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Cancer Epidemiology, Biomarkers & Prevention

Research Article

Prospective Examination of Objectively Assessed Physical Activity and Sedentary Time after Breast Cancer Treatment: *Sitting* on the Crest of the Teachable Moment

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Abstract

Background: This study prospectively examined patterns of objectively assessed sedentary time and moderate-to-vigorous physical activity (MVPA) during a 1-year period following completion of primary treatment among breast cancer survivors. The potential moderating effect of weight status on sedentary and MVPA time was also examined.

Methods: Breast cancer survivors [$n = 177$; $M(SD)_{age} = 54.9$ (11.1) years, 85% White/Caucasian; 82% stage I or II cancer; $M(SD)_{time\ since\ treatment} = 3.5$ (2.4) months] who were recruited into a convenience sample had weight, height, and waist circumference measured and wore Actigraph GT3X accelerometers for 1 week every 3 months for 1 year. Data were analyzed using repeated measures ANOVA.

Results: Survivors spent nearly 78% of their day sedentary across all time points compared with less than 2% of their day engaged in MVPA. Sedentary time remained fairly stable over 12 months, whereas MVPA levels significantly decreased. Survivors with an overweight body mass index and unhealthy waist-to-height ratio engaged in significantly less MVPA than healthy weight survivors, with significant waist-to-height ratio moderator effects for both sedentary and MVPA.

Conclusions: Sedentary time remains high in the first year following treatment for breast cancer, and MVPA decreases. These trends are more pronounced for survivors who are overweight, with stronger effects noted when waist-to-height ratio was examined compared with body mass index.

Impact: These findings suggest that breast cancer survivors may be doing very little to improve their lifestyle behaviors following a cancer diagnosis and treatments. *Cancer Epidemiol Biomarkers Prev; 23(7); 1324–30. ©2014 AACR.*

Introduction

Breast cancer survivors who are physically active at moderate-to-vigorous (MVPA) intensity during and after their cancer treatment(s) are less likely to have a cancer recurrence, less likely to die from their cancer, and more likely to live longer than survivors who are not physically active (1, 2). However, current estimates suggest that anywhere from 50% to 80% of breast cancer survivors are not meeting physical activity guidelines (i.e., 150 minutes of MVPA per week; ref. 3). These estimates are likely underestimated given the reliance on self-report assessments of MVPA. Only one study to date has used objective monitoring devices such as accelerometers to more accurately estimate MVPA among breast cancer survivors (4). Using a heterogeneous sample of breast cancer survivors drawn from the National Health and Nutrition Examination Survey (2003–2004 and 2005–2006), Lynch and colleagues (4) reported that survivors spent only 1.1% of their days in MVPA (i.e., ~4 minutes).

Similar to findings among non-cancer survivors (5), sedentary behavior may represent a health risk distinct from the physical and psychosocial burden associated with low levels of MVPA. Researchers have proposed a new cancer survivorship research agenda examining sedentary behavior across the cancer context (6). Sedentary behavior is defined as any waking behavior characterized by a low energy expenditure (i.e., ≤1.5 resting metabolic equivalents) while in a sitting or reclining posture (7). Little is known about objectively assessed sedentary time among breast cancer survivors, other than minimal descriptive data showing survivors spent an average of 66% (i.e., ~9 hours) of their day in sedentary pursuits (4). Nonetheless, self-reported sedentary time has been associated with markers of adiposity, comorbidities, and psychosocial health outcomes among colorectal cancer survivors and breast cancer survivors (6, 8). Objective assessments are

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needed to gain a better understanding of sedentary behaviors and related predictors and outcomes.

Breast cancer survivors' weight status may moderate their sedentary and MVPA time. Evidence has suggested that overweight survivors engage in more sedentary time (9) and less MVPA (10). Weight status is often assessed using body mass index (BMI), which is a generalized measure providing an index of overall body size and composition. However, alternative measures that assess central adiposity, such as waist circumference, waist-hip ratio, and waist-to-height ratio (WHtR), may be more distinguishing weight status markers for health compared with BMI (11). For example, WHtR was found to be a superior predictor of cardiometabolic risk in a large systematic review and meta-analysis compared with BMI and waist circumference (11). Few studies include both generalized and central indicators of weight status among cancer survivors and explore the unique associations with health behavior outcomes. Understanding how weight status interacts with lifestyle behaviors over time would help identify key times in the cancer trajectory when intervention efforts are likely needed. To date, no study has collected objectively assessed lifestyle behavior and weight status data at multiple time points posttreatment for breast cancer.

It has been suggested that the period immediately following primary treatment is a transient phase that may be critical for behavior modification interventions (12, 13). Therefore, it is important to understand, more precisely, survivors' lifestyle behaviors in the early posttreatment period. The primary objective of this study was to prospectively examine patterns of objectively assessed sedentary and MVPA time at 3-month intervals during a 1-year period following completion of primary treatment. The secondary objective of this study was to determine the moderating effect of weight status (BMI and WHtR) on objectively assessed sedentary behavior and MVPA.

Materials and Methods

Patients and setting

Stage I to III breast cancer survivors who had completed primary treatment in Montreal, Quebec, Canada were recruited ($n = 199$) to participate in an ongoing longitudinal study investigating the natural developmental changes in lifestyle behaviors. Survivors were recruited through advertisements and oncologist referrals from various local medical clinics and hospitals and asked to contact the research team by phone to obtain additional details on the study. Interested survivors were screened for eligibility using the following inclusion criteria: (i) at least 18 years of age; (ii) 0–20 weeks after primary treatment (i.e., surgery, chemotherapy, radiation therapy) for stage 1 to III breast cancer; (iii) had a first cancer diagnosis; (iv) able to provide written informed consent, read and speak in English or French; and (v) report no health concerns that prevent them from engaging in physical activity. The appropriate university and hospital research ethics committees approved the study protocol, and all survivors provided written informed consent before data collection began.

Lifestyle behavior

Lifestyle behaviors (sedentary behaviors and MVPA) were assessed using GT3X accelerometers (Actigraph). Survivors were asked to wear the accelerometer on their hip during waking hours for a 7-day period, except for periods of bathing/showering or other water activities. Survivors' data were downloaded in 60-second epochs, and established cutoff points (14) were used to calculate daily minutes of moderate (1,952–5,724 counts/min) and vigorous (>5,725 counts/min) physical activity while controlling for the number of days the accelerometer was worn. MVPA was a sum score of weekly minutes in MVPA. Sedentary time was analyzed as <100 counts/min, adjusted for non-wear time operationalized as at least 60 minutes of consecutive zeros (15). Data were included in the analyses if there were no extreme counts (>20,000) and if data were available for at least 500 minutes on 4 or more days. The lower limit of wear time compared with established criteria of 600 minutes was consistent with participants' daily diary records for time awake.

Weight status

A trained research assistant measured weight [using Seca model 803 weight scale (Seca) to nearest kilogram (kg)], height [using Seca model 217 stadiometer (Seca) to nearest 0.01 cm], and waist circumference (using Seca model 201 measuring tape to nearest 0.01 cm) on the first laboratory visit. Participants were also taught how to take their own waist measurement (to the nearest 0.01 cm) using a measuring tape and diagram of a torso indicating the location of the measure (i.e., the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest; ref. 16). The World Health Organization STEPwise Approach to Surveillance (STEPS) was used as a guideline for training the measurement of waist circumference. Participants were given a measuring tape and asked to take their own waist circumference (to the nearest 0.01 cm) for each subsequent data collection, along with recording their weight. Stability estimates for weight over time (intraclass correlation coefficients, ICC) were high, indicating little change in weight during the 5 data collections: $ICC_{BMI} = 0.93$, $ICC_{WHtR} = 0.87$.

BMI was calculated as kilograms (kg) divided by height in meters (m) squared. Survivors were categorized at baseline as healthy weight = 18.5–24.9 kg/m^2 or overweight/obese $\geq$ 25.0 kg/m^2. WHtR was calculated as waist circumference (cm) divided by height (cm), and a cutoff of 0.5 was used to differentiate "healthy WHtR" and "unhealthy WHtR" women (11).

Personal and medical characteristics

Personal and cancer-related characteristics were collected via a self-report questionnaire at baseline for descriptive purposes. Personal characteristics included

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age, level of education, household income, marital status, self-identified race/ethnicity using the categories provided by Census Canada and menopausal status. Cancer-related characteristics included stage of breast cancer at diagnosis, treatments received, and dates of diagnosis and treatment completion.

Data analyses

Descriptive statistics (means, SDs) were computed for all study variables. Survivors were classified as meeting MVPA guidelines if they engaged in at least 150 minutes of MVPA, or 75 minutes of vigorous activity, or some combination per week (3, 17). For the main research questions, a repeated-measures analysis of covariance (RM-ANCOVA) was conducted with BMI (healthy weight vs. overweight) or WHtR (healthy vs. unhealthy) as the between-subjects variable, time (baseline, 3-, 6-, 9-, and 12-month) as the within-subjects variable, and values for sedentary and MVPA time as the dependent variables. Covariates in all models included age, education, stage of breast cancer, and time since diagnosis. Significant within-subjects effects indicated differences in sedentary behavior and MVPA mean scores across time points, whereas significant between-subjects interaction effects indicated that patterns of change in these variables differed according to weight status. In significant models, univariate effects were computed to detect the specific significant differences in time and weight status. All statistical analyses were performed using SPSS Version 20.

Results

Descriptive statistics

Overall, 177 survivors provided complete data throughout the study (89% of the total sample). The mean age at baseline was 54.9 (SD = 11.1; range = 28–79) years and the mean BMI was 26.3 (SD = 5.8) kg/m^2, with 51.4% classified as overweight/obese. No survivors were classified as "underweight" (i.e., BMI < 18.5 kg/m^2). Mean waist circumference was 90.3 (15.1) cm. The majority of survivors had an unhealthy WHtR (71.8%), with a mean WHtR of 0.56 (SD = 0.09). Most survivors identified as White/Caucasian (84.7%) and reported being diagnosed with stage I or II breast cancer (81.9%). Treatments received included surgery (60.5% lumpectomy; 42.9% mastectomy), chemotherapy (63.3%), radiotherapy (90.4%), and prescribed hormonal therapy (52.5%). Personal and medical characteristics are presented in Table 1. The 19 women who were excluded from the analysis were not significantly different ($P > 0.05$) than the analytical sample on personal demographic or cancer-specific variables. All 19 women dropped out within the first 3 data collections, with the majority (74%) dropping out after baseline.

Compliance with wearing the accelerometers was excellent (median = 7 days, range = 4–7 days) and wear time ranged from 9.18 to 17.23 hours (551–1034 minutes) per day across all time points (see Table 2).

Table 1. Baseline personal and medical data for 177 posttreatment breast cancer survivors

Demographic and medical data	Descriptive coefficient
Age, mean (SD), y	54.93 (11.1)
Weight status	
BMI (mean, SD)[a]	26.31 (5.8)
Normal weight (%)	48.6
Overweight (%)	51.4
BMI 25–29.99 kg/m^2	31.1
BMI $\geq$ 30 kg/m^2	20.3
WHtR (Mean, SD)	0.56 (0.09)
WHtR > 0.5 (%)	71.8
WC, cm	90.30 (15.06)
WC > 88 (%)	53.8
Race (% White)	84.7
Education level (%)	
<High school	5.6
High school diploma	23.2
College/technical diploma/certificate	18.6
University degree	28.2
Postgraduate degree	24.3
Marital status (%)	
Single	15.3
Married/common-law	62.7
Separated/divorced	16.4
Widowed	5.6
Menopause (%)	
Premenopause	18.1
Perimenopause	18.6
Postmenopause	63.3
Stage of breast cancer (%)	
I	42.4
II	39.5
III	18.1
Type of treatment (%)	
Single mastectomy (yes)	27.1
Double mastectomy (yes)	15.8
Chemotherapy (yes)	63.3
Radiation (yes)	90.4
Lumpectomy (yes)	60.5
Hormonal therapy (yes)	52.5
Months since diagnosis	10.59 (3.41)
Months since treatment (mean, SD)	3.49 (2.36)

Abbreviation: WC, waist circumference.

On the basis of mean minutes per day spent in sedentary and MVPA (see Table 2), survivors were highly sedentary and inactive across all the time points. Nearly 29% of survivors met MVPA guidelines at baseline, compared with 22% at 12 months. Fewer overweight women met guidelines at all time points, regardless of weight status indicator used (data available from first author).

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Table 2. Mean percentage of time and minutes spent in sedentary and MVPA for the total sample ($n = 177$) and by BMI and WHtR weight status groups

	Baseline	3 mo	6 mo	9 mo	12 mo
Wear time (M, SD)[a], min	831.0 (78.22)	830.7 (88.5)	829.9 (90.9)	822.7 (82.9)	825.5 (86.1)
Sedentary					
Total (% M, SD)	78.10 (5.69)	77.85 (5.84)[z]	77.92 (5.81)	78.26 (6.03)	78.60 (5.93)[z]
Total (M, SD), min	647.5 (64.2)	645.4 (74.7)	645.0 (73.2)	641.3 (70.3)	647.3 (71.7)
BMI					
Healthy weight	78.29 (5.69)	77.35 (5.73)[y]	77.27 (6.09)	77.61 (5.99)	78.43 (5.82)[y]
Overweight	77.92 (5.72)[x]	78.30 (5.93)	78.51 (5.52)	78.85 (6.04)[x]	78.76 (6.04)
WHtR					
<0.05	78.37 (5.13)[wv]	76.61 (5.44)[w]	76.35 (5.56)[v]	76.81 (5.70)	77.50 (6.14)
≥0.50	77.99 (5.91)[ut]	78.34 (5.93)	**78.54 (5.82)**	**78.83 (6.09)**[u]	79.04 (5.81)[t]
MVPA					
Total (% M, SD)	1.95 (1.42)[b]	2.01 (1.53)[cd]	1.92 (1.54)[e]	1.82 (1.37)[c]	1.72 (1.38)[bde]
Total (M, SD), min	16.3 (12.1)	16.7 (12.9)	16.0 (13.2)	15.0 (11.4)	14.2 (11.4)
BMI					
Healthy weight	2.15 (1.53)	2.33 (1.65)[f]	2.27 (1.69)[g]	2.15 (1.43)	1.96 (1.40)[fg]
Overweight	1.77 (1.29)[hi]	**1.72 (1.35)**	**1.60 (1.33)**	**1.52 (1.24)**[h]	**1.51 (1.34)**[i]
WHtR					
<0.05	2.13 (1.51)[jk]	2.33 (1.64)[j]	2.23 (1.69)[k]	2.12 (1.42)	1.95 (1.39)
≥0.50	1.77 (1.31)[lmn]	**1.70 (1.36)**[op]	**1.63 (1.34)**[l]	**1.53 (1.26)**[mo]	**1.51 (1.35)**[np]

NOTE: BMI (healthy weight: $n = 86$; overweight: $n = 91$) and WHtR ($n = 50$ healthy, $n = 127$ unhealthy). Rows with bold values identify significant ($P < 0.05$) weight status mean differences within each time point: $t(1{,}176) = 2.03$ to 4.16, $d = 0.33$ to 0.47. Columns with the same alphabet superscript identify significant ($P < 0.05$) time mean differences within the total sample or each weight status category: $t(1{,}176) = 1.97$–3.98, $d = 0.07$–0.20. Effect sizes (d) can be interpreted as: small = 0.2, medium = 0.5, and large = 0.8.
[a]Accelerometer wear time in min/d.

Main analyses

All models are adjusted for baseline age, education, stage of breast cancer, and time since diagnosis. On the basis of the RM-ANCOVA results, sedentary time changed over time [$F(4{,}172) = 2.57$, $P = 0.04$] with significant quadratic effect. The main effect for weight status was not significant [$F_{\text{BMI}}(1{,}176) = 1.02$, $P = 0.31$) and $F_{\text{WHrT}}(1{,}176) = 2.42$, $P = 0.12$]. The time × BMI interaction was not significant [$F_{\text{BMI}}(1{,}176) = 1.38$, $P = 0.23$]. The time × WHtR interaction was significant [$F_{\text{WHrT}}(1{,}176) = 2.56$, $P = 0.04$; see Fig. 1]. Survivors with healthy WHtR engaged in significantly ($P < 0.05$) less sedentary time at 6 and 9 months compared with survivors with unhealthy WHtR.

MVPA significantly decreased over time [$F(4{,}172) = 3.17$, $P = 0.01$]. The main effect for weight status was significant regardless of indicator [$F_{\text{BMI}}(1{,}176) = 5.57$, $P = 0.02$) and $F_{\text{WHrT}}(1{,}176) = 6.66$, $P = 0.01$]. Survivors with healthy BMI or WHtR spent significantly more time in MVPA than overweight or unhealthy BCS at all time points except baseline. The time × BMI interaction was not significant ($P = 0.30$). The time × WHtR interaction was significant [$F(1{,}176) = 3.67$, $P = 0.05$) with evidence of quadratic effects (see Fig. 2). Specific univariate contrasts (see Table 2) suggest that breast cancer survivors with healthy WHtR engaged in greater MVPA at 3, 6, 9, and 12 months than survivors with unhealthy WHtR.

As a sensitivity analysis, all models were also examined using waist circumference as the moderating variable. Waist circumference was dichotomized at 88 cm given the recommendation for this cutoff point as indicative of heightened health risks for adult women (16). The models were consistent with the results using WHtR, the other central adiposity measure.

Discussion

Studies of change in sedentary time and MVPA post-treatment among cancer survivors are scarce and have typically used self-report measures and few time points (18–21). This study of a convenience sample of breast cancer survivors was designed to expand on the current knowledge using objective measures of lifestyle behaviors, coupled with 5 waves of data collected over the first year following the completion of systemic cancer treatments.

On the basis of the current findings, sedentary time remained high and stable in the first year following treatment for breast cancer. The percentage of time spent being sedentary was comparable to the only other known study to report on sedentary behavior among breast

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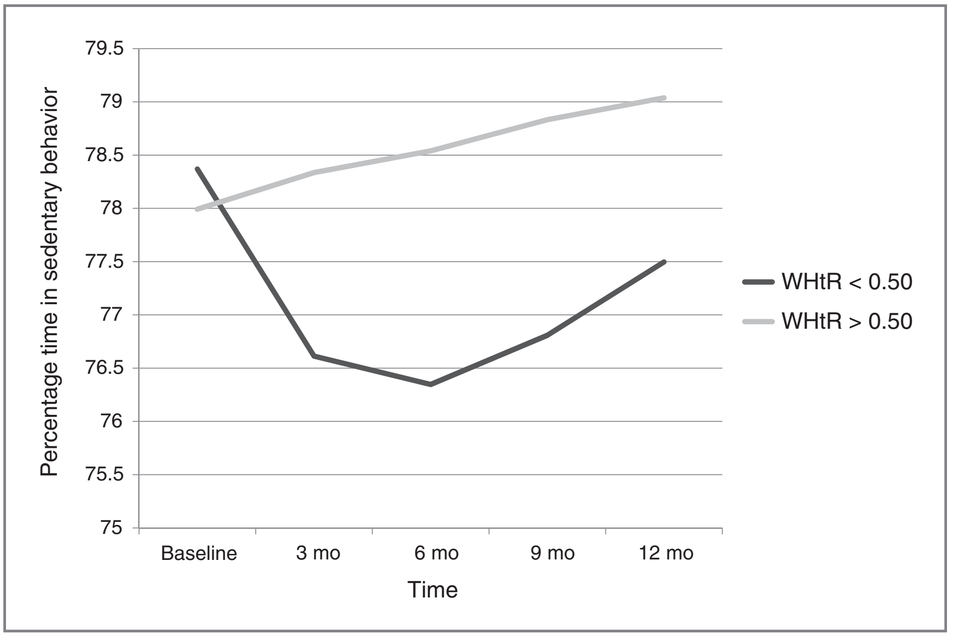

Figure 1. Time × WHtR interaction for percentage of time per day spent sedentary over time among 177 breast cancer survivors who have healthy (<0.50) and unhealthy (≥0.50) WHtR.

cancer survivors (4) and higher to estimates of adult women without a cancer diagnosis (22). Also, this is the first study to report that objectively assessed sedentary time may change in the early posttreatment period, with an apparent differential trend in sedentary time for healthy and overweight women. Specifically, healthy weight women based on WHtR decreased their sedentary time early in the posttreatment period, whereas women with unhealthy weight increased their sedentary time. Women with high BMI or WHtR had between 1% and 2% increase in sedentary behavior, which amounts to nearly 10 min/d and may have clinical relevance for 2 reasons. First, the emerging evidence pointing to the various health risks associated with sedentary behavior (4–9) suggests that limiting sedentary behavior it important, yet we are seeing the opposite trend in our sample. Second, we know very little about sedentary behavior characteristics (i.e., bouts, length of time, breaks) among

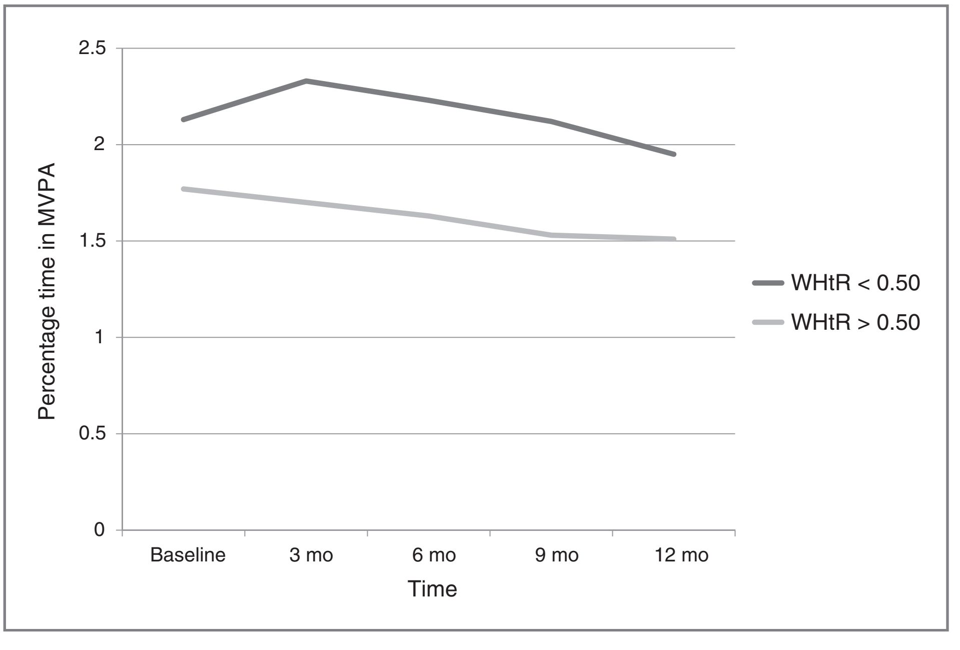

Figure 2. Time × WHtR interaction for percentage of time per day spent in MVPA over time among 177 breast cancer survivors who have healthy (<0.50) and unhealthy (≥0.50) WHtR.

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breast cancer survivors. Drawing on the physical activity literature, bouts as small as 5 to 10 minutes produce significant health benefit (23, 24). More research is needed to understand the clinical relevance of specific bout lengths of sedentary time. While there are dose responses showing that quartiles of increasing sedentary time are associated with health challenges and breast cancer mortality (9), more research is needed to understand clinically meaningful cutoff points of sedentary behavior and associated health risks. Nonetheless, given the findings of this study, survivors with high WHtR are likely a high-risk target group for interventions aimed at reducing sedentary time.

Consistent with prior research (19, 20), the current findings show that breast cancer survivors' MVPA levels are low during the early posttreatment period. They also showed significant decreases over time, and these trends are more pronounced for survivors who are overweight, especially when WHtR was examined compared with BMI. Overall, women decreased their MVPA by over 2 min/d in 12 months of the early posttreatment period. This decrease shows a trend that is opposite to what we would like to see given the known benefits of increasing MVPA following a breast cancer diagnosis (1–3, 10), even if done in bouts as little as 5 to 10 minutes in length (23, 24). More research is needed to better understand the health implications of various shorter bouts, in addition to different intensities, of physical activity among breast cancer survivors. Nonetheless, Lynch and colleagues (4) reported similar percentage of time spent in MVPA (<2%) in a cross-sectional study and reported that women with higher weight status engaged in less MVPA. In one other study of combined cancer tumor groups with a moderate (43%) proportion of female breast cancer survivors, overweight survivors were significantly less active than their healthy weight counterparts (25). Taken together, these findings raise concerns that breast cancer survivors, in particular those who are overweight, are doing very little to improve their health-enhancing physical activity following a cancer diagnosis and related treatments. On the basis of these findings, it is important to focus on understanding why objectively assessed MVPA levels are low and remain low in the early period following breast cancer treatment. While it may be that survivors' motivation and interest to improve lifestyle behaviors may increase in the aftermath of breast cancer (26), there may be barriers that restrict women's ability to make the desired changes. For example, weight status is a potential barrier to improving lifestyle behaviors (decreasing sedentary and increasing MVPA time) in this sample. Moreover, intervention research aimed at developing and evaluating interventions to improve MVPA are clearly needed given the well-documented health benefits for breast cancer survivors (3). A descriptive exploration of the current data may suggest critical times for intervention include the 3- to 9-month posttreatment period. Clinicians may choose to address MVPA with their patients at this critical time.

There are limitations worth noting. The convenience sample of breast cancer survivors may limit generalizability of the findings given women were predominantly White/Caucasian, well-educated, and presented with stage I or II breast cancer. However, their personal and cancer descriptive data suggest that the sample is similar to population health reports (27). Another limitation is that accelerometers do not capture accurate workload pertaining to certain activities (e.g., stationary biking, swimming, weight training). However, objective assessment of sedentary and MVPA time provides unbiased estimates compared with self-report measures. A final limitation was that hip circumference was not measured, precluding assessments of waist-to-hip ratio as a central adiposity indicator. Despite these limitations, the current study improves on past studies. The prospective design with multiple waves of data collections at short intervals enables the identification of critical timing for natural change in sedentary and physical activity behavior. The focus on early posttreatment breast cancer survivors captures a sample that is often overlooked in research and practice.

In conclusion, the current data suggest that breast cancer survivors are "sitting" on the crest of a teachable moment (12) and may dispel the belief that health events (i.e., breast cancer diagnosis and treatment) lead to changes in sedentary time and MVPA. It is critical to develop intervention strategies to address these barriers to both reduce sedentary time and increase health-enhancing physical activity. Doing so during the early posttreatment period may be an ideal time, as it could help set lifestyle behaviors and habits for the long survivorship phase.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

Authors' Contributions

Conception and design: C.M. Sabiston, J. Brunet, S. Meterissian
Development of methodology: C.M. Sabiston, J.K. Vallance
Acquisition of data (provided animals, acquired and managed patients, provided facilities, etc.): C.M. Sabiston, J. Brunet
Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis): C.M. Sabiston, J.K. Vallance
Writing, review, and or revision of the manuscript: C.M. Sabiston, J. Brunet, J.K. Vallance, S. Meterissian
Administrative, technical, or material support (i.e., reporting or organizing data, constructing databases): C.M. Sabiston, S. Meterissian
Study supervision: C.M. Sabiston

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References

1. Holmes MD, Chen WY, Feskanich D, Kroenke CH, Colditz GA. Physical activity and survival after breast cancer diagnosis. JAMA 2005;293:2479–86.
2. Ogunleye A, Holmes MD. Physical activity and breast cancer survival. Breast Cancer Res 2009;11:106.
3. Schmitz KH, Courneya KS, Matthews C, Demark-Wahnefried W, Galvão DA, Pinto BM , et al. American College of Sports Medicine roundtable on exercise guidelines for cancer survivors. Med Sci Sports Exerc 2010;42:1409–26.
4. Lynch BM, Dunstan DW, Healy GN, Winkler E, Eakin E, Owen N. Objectively measured physical activity and sedentary time of breast cancer survivors, and associations with adiposity: findings from NHANES (2003–2006). Cancer Causes Control 2010;21:283–8.
5. Owen N. Sedentary behavior: understanding and influencing adults' prolonged sitting time. Prev Med 2012;55:535–9.
6. Lynch BM, Dunstan DW, Vallance JK, Owen N. Don't take cancer sitting down: a new survivorship research agenda. Cancer 2013;119:1928–35.
7. Sedentary Behavior Research Network. Letter to the editor: Standardized use of the terms "sedentary" and "sedentary behaviors". Appl Physiol Nutr Metab 2012;542:540–42.
8. Lynch BM. Sedentary behavior and cancer: a systematic review of the literature and proposed biological mechanisms. Cancer Epidemiol Biomarkers Prevent 2010;19:2691–709.
9. Dallal CM, Brinton LA, Mathews CE, Lissowska J, Peplonska B, Hartman TJ , et al. Accelerometer-based measures of active and sedentary behavior in relation to breast cancer risk. Breast Cancer Res Treat 2012;134:1279–90.
10. Irwin ML, McTiernan A, Bernstein L, Gilliland FD, Baumgartner R, Baumgartner K, et al.Physical activity levels among breast cancer survivors. Med Sci Sports Exerc 2004;36:1484–91.
11. Ashwell M, Gunn P, Gibson S. Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: systematic review and meta-analysis. Obes Rev 2012;13:275–86.
12. Demark-Wahnefried W, Aziz NM, Rowland JH, Pinto BM. Riding the crest of the teachable moment: promoting long-term health after the diagnosis of cancer. J Clin Oncol 2005;23:5814–30.
13. Rabin C. Promoting lifestyle change among cancer survivors: when is the teachable moment? Am J Lifestyle Med 2009;3:369–78.
14. Freedson PS, Melanson E, Sirard J. Calibration of the Computer Science and Applications, Inc. accelerometer. Med Sci Sports Exerc 1998;30:777–81.
15. Troiano RP, Berrigan D, Dodd KW, Mâsse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc 2008;40:181–8.
16. Waist circumference and waist–hip ratio: report of a WHO expert consultation, Geneva, 8–11 December 2008. World Health Organization. [cited 2014 Feb 23]. Available from: http://whqlibdoc.who.int/publications/2011/9789241501491_eng.pdf.
17. Tremblay MS, Kho ME, Tricco AC, Duggan M. Process description and evaluation of Canadian Physical Activity Guidelines development. Int J Behav Nutr Phys Act 2010;7:42.
18. Littman AJ, Tang MT, Rossing MA. Longitudinal study of recreational physical activity in breast cancer survivors. J Cancer Surviv 2010;4:119–27.
19. Irwin ML, Crumley D, McTiernan A, Berstein L, Baumgertner R, Gilliland FD, et al. Physical activity levels before and after a diagnosis of breast carcinoma: the Health, Eating, Activity, and Lifestyle (HEAL) study. Cancer 2003;97:1746–57.
20. Harrison S, Hayes SC, Newman B. Level of physical activity and characteristics associated with change following breast cancer diagnosis and treatment. Psychooncology 2009;18:387–94.
21. Devoogdt N, VanKampen M, Geraerts I, Coremans T, Fleuws S, Lefevre J, et al. Physical activity levels after treatment for breast cancer: one-year follow-up. Breast Cancer Res Treat 2010;123:417–25.
22. Mathews CE, Chen KY, Freedson PS, Buchowski MS, Beech BM, Pate RR, et al. Amount of time spent in sedentary behaviors in the United States, 2003–2004. Am J Epidemiol 2008;167:875–881.
23. Glazer NL, Lyass A, Esliger DW, Blease SJ, Freedson PS, Massaro JM, et al. Sustained and shorter bouts of physical activity are related to cardiovascular health. Med Sci Sports Exerc 2013;45:109–115.
24. Holman R, Carson V, Janssen I. Does the fractionalization of daily physical activity (sporadic vs. bouts) impact cardiometabolic risk factors in children and youth? PLoS One 2011;6:e25733.
25. Loprinzi PD, Lee H, Cardinal BJ. Objectively measured physical activity among US cancer survivors: considerations by weight status. J Cancer Surviv 2013;7:493–499.
26. Brunet J, Burke SM, Sabiston CM. The benefits of being self-determined in promoting physical activity and affective well-being among women recently treated for breast cancer. Psycho-Oncol 2013:22:2245–52.
27. Blanchard CM, Courneya KS, Stein K. Cancer survivors' adherence to lifestyle behavior recommendations and associations with health-related quality of life: results from the American Cancer Society's SCS-II. J Clin Oncol 2008;26:2198–2204.

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