in the past month

QoL variable	CS (*n* = 324), mean ± SD	IA (*n* = 86), mean ± SD	MG (*n* = 115), mean ± SD	Between-group comparisons: mean difference (95% CI), *P*		
				IA vs CS	MG vs IA	MG vs CS
FACT-Bl (0-152)	121.2 ± 20.4	125.8 ± 15.2	128.8 ± 17.5	4.6 (0.1, 9.1), 0.046	3.0 (−2.3, 8.3), 0.266	7.6 (3.6, 11.7), <001
Adjusted	121.7	124.8	128.2	3.1 (−1.4, 7.6), 0.178	3.4 (−1.7, 8.6), 0.193	6.5 (2.5, 10.5), 0.001
FACT-G (0-108)	86.5 ± 15.1	90.0 ± 11.9	91.6 ± 13.7	3.5 (0.1, 6.9), 0.043	1.6 (−2.5, 5.6), 0.447	5.1 (2.0, 8.1), 001
Adjusted	86.7	89.4	91.3	2.7 (−0.7, 6.1), 0.115	1.9 (−2.0, 5.7), 0.352	4.6 (1.5, 7.6), 0.003
TOI (0-104)	81.0 ± 15.3	84.8 ± 11.0	87.0 ± 12.3	3.9 (0.5, 7.2), 0.024	2.2 (−1.7, 6.1), 0.269	6.1 (3.1, 9.1), <001
Adjusted	81.4	83.9	86.4	2.4 (−0.9, 5.7), 0.150	2.5 (−1.3, 6.4), 0.192	5.0 (2.0, 7.9), 0.001
PWB (0-28)	25.0 ± 4.6	26.4 ± 2.4	26.1 ± 3.8	1.5 (0.5, 2.4), 0.004	−0.3 (−1.4, 0.9), 0.626	1.2 (0.3, 2.0), 0.009
Adjusted	25.0	26.2	26.0	1.2 (0.3, 2.2), 0.011	0.2 (−0.9, 1.3), 0.712	1.0 (0.2, 1.9), 0.018
FWB (0-28)	21.3 ± 6.3	22.6 ± 5.3	23.6 ± 4.9	1.3 (−0.1, 2.7), 0.065	1.0 (−0.6, 2.7), 0.214	2.3 (1.1, 3.6), <0.001
Adjusted	21.5	22.3	23.4	0.8 (−0.6, 2.2), 0.247	1.2 (−0.4, 2.8), 0.155	2.0 (0.7, 3.2), 0.002
EWB (0-24)	20.9 ± 3.8	20.9 ± 3.5	21.5 ± 3.1	0.0 (−0.8, 0.9), 0.939	0.6 (−0.3, 1.5), 0.213	0.6 (−0.2, 1.4), 134
Adjusted	20.9	21.0	21.4	0.1 (−0.7, 1.0), 0.742	0.3 (−0.6, 1.3), 0.499	0.5 (−0.3, 1.2), 0.214
SWB (0-28)	19.3 ± 5.4	19.9 ± 4.5	20.5 ± 4.9	0.6 (−0.6, 1.8), 0.352	0.5 (−0.9, 2.0), 0.471	1.1 (0.0, 2.2), 0.047
Adjusted	19.4	19.9	20.4	0.5 (−0.7, 1.8), 0.423	0.6 (−0.9, 2.0), 0.446	1.1 (−0.0, 2.3), 0.060
Additional concerns (0-48)	34.7 ± 7.3	35.8 ± 6.4	37.3 ± 7.1	1.1 (−0.6, 2.8), 0.206	1.5 (−0.5, 3.4), 0.148	2.6 (1.0, 4.1), 0.001
Adjusted	35.0	35.3	37.0	0.4 (−1.3, 2.1), 0.667	1.6 (−0.4, 3.5), 0.110	2.0 (0.5, 3.5), 0.011
Urinary (0-12)	9.6 ± 2.4	9.4 ± 2.4	9.8 ± 1.9	−0.2 (−0.7, 0.4), 0.541	0.4 (−0.2, 1.1), 0.199	0.3 (−0.2, 0.7), 0.315
Adjusted	9.6	9.4	9.8	−0.2 (−0.8, 0.3), 0.461	0.4 (−0.2, 1.1), 0.190	0.2 (−0.3, 0.8), 0.383
Bowel (0-8)	6.9 ± 1.5	6.9 ± 1.5	7.0 ± 1.5	0.0 (−0.3, 0.4), 0.918	0.1 (−0.4, 0.5), 0.799	0.1 (−0.3, 0.4), 0.653
Adjusted	6.9	6.9	7.0	0.0 (−0.3, 0.4), 0.884	0.1 (−0.4, 0.5), 0.761	0.0 (−0.3, 0.4), 0.817
Sex interest (0-4)	1.6 ± 1.3	2.0 ± 1.3	2.2 ± 1.3	0.4 (0.1, 0.7), 0.013	0.3 (−0.1, 0.7), 0.143	0.7 (0.4, 1.0), <0.001
Adjusted	1.6	1.8	2.1	0.2 (−0.1, 0.5), 0.289	0.3 (0.0, 0.7), 0.071	0.5 (0.2, 0.8), <0.001
Erectile dysfunction (0-4)	1.2 ± 1.3	1.4 ± 1.4	1.8 ± 1.4	0.2 (−0.2, 0.6), 0.250	0.4 (−0.1, 0.8), 0.088	0.6 (0.3, 0.9), <0.001
Adjusted	1.3	1.2	1.7	−0.1 (−0.4, 0.2), 0.583	0.5 (0.1, 0.9), 0.010	0.4 (0.1, 0.7), 0.006
Body image (0-4)	2.3 ± 1.3	2.6 ± 1.1	2.8 ± 0.9	0.3 (0.0, 0.5), 0.036	0.3 (−0.1, 0.6), 0.124	0.5 (0.3, 0.8), <0.001
Adjusted	2.3	2.6	2.8	0.3 (0.0, 0.6), 0.036	0.3 (−0.1, 0.6), 0.122	0.6 (0.3, 0.8), <0.001

Abbreviations: 95% CI, 95% confidence interval; CS, completely sedentary; IA, insufficiently active; MG, meeting guidelines.

Table 6. Fatigue differences in bladder cancer survivors based on exercise category in the past month

Fatigue variable	CS (n = 324), mean ± SD	IA (n = 84), mean ± SD	MG (n = 117), mean ± SD	Between-group comparisons: mean difference (95% CI), P		
				IA vs CS	MG vs IA	MG vs CS
Most fatigue (0-10)	4.0 ± 2.9	4.5 ± 2.7	3.6 ± 2.7	0.5 (−0.2, 1.1), 0.163	−0.9 (−1.7, −0.1), 0.027	−0.4 (−1.0, 0.2), 0.180
Adjusted	4.0	4.5	3.6	0.5 (−0.2, 1.2), 0.157	−0.9 (−1.7, −0.1), 0.021	−0.4 (−1.0, 0.2), 0.165
Least fatigue (0-10)	2.2 ± 2.2	2.0 ± 2.0	1.5 ± 1.8	−0.3 (−0.8, 0.3), 0.309	−0.4 (−1.0, 0.2), 0.163	−0.7 (−1.1, −0.2), 0.003
Adjusted	2.1	2.1	1.6	0.0 (−0.5, 0.5), 0.850	−0.5 (−1.0, 0.1), 0.125	−0.5 (−0.9, −0.1), 0.029
Average fatigue (0-10)	3.0 ± 2.4	3.2 ± 2.3	2.4 ± 2.1	0.2 (−0.3, 0.8), 0.442	−0.8 (−1.5, −0.2), 0.012	−0.6 (−1.1, −0.1), 0.014
Adjusted	3.0	3.3	2.5	0.4 (−0.2, 0.9), 0.201	−0.9 (−1.5, −0.2), 0.008	−0.5 (−1.0, 0.0), 0.047
Fatigue now (0-10)	2.6 ± 2.7	2.7 ± 2.5	1.9 ± 2.3	0.1 (−0.5, 0.7), 0.775	−0.8 (−1.5, −0.1), 0.026	−0.7 (−1.3, −0.2), 0.009
Adjusted	2.5	2.8	1.9	0.2 (−0.4, 0.8), 0.502	−0.9 (−1.6, −0.1), 0.018	−0.7 (−1.2, −0.1), 0.022
Days fatigued (0-7)	2.9 ± 2.5	2.7 ± 2.1	2.5 ± 2.3	−0.3 (−0.8, 0.3), 0.378	−0.2 (−0.9, 0.5), 0.561	−0.5 (−1.0, 0.1), 0.081
Adjusted	2.9	2.7	2.5	−0.1 (−0.7, 0.4), 0.671	−0.2 (−0.9, 0.4), 0.475	−0.4 (−0.9, 0.1), 0.163
Time fatigued/day (0-10)	2.8 ± 2.7	2.4 ± 1.8	2.1 ± 2.0	−0.4 (−1.0, 0.2), 0.155	−0.3 (−1.0, 0.4), 0.446	−0.7 (−1.2, −0.2), 0.010
Adjusted	2.8	2.5	2.2	−0.2 (−0.8, 0.4), 0.406	−0.3 (−1.0, 0.4), 0.350	−0.6 (−1.1, 0.0), 0.033
Interference (0-10)	1.8 ± 2.2	1.5 ± 1.7	1.3 ± 1.7	−0.3 (−0.8, 0.2), 0.252	−0.2 (−0.8, 0.3), 0.398	−0.5 (−0.9, 0.1), 0.017
Adjusted	1.8	1.6	1.3	−0.2 (−0.7, 0.3), 0.422	−0.3 (−0.8, 0.3), 0.305	−0.5 (−0.9, −0.1), 0.027

Discussion

As hypothesized, the exercise prevalence rate in bladder cancer survivors was lower (22%) than the general Alberta adult population ages 55 years and older (34% for men and 29% for women; ref. 26) but was similar to other cancer survivor groups (20-30%; refs. 14-16, 27). We also found that exercise levels decreased from pre-diagnosis to active treatment and then increased from active treatment to the past month, but not back to pre-diagnosis levels. These changes seem to exceed those that would be expected from aging alone. Specifically, the difference of 5.5 percentage points in the number of participants meeting public health exercise guidelines between pre-diagnosis and past month (~6 years on average) is higher than the expected decrease of ~3 percentage points per decade for older adults in the general population (26). When we examined the exercise patterns of bladder cancer survivors, we found that over 90% could be categorized into one of four groups (i.e., maintainers, temporary relapsers, permanent relapsers, and nonexercisers). These findings are consistent with previous studies of colorectal and breast cancer survivors (28, 29). In the present study, the majority of participants (68%) were nonexercisers, indicating that many participants had a long history of inactivity. Because physical inactivity is related to other poor lifestyle choices, such as smoking and unhealthy dietary habits (30), these factors may have contributed to the onset of bladder cancer in some of these cases. The finding that the majority of bladder cancer survivors are long-time nonexercisers suggests that exercise behavior change interventions are needed in this population but may be challenging.

Also consistent with our hypotheses, we found that that exercise was positively associated with QoL in bladder cancer survivors. The results generally indicated a dose-response relationship between exercise and QoL, with the lowest QoL scores being reported by the completely sedentary group, slightly higher scores in the insufficiently active group, and the highest QoL scores in the meeting guidelines group. Statistically significant and meaningful associations were found with FACT-Bl, FACT-G, TOI, FWB subscale, PWB subscale, additional concern subscale, sexual interest, erectile function, and body image. Even the adjusted differences between the groups seem to be meaningful. The adjusted difference in FACT-G score between the completely sedentary and meeting guidelines groups was 4.6, which exceeds the proposed minimally important difference of 4.0 for this scale (31). Although there are no published minimally important differences for FACT-Bl, the minimally important differences for other FACT scales, such as FACT-B (32) and FACT-C (33), are typically around 7 points. In the present study, the adjusted difference between the completely sedentary and meeting guidelines groups on scores on FACT-Bl was 6.5, suggesting that survivors meeting public health exercise guidelines may perceive a meaningfully better QoL than their completely sedentary counterparts.

Findings from our study are consistent with those in other cancer survivor groups that indicate exercise is positively associated with QoL (12-16). Specifically, data from the present study suggest that exercise is associated primarily with the physical and functional aspects of QoL, rather than the social and emotional dimensions. This finding is also consistent with other studies of cancer survivors, suggesting that exercise may have the most benefits for cancer survivors in the physical and functional domains of QoL (12, 13). Mechanisms through which exercise may influence physical and functional QoL in bladder cancer survivors include improved aerobic fitness, muscular strength, range of motion, balance, body composition, and comorbidity profile. This finding is important because it suggests that exercise may have similar associations with QoL in bladder cancer survivors as it does in other cancer groups.

The present study also found that exercise was positively associated with sexual interest in men and women and erectile function in men. This finding is of particular interest because sexual dysfunction is one of the main QoL issues surrounding bladder cancer (6). The results of the present study are consistent with one recent study that reported a positive association between exercise and sexual function in prostate cancer survivors (34). Moreover, in the general population, exercise has been found to improve sexual function in both men and women (35, 36). Explanations for this association may include physiologic mechanisms, such as increased blood flow and circulating testosterone levels, and social-cognitive factors, such as improved self-efficacy, mood states, and better self-esteem.

Exercise was also found to be positively associated with body image in the present study. This finding is consistent with studies of breast cancer survivors and healthy populations of men (37) and women (38). The mechanisms for this effect may be through improvements in stamina, strength, agility, and body composition (39, 40). Unique to bladder cancer, urinary and sexual dysfunction may also mediate body image disturbance by causing negative changes in sexual body image, identity, and body dissatisfaction from treatment-related side effects like scarring and urinary diversion. By improving sexual function, exercise may also improve body image.

We also found exercise to be negatively associated with several aspects of fatigue, a finding that is consistent with other studies of cancer survivors (10, 11). Previous studies, however, have used only unidimensional fatigue measures,

such as the FACT-Fatigue (14), European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core Module (41), and Profile of Mood States (42), which precludes any determination of what aspects of fatigue might be most related to exercise. To our knowledge, our study is the first in cancer survivors to examine exercise and multidimensional fatigue. Interestingly, we found exercise to be significantly associated with decreased levels of least, average, and current fatigue; average amount of time per day spent fatigued; and fatigue interference but not most fatigue or number of days spent fatigued. In terms of intensity of fatigue, these findings suggest that exercise may be beneficial for improving lower to moderate levels of fatigue but may not have utility for improving the most intense fatigue. In terms of duration, exercise may reduce the amount of fatigue experienced in a given day but not the number of days fatigued. Randomized controlled trials are needed to verify these observations.

In the present study, we also found no demographic or medical moderators of the associations between exercise and QoL. This finding is important because it suggests that exercise is associated with QoL in bladder cancer survivors regardless of sex, body mass index, age, presence of an ostomy appliance, tumor invasiveness, adjuvant therapy, or current cancer status.

Our study has important strengths and limitations. To the best of our knowledge, our study is the first to examine exercise issues in bladder cancer survivors and the first exercise study to use a multidimensional measure of fatigue in cancer survivors. Moreover, we obtained a large sample of bladder cancer survivors that were representative of the population of bladder cancer survivors in Alberta, Canada. The main limitation of our study is the cross-sectional design that does not allow us to conclude the causal role of exercise in QoL. From this study, we cannot know with certainty if exercise improves QoL, or if participants with higher levels of QoL are more likely to exercise. Another important limitation is the self-report exercise measure, which may have resulted in an overreporting of exercise. Nevertheless, our study provides important preliminary data suggesting that randomized controlled trials of exercise and QoL in bladder cancer survivors are warranted.

In conclusion, the present study examined exercise prevalence rates and the associations between exercise and QoL in a population-based sample of 525 bladder cancer survivors. We found that only 22% of bladder cancer survivors reported meeting public health exercise guidelines, a percentage considerably lower than the general population. We also found significant associations between exercise and multiple QoL indicators that are important to bladder cancer survivors. The associations held for men and women, obese and nonobese, and young and old regardless of the presence of an ostomy appliance, tumor invasiveness, adjuvant therapy, or current cancer status. Findings from our study provide a rationale for randomized controlled trials of exercise in bladder cancer survivors to determine the causal effects of exercise on QoL and health in this population. These findings, if validated, may warrant efforts to promote exercise for this important, but understudied, cancer survivor group.

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