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Physical Activity and Psychological Health in Breast Cancer Survivors: An Application of Basic Psychological Needs Theory

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Objective: The role of psychological need satisfaction in terms of understanding the mechanisms through which leisure-time physical activity (LTPA) is associated with psychological health in breast cancer survivors who have recently completed treatment was examined. **Methods:** Adopting a longitudinal two-wave design, female breast cancer survivors ($N = 144$) completed self-report instruments of LTPA, psychological need satisfaction, and psychological health at two points separated by 3 months. The first test administration period was 6 months following the completion of primary treatment. **Results:** Change score analyses demonstrated that greater LTPA across the 3-month period was associated with greater perceptions of well-being (*r*s ranged from .17 to .20) and lower ill-being (*r*s ranged from −.06 to −.21). Results of multiple mediation analyses demonstrated that psychological need fulfillment underpinned the LTPA–well-being relationship only. **Conclusions:** Collectively these findings indicate that increased engagement in LTPA represents one factor associated with greater psychological health in breast cancer survivors, with fulfilling the psychological need for relatedness most salient in understanding this relationship. Continued investigation into the mechanisms associated with reductions in ill-being in breast cancer survivors appear justified.

Keywords: breast cancer survivors, physical activity, psychological health, psychological need satisfaction

INTRODUCTION

Breast cancer is the most common oncology malignancy affecting females in the world (International Agency for Research on Cancer, 2002). In Canada,

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approximately 23,800 women will be diagnosed with breast cancer annually (Canadian Cancer Society [CCS], 2013) and 1 in 9 women will be diagnosed with breast cancer over their lifetime, with a mortality rate of 1 in 29 (CCS, 2013). Medical advancements centered on early detection and improved treatment options have resulted in increased 5-year survival rates (i.e. approximately 89%) and lower mortality rates, yet variability of prognosis is evident depending on age and stage of disease (CCS, 2013). With improvements in screening and treatment offering promise for women diagnosed with breast cancer, attention to factors that facilitate the progression of physical, biological, and psychological health in survivorship is warranted.

Physical activity has been advocated as one non-pharmacological intervention that may alleviate sequelae related to a diagnosis of breast cancer during both the acute phase of treatment and throughout survivorship (Courneya, Mackey, & McKenzie, 2002). Physical activity has been defined as any bodily movement produced by skeletal muscles requiring energy expenditure (Bouchard, Blair, & Haskell, 2007). Despite the potential benefits of engaging in physical activity, many breast cancer survivors do not meet current physical activity recommendations (Harrison, Hayes, & Newman, 2009). Most notably, physical activity has been found to decline within the 12-month period following diagnosis (e.g. Devoogdt et al., 2010) with engagement in this important health behavior generally not returning to the level reported prior to pre-diagnosis (Littman, Tang, & Rossing, 2010).

Most researchers examining the benefits of physical activity for breast cancer survivors have focused on physical or health outcomes (e.g. body composition, fitness, relapse, mortality rates; Markes, Brockow, & Resch, 2009; Speck, Courneya, Mâsse, Duval, & Schmitz, 2010) with some evidence noted for a dose–response relationship (Ballard-Barbash et al., 2012). Extending beyond biomedical outcomes, evidence attesting to the role of physical activity toward improved psychological health[1] for breast cancer survivors is equivocal (e.g. Cadmus et al., 2009; Courneya et al., 2003; Markes et al., 2009). Given the somewhat ambiguous nature of the relationship between physical activity and psychological health outcomes (e.g. well-being, depression) in this cohort, ongoing investigation into the beneficial effects of physical activity among breast cancer survivors is warranted. The present investigation extends the current state of knowledge in two ways.

First, the bulk of existing research examining the physical activity–psychological health relationship in breast cancer has primarily been con-

[1] The definition of psychological health adopted in this investigation is consistent with that advocated by the World Health Organization: "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." As such, markers of psychological health spanning both well- (e.g. positive affect and self-acceptance) and ill-being (e.g. stress and depression) were adopted.

ducted using individually tailored structured exercise interventions (e.g. Cadmus et al., 2009; Mutrie et al., 2007), often during the acute phase of treatment (Markes et al., 2009). With the efficacy of these investigations not under challenge, continued research is needed as (1) the majority of breast cancer survivors report engaging in leisure-time physical activity (LTPA) as opposed to more "structured" forms of exercise (Harrison et al., 2009) and (2) most women prefer unsupervised as opposed to supervised physical activity programs (Rogers, Markwell, Verhulst, McAuley, & Courneya, 2009). Researchers (e.g. Miilunpalo, 2001) have identified five different domains of PA (i.e. occupational, commuting, recreational, exercise and sporting activities) that differ in terms of social context, psychological meaning, resources, and the degree of free choice associated with engagement (Marttila, Laitakari, Nupponen, Miilunpalo, & Paronen, 1998). As such, the prevailing focus of existing literature on structured, supervised exercise may be restrictive in its focus as it does not accurately capture LTPA in all its forms, nor does it necessarily consider the preferences for behavioral engagement of individuals living with breast cancer. The present investigation was designed to be inclusive of supervised and unsupervised recreational, exercise, and sporting activities consistent with LTPA. Understanding LTPA and its associated outcomes affords breast cancer survivors greater flexibility for incorporating physical activity into their daily routine, without the barriers (e.g. structure, cost) linked to participation in structured exercise. Therefore, one research priority concerns examining variation in LTPA participation as a mechanism to promote (or thwart) changes in psychological health among breast cancer survivors.

Second, calls advocating a greater understanding of the psycho-social mechanisms underpinning the physical activity–psychological health relationship in breast cancer survivors have emerged (Pinto & Ciccolo, 2011). Current literature is dominated by insight into barriers associated with physical activity (e.g. Ottenbacher et al., 2011) or studies grounded in Social Cognitive Theories (e.g. Phillips & McAuley, 2013). However, Pinto and Ciccolo (2011) suggest that Self-Determination Theory (SDT; Deci & Ryan, 2002) represents a promising theory to guide research with cancer survivors as it captures variance (and consequently insight) not accounted for by other theoretical frameworks. SDT is an organismic dialectic, macro-level approach that accounts for the quality of motivation regulating behavior and the processes that facilitate motivational development, optimal growth, and human development (Deci & Ryan, 2002). Under the rubric of Basic Psychological Needs Theory, a subcomponent of the SDT framework, Deci and Ryan (2002) posit that fulfilling *competence*, *autonomy*, and *relatedness* needs in an ongoing and authentic manner are necessary ingredients for integration, adaptation, and psychological health. Conversely, contexts perceived to thwart psychological needs are theorised to engender ill-being,

diminished motivation, and a fragmented sense of self (Deci & Ryan, 2002). The psychological need for *competence* refers to one's natural desire to explore, manipulate, and feel proficient when mastering optimal challenges within one's environment (White, 1963). *Autonomy* concerns feeling self-governing in the behaviors engaged in such that one's actions are undertaken volitionally and stem from an internal locus of causality (deCharms, 1968). *Relatedness* reflects the need to establish and maintain satisfying and supportive social relationships and feel emotionally connected to others (Baumeister & Leary, 1995). According to Deci and Ryan (2002), feeling competent, a sense of autonomy, and a secure connection to others represent essential foundations that exert unique and "direct" effects on well-being. Support for the role played by fulfilling the basic psychological needs outlined by Deci and Ryan (2002) on psychological health and behavior have been demonstrated in physical activity contexts (Wilson, Mack, Gunnell, Oster, & Gregson, 2008), including physical activity research focused on cancer survivors (Peddle, Plotnikoff, Wild, Au, & Courneya, 2008). Further support for the importance of psychological need fulfillment in clinical cohorts has been forthcoming with a recent study demonstrating that the LTPA–well-being relationship in individuals living with osteoporosis is mediated by psychological need satisfaction (Gunnell, Mack, Wilson, & Adachi, 2011). Given the importance of understanding and promoting psychological outcomes in breast cancer survivors, consideration of the role of psychological need satisfaction as experienced in physical activity contexts represents an important theoretical and practical extension to our current understanding.

The overall purpose of this study was to ascertain whether variation in LTPA was associated with change in psychological health across a 3-month period in female breast cancer survivors who had recently completed treatment. Consistent with existing literature (e.g. Mutrie et al., 2007; Perna et al., 2010), it was hypothesised that increases in LTPA would be associated with improved well-being and reduced ill-being. The role of fulfilling basic psychological needs as a framework accounting for the association between LTPA on psychological health was also examined. Consistent with Basic Psychological Needs Theory (Deci & Ryan, 2002) and existing research (Gunnell et al., 2011; Mack et al., 2012), it was hypothesised that psychological need satisfaction would be one mechanism underpinning the LTPA–psychological health relationship.

METHODS

Procedures

Participants were recruited as part of a prospective longitudinal study examining the relationship between physical activity and health outcomes in breast

cancer survivors in Montreal, Canada. Following university and hospital ethical clearance, participants were recruited through advertisements and oncologist referral. Those expressing interest were asked to contact a member of the research team by phone to obtain additional study information and were subsequently screened for eligibility. Inclusion criteria were (a) women 18 years of age or older, (b) 0–20 weeks after primary treatment (i.e. surgery, chemotherapy, radiation), (c) diagnosed with Stage I–III breast cancer, (d) able to provide written informed consent, read and speak in English or French, and (e) report no health concerns which prevented participants from engaging in LTPA. Participants meeting eligibility criteria were mailed the survey package including informed consent. Questionnaires were mailed again at the second test administration period 3 months later. All completed questionnaires were returned in a self-addressed stamped envelope provided to each participant by a member of the research team.

Measures

Demographics. Participants provided self-reported data pertaining to gender, height/weight, marital status, and ethnicity.

Leisure-Time Physical Activity. The three-item Godin Leisure-Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1985) was completed to assess the frequency of mild (e.g. minimal effort), moderate (e.g. not exhausting), and strenuous (e.g. heart beats rapidly) bouts of LTPA engaged in during a typical week. A total LTPA score was calculated using the following formula: $\Sigma([\text{Mild} \times 3] + [\text{Moderate} \times 5] + [\text{Strenuous} \times 9])$. The weights assigned to LTEQ item scores represent metabolic equivalent values (METS) that serve as an index of energy expenditure (Godin & Shephard, 1985). Previous studies have provided support for select aspects of construct validity and reliability of LTEQ scores in women with breast cancer (Perna et al., 2010; Phillips & McAuley, 2013).

Psychological Health. Psychological health was measured via markers assessing well-being (i.e. self-acceptance, positive affect, negative affect) and ill-being (i.e. stress and depression).

Self-Acceptance. The three-item self-acceptance subscale of the Scales of Psychological Well-Being (SPWB; Ryff & Keyes, 1995) assesses the extent to which an individual has a positive attitude about themselves and their past life. Participants responded to each item (Sample item "I like most aspects of my personality") based on the how they felt across the previous month on a 7-point Likert scale ranging from "1" (*Strongly Disagree*) to "7" (*Strongly Agree*). One of the three self-acceptance items was negatively worded and

reverse-scored prior to analysis such that higher average scores were reflective of a more positive attitude about the self. Reliability of test scores for the three-item self-acceptance subscale has been reported in cancer survivors (Costanzo, Ryff, & Singer, 2009).

Affect. The Positive Affect Negative Affect Schedule (PANAS; Watson, Clark, & Tellegren, 1988) was used to capture the intensity associated with both positive (Sample item: "Enthusiastic"; $n = 10$ items) and negative (Sample item: "Afraid"; $n = 10$ items) dimensions of affect as experienced by breast cancer survivors during the previous week. Participants were asked to respond to each of the 20 items comprising the PANAS using a 5-point Likert scale ranging from "1" (*Not At All or Very Slightly*) to "5" (*Very Much*). Previous studies have provided support for the construct validity and reliability of test scores for the PANAS in women with breast cancer (Kolden et al., 2002).

Stress. Participants completed the 10-item Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983) to assess perceptions of the extent to which their life was perceived to be unpredictable and uncontrollable across the previous month. Responses (Sample item: "How often have you felt nervous or stressed?") were scored across a 5-point Likert scale ranging from "1" (*Never*) to "5" (*Very Often*). Positively worded PPS items were reverse-scored prior to calculation of an average score such that higher scores represent greater stress. Support for construct validity and reliability of PPS scores has been reported in breast cancer survivors (Golden-Kreutz & Andersen, 2004).

Depression. The short-form (Kohout, Evans, & Cornoni-Huntley, 1993) of the Centre of Epidemiological Studies Depression scale (CES-D; Radloff, 1977) was used to identify symptoms of depression with an emphasis on the affective component. The 10-item CED-S (Sample item: "I felt everything I did was an effort") was rated across a 4-point Likert scale ranging from "1" (*Rarely or none of the time*) to "4" (*Most or all of the time*) and reflected feelings in the previous week. Following reverse-scoring of the two positively worded items, possible scores range from 0 to 30. Support for construct validity and reliability for CES-D scores in women with breast cancer has been reported (Golden-Kreutz & Andersen, 2004).

Psychological Need Satisfaction. Participants completed the 18-item Psychological Need Satisfaction in Exercise Scale (PNSE; Wilson, Rogers, Rodgers, & Wild, 2006). The PNSE is a self-report instrument designed to measure perceived feelings of competence, autonomy, and relatedness for exercise (Wilson et al., 2006). Following the instructional stem "The follow-

ing statements represent different feelings people have when they engage in exercise. Please answer the following questions by considering how you typically feel while you are exercising", with item responses on a 6-point Likert scale anchored by "1" (*False*) and "6" (*True*). Substantial evidence has supported the construct validity and score reliability of data collected using the PNSE (Wilson et al., 2008) including colorectal cancer survivors (Peddle et al., 2008).

Data Analysis

First, data were screened for missing values, statistical outliers, and tested for conformity with relevant assumptions underpinning inferential tests. Second, estimates of internal consistency score reliability (Cronbach's coefficient α; Cronbach, 1951) and summary descriptive statistics were calculated for each study variable. Third, a series of bivariate correlations and 95 per cent confidence intervals between residual change scores for study variables were calculated. To calculate residual change scores Time 2 scores were regressed onto Time 1 scores, and the standardised residual was saved as an estimate of change over time associated with each variable (Zumbo, 1999). Finally, multiple mediation with bootstrapping (Preacher & Hayes, 2008) was employed to examine the role of all three psychological needs in the LTPA–psychological health relationship (see Figure 1). Separate analyses were conducted for each psychological health outcome with effect size (ES) estimates reported consistent with Hayes (2013). Evidence for mediation in the bootstrap samples ($k = 5{,}000$) is observed with the absence of zero in the 95 per cent bias corrected and accelerated confidence interval (Bca CI; Preacher & Hayes, 2008). The bootstrapping procedure is considered to be superior to conventional mediation models because it does not assume that the population is normally distributed, thus reducing Type I error rates (Preacher & Hayes, 2008). Specific indirect effects and pairwise contrasts were examined through the use of Bca CIs to examine the unique contribution and strength of each psychological need in the multiple mediator model analysis.

RESULTS

Participants

Breast cancer survivors were assessed at 6 (Time 1) and 9 (Time 2) months after completion of primary treatment. Participants were 144 female breast cancer survivors ($M_{age} = 55.09$ years; $SD_{age} = 10.88$ years). The majority of participants self-identified their cultural origin as "Caucasian" (86.70%). Sixty-five per cent ($n = 94$) identified their current status as "married or living with life partner" with a modal household income of between $50,000 and

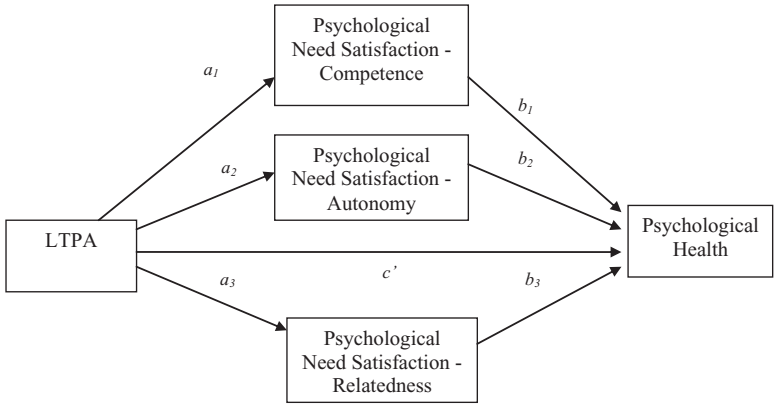

FIGURE 1. Diagram of multiple mediation analyses tested in this study depicting the indirect effect of LTPA on psychological health through the satisfaction of the psychological needs for competence, autonomy, and relatedness. c' is the direct effect of LTPA on psychological health holding all mediators constant. a_1 estimates the effects of LTPA on competence; a_2 estimates the effects of LTPA on autonomy; a_3 estimates the effects of LTPA on relatedness; b_1 estimates the effects of competence on psychological health controlling for LTPA; b_2 estimates the effects of autonomy on psychological health controlling for LTPA; and b_3 estimates the effects of relatedness on psychological health controlling for LTPA. Separate analyses were conducted for each marker of psychological health assessed in this study.

$60,000 reported for 97.10 per cent of respondents. Forty-four per cent ($n = 63$) of participants were diagnosed with Stage II breast cancer, with chemotherapy and radiotherapy serving as the most frequent treatment received (see Table 1).

Preliminary Data Screening

A total of 169 female breast cancer survivors provided data at Time 1. Fifteen per cent ($n = 25$) of individuals providing data at Time 1 (6 months post-treatment) did not provide data at the second test administration (9 months post-treatment) and were removed from consideration in subsequent analyses. Differences between those retained and those removed from the sample were minimal across demographic, LTPA, psychological health, and psychological need satisfaction variables ($p > .05$; Cohen's d (Cohen, 1988) ranged from 0.01 to 0.14). Subsequent analyses were conducted on a final sample size of 144 breast cancer survivors.

A small percentage of the sample had omitted at least one instrument entirely from their responses. More specifically, non-response errors ranged from ($n = 4$) for Perceived Stress to ($n = 11$) for the PNSE. For cases

TABLE 1
Health Characteristics

	%
Stage of breast cancer diagnosis	
I	33.60
II	44.00
III	16.40
Treatment received	
Lymph/axillary node dissection	65.30
Lumpectomy	73.40
Single mastectomy	33.00
Double mastectomy	21.30
Reconstructive surgery	7.60
Chemotherapy	74.60
Radiotherapy	89.90
Hormonal therapy	59.80
Other	81.90

Note: Values do not equal 100 because of either missing data or receiving multiple treatments.

providing partial responses per subscale/instrument, initial inspection of the data indicated the presence of minimal non-response error with no more than 0.70 per cent of data missing on any individual item. Missing data were deemed to be missing completely at random and were replaced using an expectation maximisation algorithm in SPSS. Following the imputation of missing data, an inspection of the distributional properties (see Table 2) indicated that skewness values ranged from –0.99 to 1.94 and kurtosis values ranged from –0.73 to 4.93 across all study variables. Estimates of internal consistency reliability in this sample ranged from $0.63 \leq \alpha \leq 0.95$ (see Table 2).[2]

Descriptive Statistics and Bivariate Correlations

Descriptive statistics for all study variables can be found in Table 2.[3] Participants reported engaging in an average of 38.45 METS ($SD = 21.78$;

[2] The number of items comprising an instrument is known to influence Cronbach's alpha (Nunnally & Bernstein, 1994). The values reported for the measure of Self-Acceptance may be associated with the length of the scale (i.e. three items) as opposed to lower estimates of score reliability. Scores reported in the present investigation for the three-item measure of self-acceptance are generally consistent with those noted by Costanzo, Ryff, and Singer (2009).

[3] Patterns of association between study variables and potential confounders in the form of illness characteristics (e.g. date of last breast cancer diagnosis, cancer stage) and socio-demographic variables (e.g. age, marital status, level of education) were examined. In general, illness characteristics were not associated with study variables with the exception of date of last breast cancer diagnosis and Time 2 LTPA scores ($r = .24$; $p = .003$). Socio-demographic variables demonstrated a pattern of negligible to small relationships with study variables (r_{12} ranged from –.01 to .25).

TABLE 2
Descriptive Statistics and Internal Consistency Reliability Estimates

Variables	M	SD	R	α
Self-Acceptance—Time 1	5.04	1.15	1–7	0.63
Self-Acceptance—Time 2	5.01	1.24	1–7	0.69
Positive Affect—Time 1	3.23	0.69	1–5	0.88
Positive Affect—Time 2	3.19	0.74	1–5	0.90
Negative Affect—Time 1	1.65	0.66	1–5	0.91
Negative Affect—Time 2	1.68	0.67	1–5	0.89
Stress—Time 1	2.57	0.55	1–5	0.80
Stress—Time 2	2.56	0.51	1–5	0.80
Depression—Time 1	16.91	4.80	10–40	0.77
Depression—Time 2	17.24	5.48	10–40	0.87
Psychological Need Satisfaction—Competence—Time 1	4.26	1.05	1–6	0.93
Psychological Need Satisfaction—Competence—Time 1	4.25	1.14	1–6	0.95
Psychological Need Satisfaction—Autonomy—Time 1	4.98	0.93	1–6	0.94
Psychological Need Satisfaction—Autonomy—Time 2	4.94	1.00	1–6	0.93
Psychological Need Satisfaction—Relatedness—Time 1	3.78	1.34	1–6	0.91
Psychological Need Satisfaction—Relatedness—Time 2	3.72	1.35	1–6	0.92
LTPA—Time 1	38.45	21.78	0–∞	—
LTPA—Time 2	36.31	23.16	0–∞	—

Note: *M* = Mean. *SD* = Standard deviation. *R* = Range. α = Cronbach's (1951) internal consistency reliability coefficient. LTPA = Leisure-time physical activity. LTPA scores reflect estimates of energy expenditure expressed in MET minutes/week.

Range = 0.00–119.00) of LTPA across a typical week at Time 1 and 36.31. METS (*SD* = 23.16; Range = 0.00–119.00) per week at Time 2 ($t(143) = -0.87$, $p = 0.39$; $d = 0.07$). Aside from negative affect, the reported values for markers of psychological health and psychological need satisfaction in LTPA contexts were all above the theoretical midpoint of the plausible range per instrument (see Table 2). On average, levels of stress and depression, regardless of test administration period, scored just above the midpoint of the response options provided.

Bivariate correlations and corresponding 95 percent confidence intervals between change (Δ) scores for study variables can be found in Table 3. A pattern of small-to-moderate relationships was noted between indices of psychological health represented by well-being and ill-being (r_{12}s ranged from –.34 to –.58). Negative affect was negatively related to indicators of well-being (r_{12}s ranged from –.33 to –.47) and positively related to ill-being markers (r_{12}s ranged from .37 to .70). Variation in psychological need satisfaction was associated with well- and ill-being outcomes in the expected direction. A pattern of weak-to-small relationships between changes in LTPA and variation in psychological health were noted (r_{12}s ranged from –.21 to .20). Change in LTPA across the three months was positively associated with

TABLE 3
Bivariate Correlations between Study Variables

Variables	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1. ΔSelf-Acceptance	—								
2. ΔPositive Affect	.44** (.29, .57)	—							
3. ΔNegative Affect	−.33** (−.47, −.17)	−.47** (−.59, −.33)	—						
4. ΔStress	−.34** (.48, −.18)	−.47** (−.59, −.33)	.37** (.21, .50)	—					
5. ΔDepression	−.35** (−.49, −.20)	−.58** (−.68, −.45)	.70** (.60, .78)	.38** (.23, .52)	—				
6. Δ Psychological Need Satisfaction—Competence	.20* (.03, .36)	.23** (.05, .39)	−.07 (−.02, .11)	−.14 (−.31, .04)	−.09 (−.26, .09)	—			
7. Δ Psychological Need Satisfaction—Autonomy	.23** (.06, .39)	.24** (.07, .40)	−.14 (−.31, .03)	−.22** (−.38, −.04)	−.13 (−.30, .05)	.19* (.01, .35)	—		
8. Δ Psychological Need Satisfaction—Relatedness	.25** (.08, .41)	.30** (.12, .45)	−.24** (−.40, −.06)	−.24** (−.40, −.06)	−.20* (−.37, −.03)	.40** (.24, .53)	.12 (−.05, .29)	—	
9. ΔLTPA	.17* (.02, .32)	.20* (.02, .35)	−.18* (−.34, −.02)	−.06 (−.22, .11)	−.21** (−.36, −.04)	.21* (.04, .37)	.07 (−.10, .23)	.13 (−.04, .30)	—

Note: Δ = Standardised Residuals Time 1—Time 2. LTPA = Leisure-time physical activity. Sample size ranges between 119 and 140. *$p < .05$ (one-tailed); **$p < .01$ (one-tailed).

change in psychological need satisfaction (r_{12}s ranged from .07 to .21). Based on the interpretation of the 95 percent confidence intervals spanning each bivariate correlation, change in LTPA was associated with change in the three well-being indices and the psychological need for competence.

Main Analyses

Given the well-documented concerns stemming from issues of multicollinearity in studies that use regression-based models, including multiple mediation analyses, the diagnostic criteria advanced by Pedhazur (1997) were used to screen the data. Joint consideration of the Variance Inflation Factor (Range = 1.03–1.24) and Tolerance (Range = 0.80–0.98) values plus the observation that no pair of Variance Proportion Values (Range = 0.00–0.75) exceeded a threshold of 0.50 when the Condition Index (Range = 1.00–1.65) was clearly elevated (i.e. >30) imply that multicollinearity is less likely to impact parameter estimation and interpretation in the multiple mediator model analyses (Pedhazur, 1997).

Results of the bootstrapping procedure to test for multiple mediation can be found in Table 4. Variation in psychological need satisfaction mediated the ΔLTPA–Δself-acceptance relationship ($R^2_{adj} = 0.10$; point estimate = 0.10; Bca CI = 0.01 to 0.21) and ΔLTPA–Δpositive affect relationship ($R^2_{adj} = 0.13$; point estimate = 0.10; Bca CI = 0.01 to 0.25). Interpretation of the specific indirect effects indicated that no individual psychological need contributed uniquely to the model using self-acceptance as the criterion variable. Variation in the fulfillment of relatedness to others via exercise was a unique mediator when change in positive affect served as the criterion variable of interest. Interpretation of effect size estimates for positive affect ($ES = .11$) and self-acceptance ($ES = .08$) were small. In contrast, the ΔLTPA–Δnegative affect relationship ($R^2_{adj} = 0.04$; point estimate = –0.06; Bca CI = –0.22 to 0.01) was not mediated by variation in psychological need fulfillment. Consideration of the pairwise contrasts for each psychological need suggested that the magnitude of the effects was comparable (i.e. the Bca 95% CI spanned zero and therefore was deemed not statistically significant) regardless of the criterion variable under study. Psychological need fulfillment did not mediate the ΔLTPA–Δstress relationship ($R^2_{adj} = 0.02$; point estimate = –0.05; Bca CI = –0.12 to 0.03). Similarly, the ΔLTPA–Δdepression relationship ($R^2_{adj} = 0.02$; point estimate = –0.02; Bca CI = –0.11 to 0.04) was not mediated by variation in psychological need satisfaction.

DISCUSSION

Advancements in medical treatments for individuals diagnosed with breast cancer have resulted in a burgeoning population of survivors (CCS, 2013).

TABLE 4
Bootstrapped Indirect Effects of Change in LTPA on Change Well- and Ill-Being through Psychological Need Satisfaction

Variable	*Point Estimate*	*Bca CI*	R^2*adj.*
Self-Acceptance			.10*
Total	**.091**	**.01–.21**	
Psychological Need Satisfaction—Competence	.039	.00–.11	
Psychological Need Satisfaction—Autonomy	.022	–.01–.12	
Psychological Need Satisfaction—Relatedness	.029	–.01–.11	
Positive Affect			.13**
Total	**.095**	**.01–.25**	
Psychological Need Satisfaction—Competence	.022	–.01–.10	
Psychological Need Satisfaction—Autonomy	.029	–.03–.12	
Psychological Need Satisfaction—Relatedness	**.044**	**.01–.16**	
Negative Affect			.04
Total	–.058	–.22–.01	
Psychological Need Satisfaction—Competence	–.015	–.11–.01	
Psychological Need Satisfaction—Autonomy	.011	–.02–.09	
Psychological Need Satisfaction—Relatedness	–.054	–.22–.02	
Stress			.02
Total	–.046	–.12–.03	
Psychological Need Satisfaction—Competence	–.009	–.09–.02	
Psychological Need Satisfaction—Autonomy	–.001	–.07–.05	
Psychological Need Satisfaction—Relatedness	–.036	–.15–.01	
Depression			.02
Total	–.016	–.11–.04	
Psychological Need Satisfaction—Competence	–.003	–.07–.02	
Psychological Need Satisfaction—Autonomy	.011	–.02–.08	
Psychological Need Satisfaction—Relatedness	–.024	–.11–.01	

Note: Number of bootstrap resamples = 5,000. Total = the sum of the specific indirect effects. Point Estimate = the indirect effect of *ab* path. Bca CI = 95% Bias Corrected and Accelerated Confidence Intervals. **Bold text** = significant effects. *p = .01; **p = .001.

Consequently, investigation into modifiable lifestyle characteristics is integral to survivorship in this cohort. With this in mind, the purposes of this study were (a) to examine whether variation in LTPA was associated with changes in psychological health reported among breast cancer survivors who recently completed treatment, and (b) to test the role of fulfilling basic psychological needs for competence, autonomy, and relatedness via exercise in mediating the LTPA–psychological health relationship in this cohort of cancer survivors. Interpretation of LTEQ scores indicates that breast cancer survivors comprising this sample were less active compared to normative values (Godin & Shephard, 1985), and slightly higher than reported in other published studies of breast cancer survivors (e.g. Phillips & McAuley,

2013). Consistent with our original hypotheses and existing literature (Mutrie et al., 2007; Perna et al., 2010), increased LTPA over a 3-month period was associated with increased psychological health with the notable exception of perceived stress. Addressing calls for the inclusion of theory in studies of physical activity among cancer survivors (e.g. Pinto & Ciccolo, 2011), the results of this study focused on Basic Psychological Needs Theory (Deci & Ryan, 2002) lend credence to the role of satisfying key psychological needs for competence, autonomy, and relatedness via exercise that in turn positively influence psychological health among women surviving breast cancer.

Consistent with our initial hypotheses, study results depicting the LTPA–psychological health relationship were generally in the anticipated direction. As self-acceptance has been shown to be relatively stable pre- and post-diagnosis of cancer (Costanzo et al., 2009), it is worth noting that the results of this investigation suggest that LTPA may be one promising mechanism through which enhanced acceptance of the self may be increased in this cohort post-treatment. Researchers have documented the beneficial effects of structured exercise on positive affect (Kolden et al., 2002; Mutrie et al., 2007) and a trend for reductions in depressive symptoms (Bower et al., 2012; Perna et al., 2010). Equivocal support for the association between negative affect and structured exercise has also been noted in the literature (Kolden et al., 2002; Mutrie et al., 2007). Finally, consistent with findings reported in this study, perceptions of stress were not associated with a yoga intervention across a 3-month period (Bower et al., 2012). Extrapolating from the results of this study, it would appear that the beneficial effects of structured exercise on psychological health could be extended to include broader forms of LTPA which in turn expands available programmatic offerings for individuals living with breast cancer, and health promotion practitioners working with breast cancer survivors. Further, the above findings were found across a 3-month period on naturally occurring changes (as opposed to interventions designed to increase) in LTPA behavior, suggesting that greater attention to the beneficial effects of unstructured forms of LTPA noted within observational studies may be a promising avenue for future research with breast cancer survivors.

Based on our findings over a 3-month period post-treatment, and in support of Basic Psychological Needs Theory (Deci & Ryan, 2002), feeling competent, a sense of autonomy, and securely related to others is essential as each psychological need exerts a unique, direct, and positive influence on psychological health (Deci & Ryan, 2002). Of notable interest is the role played by each individual psychological need espoused by Deci and Ryan (2002) within Basic Psychological Needs Theory. Change in the fulfillment of perceived competence in exercise was associated with increased self-acceptance and positive affect. When LTPA engenders feelings of

autonomy, change in the hypothesised direction was noted for three of five psychological health markers. Finally, increased positive interpersonal connections and trusting relationships (i.e. enhanced relatedness) via exercise was associated with changes in all psychological health markers in the hypothesised direction. The importance of social connectedness has been identified as one factor associated with engagement in physical activity for cancer survivors (Sabiston & Brunet, 2011). A critical issue for researchers to target in future studies is the relative and unique contributions of each psychological need across different physical activity contexts (e.g. structured exercise, LTPA) and participant characteristics (e.g. age, health). Nevertheless, the findings reported in this study do nothing to undermine a key premise of Basic Psychological Needs Theory, namely that when social contexts (such as exercise) provide an opportunity to satisfy competence, autonomy, and relatedness needs in an ongoing and authentic fashion improvements in psychological health will ensue. Future studies exploring this issue in other cohorts of cancer survivors (e.g. bladder, colorectal, lung, etc.) would seem worthwhile in order to determine the generalisability of the findings reported in this study across the spectrum of cancer care.

When interpreting results of the meditational models, support for the role of psychological need fulfillment in the LTPA–psychological health relationship was noted for self-acceptance and positive affect. As such, study findings are consistent with Basic Psychological Needs Theory (Deci & Ryan, 2002) as psychological need fulfillment represents a necessary ingredient for the optimisation of personal health and overall well-being. The importance of being socially connected (i.e. fulfillment of the psychological need for relatedness) served as the only unique mediator of the LTPA–psychological health relationship in this cohort of breast cancer survivors. This importance of relatedness over other psychological needs in the LTPA–psychological health literature was further highlighted by Mack et al. (2012). More specifically, Mack and colleagues report data specific to the link between perceived relatedness and positive/negative affect that differ from those noted in the present investigation. This discrepancy may be partially explained given differences in characteristics of the sample (i.e. young adults with no known health conditions), instruments used (measure of positive and negative affect not limited to the previous week), and time between test administration periods (6 months) adopted by Mack et al. (2012). Future research would do well to determine the extent to which psychological need fulfillment serves as the key (or adjunct) psychological mechanism which underpins the LTPA–psychological health relationship among cancer survivors. Health promotion specialists looking to enhance well-being in breast cancer survivors may want to emphasise the importance of establishing and maintaining an authentic connection with others in contexts where various forms of LTPA naturally occur.

Contrary to this study's hypotheses, LTPA was not associated indirectly via psychological need satisfaction with any form of ill-being. More specifically, the fulfillment of competence, autonomy, and relatedness was not found to transmit the influence of increased LTPA on reductions in perceived stress and depression. According to Ryan and Deci (2000), Basic Psychological Needs Theory can be applied to growth and well-being, but also to the ". . . undermining, alienating, and pathogenic effects of need thwarting environments" (p. 319). In other words, when psychological needs are thwarted, people become vulnerable to experiencing lower levels of optimal functioning and enhanced psychopathology. Psychological need thwarting has been conceptualised as an active process that has been differentiated from lower psychological need satisfaction (e.g. Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011; Gunnell, Crocker, Wilson, Mack, & Zumbo, 2013). Consequently it may be that assessing psychological need thwarting would help understand factors that link LTPA with ill-being or reduced psychological health among breast cancer survivors. In addition, consideration of other psychological constructs grounded in relevant theory (e.g. outcome expectations) which may explain the association between LTPA and diminished psychological health should be investigated within cohorts of breast cancer survivors.

While the results of this investigation hold theoretical and practical merit, a number of limitations are recognised. First, conclusions are advanced based on a unidirectional relationship between LTPA and psychological health, yet the possibility of a bi-directional relationship was not examined in this study. Lyubomirsky, King, and Diener (2005) suggested that those who report greater well-being are more likely to engage in LTPA. Such a conclusion regarding the causal flow of relationships between LTPA and psychological health cannot be ruled out on the basis of research design in the present investigation. Second, data collection procedures included non-probability-based sampling that may contain volunteer bias which constrains the inferences that can be drawn from statistical tests and claims of external validity (Pedhazur & Pedhazur Schmelkin, 1991). Third, the present investigation relied exclusively on self-report data, which can be susceptible to response bias and distortion from common methods variance (Campbell & Fiske, 1959). Fourth, study findings likely apply only to individuals within the first year of cancer survivorship. The LTPA–psychological health relationship, and the contribution of psychological need satisfaction, may vary across a continuum of breast cancer survivorship. Finally, the instructional stems for each psychological health variable measured in this study asked participants to reflect upon different temporal periods ranging from the previous week to the previous month. The extent to which instructional differences influenced study conclusions is unknown.

Overall, the results of this study make it apparent that engagement (and change) in LTPA was associated with psychological health in the first year of breast cancer survivorship. Further support for the role of psychological need satisfaction as a mechanism to explain the LTPA–psychological health relationship was observed in this study of women who survived breast cancer. With evidence attesting to the benefits of LTPA on biomedical and fitness outcomes well established for breast cancer survivors (Courneya et al., 2002; Courneya et al., 2003), findings from this study imply that LTPA can also be linked to improved affective outcomes and self-acceptance representing optimal psychological health in the year following breast cancer treatment. Future studies examining the role of unique psychological needs in the promotion of psychological health and the potential role of psychological need thwarting toward enhancing our understanding of ill-being are recommended. It should be noted that considerable scope for intervention studies targeting the manipulation of perceived competence, autonomy, and relatedness needs exists to improve the psychological health of breast cancer survivors.

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