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Correlates of objectively measured sedentary behavior in cancer patients with brain metastases: an application of the theory of planned behavior

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Abstract

***Objective*: The aim of this study is to examine the demographic, medical, and social-cognitive correlates of objectively measured sedentary behavior in advanced cancer patients with brain metastases.**

***Methods*: Advanced cancer patients diagnosed with brain metastases, aged 18 years or older, cognitively intact, and with palliative performance scale greater than 30%, were recruited from a Rapid Access Palliative Radiotherapy Program multidisciplinary brain metastases clinic. A cross-sectional survey interview assessed the theory of planned behavior variables and medical and demographic information. Participants wore activPAL™ (PAL Technologies Ltd, Glasgow, United Kingdom) accelerometers recording time spent supine, sitting, standing, and stepping during 7 days encompassing palliative whole brain radiotherapy treatments.**

***Results*: Thirty-one patients were recruited. Correlates of median time spent supine or sitting in hours per day were instrumental attitude (i.e., perceived benefits) of physical activity ($r = -0.42$; $p = 0.030$) and affective attitude (i.e., perceived enjoyment) of physical activity ($r = -0.43$; $p = 0.024$). Moreover, participants who sat or were supine for greater than 20.7 h per day reported significantly lower instrumental attitude ($M = 0.7$; 95% CI = 0.0–1.4; $p = 0.051$) and affective attitude ($M = 0.7$; 95% CI = 0.0–1.4; $p = 0.041$). Finally, participants who were older than 60 years of age spent more time sitting or being supine.**

***Conclusions*: Instrumental attitude and affective attitude were the strongest correlates of objectively measured sedentary behavior. This information could inform intervention studies to increase physical activity in advanced cancer patients with brain metastases.**

Introduction

Two recent Cochrane reviews determined that physical activity has beneficial effects on physical functioning, fatigue, and overall quality of life in cancer patients both during and post treatment [1,2]. In their Physical Activity and Cancer Control framework of the entire cancer control continuum, Courneya and Friedenreich [3] concluded that the effects of physical activity in cancer patients at the end of life are unknown. Our systematic review showed preliminary evidence that at least some advanced cancer patients were willing and able to tolerate physical activity interventions, with some demonstrating improvement in select quality of life outcomes [4].

The quality of life of advanced cancer patients is negatively impacted by metastatic disease [5]. The most common intracranial tumors in adults are brain metastases, which occur in up to 40% of all cancer patients during the course of their illness [6]. Metastatic spread to the brain contributes to significant morbidity; in a prospective study of 170 patients with brain metastases referred to an outpatient palliative radiotherapy clinic, the two most prevalent symptoms were fatigue and poor sense of well-being [7]. In a qualitative study using semi-structured interviews of nine non-small cell lung cancer patients with brain metastases, participants identified mobility and body image as among the most important determinants of their quality of life [8].

When facilitating behavior change in any population, utilizing a theoretical framework can identify targets by which motivation and adherence can be maximized [9]. The social-cognitive theory [10], self-determination theory [11], and attribution theory [12] have all been used to examine constructs related to physical activity motivation and behavior in various cancer populations. Most research, however, has examined and supported the theory of planned behavior (TPB) in understanding physical activity behavior in cancer populations [13–15]. In our pilot study of fifty advanced cancer patients with a median survival of 104 days, affective attitude, self-efficacy, and intention were the strongest correlates of self-reported physical activity [16].

Most recently, we conducted a study examining objectively measured physical activity and quality of life in

cancer patients with brain metastases who were undergoing palliative whole brain radiotherapy [17]. There were moderate to large associations between higher levels of sedentary behavior and poor quality of life in our sample of brain metastases patients who were undergoing palliative whole brain radiotherapy. The present article reports the demographic, medical, and social-cognitive correlates of objectively measured sedentary behavior from that study. The hypothesis was that TPB variables would have medium to large correlations (i.e., $r = 0.3$–0.5) with objectively measured sedentary behavior.

Theoretical framework

One validated social-cognitive model of human motivation to facilitate understanding of behavior is the TPB (Fig. 1) [18]. An individual's intention is the primary determinant of behavior in the TPB and is influenced by three independent factors: attitude, perceived behavioral control (PBC), and subjective norm. Attitude is defined as the positive or negative appraisal of a given behavior, and comprised the following: (a) affective attitude, or the feelings elicited by the possibility of performing the given behavior, and (b) instrumental attitude, or the rational evaluation of potential benefits of performing the given behavior. Ajzen [18] posits that attitudes are grounded in behavioral beliefs, including the advantages and disadvantages from performing a given behavior. PBC is defined as an individual's perceived control over and confidence in performing a given behavior, and is divided into the following: (a) perceived controllability, or the individual's control over performing a given behavior, and (b) perceived self-efficacy, or the difficulty or ease of performing a given behavior. Ajzen [18] contends that PBC is grounded in control beliefs, including the extent to which certain preventative or helpful factors could influence behavior. PBC and intention together can directly impact behavior. Subjective norm is defined as perceived social pressure to perform or not perform a given behavior. The higher the PBC and the more positive the attitude and subjective norm, the greater the individual's intention would be to perform a given behavior [18].

Methods

Complete details regarding the methods of the parent study have been provided elsewhere [17]; hence, a summary of the main methods with supplemental information on TPB variable assessment is presented here. Ethical approval was obtained to approach consecutive patients through the Rapid Access Palliative Radiotherapy Program multidisciplinary brain metastases clinic [19] at the Cross Cancer Institute in Edmonton, Canada. Eligibility criteria included the following: (a) diagnosis of brain metastases; (b) 18 years of age or older; (c) able to understand, provide written informed consent in, and speak English; and (d) cognitive ability to participate (defined as normal Folstein's Mini-Mental State Score for patient's age and education level [20]). Participants were ineligible if they presented either with a Palliative Performance Scale level of 30% or less [21], or any absolute contraindications to physical activity.

At the time of survey, all participants were asked to wear an activPAL™ accelerometer [22] to monitor supine, sitting, standing, and stepping levels for up to 7 days of their whole brain radiotherapy treatments. The study coordinator administered a cross-sectional survey via face-to-face interviews to all participants. At the beginning of each interview, the study coordinator defined physical activity as any bodily movement produced by the skeletal muscles that results in a substantial increase in energy expenditure over resting levels [23]. Each TPB standardized item has established reliability and validity from previous research in cancer populations [13–16]. Scores for each TPB variable were calculated through averages of the respective items.

Attitude. The scales were preceded by the phrase 'I think that for me to perform regular physical activity over the next month would be…' Six items were used to assess affective (i.e., enjoyable/unenjoyable, pleasurable/painful, and fun/boring) and instrumental (i.e., useful/useless, beneficial/harmful, and important/unimportant) attitudes. The 7-point scales were used with the descriptors of extremely (1 and 7), quite (2 and 6), and slightly (3 and 5; 4 was not labeled). As measured by Cronbach's α, internal consistency for affective and instrumental attitude was 0.95 and 0.75, respectively.

Subjective norm. For injunctive norms, the scales were preceded by the phrase 'I think that if I engaged in regular physical activity over the next month, most people who are important to me would be…' Three items were used to assess injunctive norm. (i.e., approving/disapproving, encouraging/discouraging, and supportive/unsupportive). For descriptive norms, the scales were preceded by the phrase 'I think that over the next month, most people who are important to me will themselves be…' Two items were used to assess descriptive norm (i.e., active/inactive and agree/disagree that important others will be physically active regularly). The 7-point scales were used with the descriptors of extremely/strongly (1 and 7), quite/moderately (2 and 6), and slightly (3 and 5; 4 was not labeled). As measured by Cronbach's α, internal consistency for injunctive and descriptive norm was 0.97 and 0.81, respectively.

PBC and self-efficacy. The phrase 'If you were really motivated…' followed by (a) how controllable would it be for you to do regular physical activity over the next month? (1 [extremely uncontrollable] to 7 [extremely controllable] was used to measure PBC. The phrase 'if you were really motivated…' followed by 'how confident

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would you be that you could do regular physical activity over the next month (1 [extremely unconfident] to 7 [extremely confident]) was used to measure self-efficacy.

Intention. Three items were used to assess intention: (a) how motivated are you to perform regular physical activity over the next month? (1 [extremely unmotivated] to 7 [extremely motivated]), (b) how committed are you to doing regular physical activity over the next month? (1 [extremely uncommitted] to 7 [extremely committed]), and (c) I intend to do regular physical activity over the next month (1 [strongly disagree] to 7 [strongly agree]). As measured by Cronbach's α, internal consistency for intention was 0.93.

Data analysis was performed using SPSS version 20.0 software (SPSS, Inc., Evanston, IL). As supported by a recent systematic review of accelerometry analysis of physical activity and sedentary behavior in older adults [24], participants were divided into two categories on the basis of a roughly median split of their sedentary behavior as measured by the activPAL™ accelerometer (<20.7 vs. ≥20.7 h spent sitting or supine per day). Pearson's correlations were used to examine associations between objectively measured sedentary behavior and TPB constructs, and the intercorrelations between TPB constructs were also analyzed. Medium to large correlations were defined as $r = 0.3$–0.5 according to Cohen [25]. Independent samples *t*-tests were performed to compare the following: (a) differences in objectively measured sedentary behavior based on medical and demographic factors, and (b) differences in TPB constructs based on the cut-point of 20.7 h spent sitting or supine per day. All statistical tests were two-sided ($\alpha = 0.05$). Because of the small sample size, associations were interpreted on the basis of both effect sizes and *p* values. A medium effect size of $d = 0.5$ for between-group comparisons, and $r = 0.3$ for correlations, were considered to be meaningful associations.

Results

Complete details regarding recruitment, sample medical, and demographic characteristics have been provided elsewhere [17]. Briefly, 31 participants were recruited from the Rapid Access Palliative Radiotherapy Program multidisciplinary brain metastases clinic between November 2009 and June 2011. As of November 1, 2013, 90% (28 of 31) of the participants were deceased, with a median survival of 171 days from the time of study consent to the time of death.

Table 1 shows that participants demonstrated high levels of all TPB variables, with means ranging 5.9–6.4 on the 7-point scales. Intercorrelations between TPB variables were generally medium. Overall, instrumental attitude ($r = -0.42$, $p = 0.03$) and affective attitude ($r = -0.43$, $p = 0.04$) showed the strongest correlation with objectively measured sedentary behavior; the negative correlations indicate that higher levels of TPB variables are correlated with lower levels of objectively measured sedentary behavior. The correlation between intention and objectively measured sedentary behavior ($r = -0.32$, $p = 0.10$) was not statistically significant, but potentially meaningful.

Table 2 presents differences in TPB variables between participants based on the median of 20.7 h spent sitting or supine per day. Participants whose activPAL™ accelerometers recorded higher levels of objectively measured sedentary behavior reported significantly lower instrumental attitude ($M = 0.7$, 95% CI 0.0–1.4, $p = 0.051$) and affective attitude ($M = 0.7$, 95% CI 0.0–1.4, $p = 0.041$). Differences in PBC ($M = 0.7$, 95% CI −0.1–1.6, $p = 0.084$), self-efficacy ($M = 0.7$, 95% CI −0.1–1.5, $p = 0.099$), and intention ($M = 0.6$, 95% CI −0.2–1.4, $P = 0.123$) were not statistically significant, but were potentially meaningful (*d* values > 0.5).

Table 3 presents differences in objectively measured sedentary levels based on medical and demographic factors. Participants who were <60 years of age ($M = 19.4$, 95% CI −4.0–0.0, $p = 0.055$) recorded less time spent sitting or supine per day on their activPAL™ accelerometers. There were no other significant or meaningful associations found between objectively measured sedentary levels and BMI, gender, cancer diagnosis, comorbidities, income, education, and marital status.

Table 1. Median time spent sitting or supine in hours per day and theory of planned behavior variables: descriptive statistics and bivariate correlations

Variable	1	2	3	4	5	6	7	Mean	SD
1. Median time spent sitting or supine in hours per day								20.6	2.6
2. Instrumental attitude	−0.42*							6.2	1.0
3. Affective attitude	−0.43*	0.88**						5.9	1.2
4. Injunctive norm	−0.16	0.44*	0.32					6.4	1.1
5. Descriptive norm	0.18	0.17	0.14	0.28				6.4	0.6
6. Perceived behavioral control	−0.15	0.56**	0.37*	0.17	0.19			5.9	1.1
7. Self-efficacy	−0.14	0.48**	0.40*	0.20	0.53**	0.71**		6.0	1.2
8. Intention	−0.32	0.63**	0.53**	0.33	0.18	0.57**	0.37*	5.9	1.0

*$p = 0.05$ (two-tailed).
**$p = 0.01$ (two-tailed).

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Table 2. Difference in theory of planned behavior according to median time spent sitting or supine in hours per day

Variable	Sitting or supine less than 20.7 h per day (N = 12)		Sitting or supine for 20.7 h or more per day (N = 12)		Mean Difference	95% CI	t	Effect Size	p
	Mean	SD	Mean	SD				(d)	
Instrumental attitude	6.6	0.9	5.9	0.9	0.7	0.0–1.4	2.1	0.78	0.051
Affective attitude	6.4	0.8	5.7	1.0	0.7	0.0–1.4	2.2	0.72	0.041
Injunctive norm	6.5	0.5	6.2	1.5	0.4	−0.5–1.3	0.8	0.36	0.41
Descriptive norm	6.3	0.4	6.4	0.7	−0.1	−0.5–0.4	−0.4	−0.18	0.70
Perceived behavioral control	6.2	0.7	5.5	1.3	0.7	−0.1–1.6	1.8	0.67	0.084
Self-efficacy	6.3	0.6	5.6	1.3	0.7	−0.1–1.5	1.7	0.69	0.099
Intention	6.2	0.8	5.6	1.1	0.6	−0.2–1.4	1.6	0.62	0.12

Table 3. Differences in median time spent sitting or supine in hours per day based on demographic and medical variables

Variable	Mean	SD	Mean difference	95% CI	t	Effect size (d)	p
Age (years)			−2.1	−4.1 to−0.2	−2.2	0.89	0.035
Younger than 60 (n = 9)	18.9	2.8					
60 or older (n = 15)	21.0	1.8					
Gender			0.8	−1.2 to 2.9	0.9	0.34	0.41
Male (n = 11)	20.6	1.8					
Female (n = 13)	19.8	2.8					
Body mass index			−1.5	−4.9 to 1.9	−1.1	0.53	0.33
Normal/underweight (n = 7)	19.1	3.6					
Overweight/obese (n = 17)	20.6	1.7					
Diagnosis			0.1	−2.0 to 2.2	0.1	0.08	0.90
Other cancer (n = 11)	20.3	2.4					
Lung cancer (n = 13)	20.1	2.6					
Comorbidities			−0.1	−2.2 to 2.0	−0.1	0.04	0.92
<2 (n = 12)	20.1	2.0					
≥2 (n = 12)	20.1	2.9					

Discussion

The purpose of this study was to examine the demographic, medical, and social-cognitive correlates of objectively measured sedentary behavior in cancer patients with brain metastases undergoing palliative whole brain radiotherapy. Overall, instrumental attitude and affective attitude were the strongest correlates of objectively measured sedentary levels. Although not statistically significant, there were potentially meaningful differences in PBC, self-efficacy and intention, and a potentially meaningful association between intention and objectively measured sedentary behavior. Older age was associated with higher level of objectively measured sedentary behavior. These findings lend rationale to future pilot research exploring behavioral interventions for cancer patients with brain metastases undergoing palliative whole brain radiotherapy.

Consistent with our hypothesis, TPB variables showed medium to large correlations with objectively measured levels of sedentary behavior. In particular, those participants who spent less time sitting or supine per day also reported higher instrumental attitude. These findings correspond with previous research that showed that instrumental attitude is an independent predictor of exercise intentions in multiple myeloma patients [26], bladder cancer patients [27], and lung cancer patients [14]. Because this is an exploratory pilot study, one cannot determine whether patients with brain metastases who anticipated greater benefits from physical activity engaged in less sedentary behavior. Future studies are needed to determine whether emphasizing the unique advantages of physical activity may be one means of improving instrumental attitude and reducing sedentary behavior in this patient population.

Affective attitude was another significant correlate to objectively measured sedentary levels in our sample of advanced cancer patients with brain metastases. Those participants who spent less time sitting or supine per day also reported higher affective attitude than those who recorded spending more time in objectively measured sedentary behavior. These findings correspond with previous research that showed that affective attitude is an independent predictor of exercise intentions in endometrial cancer patients [28], non-Hodgkin's lymphoma patients [29], bladder cancer patients [27], and lung cancer patients [14]. Because this is an exploratory pilot study, it is not known whether patients with brain metastases who felt that physical activity would be enjoyable engaged in less sedentary behavior. Future studies are needed to investigate whether emphasizing the enjoyable elements

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of physical activity may be another means of improving affective attitude and reducing sedentary behavior in this patient population.

From our previous research in advanced cancer patients, affective attitude, self-efficacy, and intention were the strongest correlates of patient-reported physical activity levels [16]. In the present study, affective attitude and instrumental attitude were the strongest correlates, with potentially meaningful associations noted for intention, PBC, and self-efficacy. These differences may be due to the fact that our brain metastases sample had a median survival of 171 days, versus 104 days in our previous sample of advanced cancer patients; conversely, 62% of our brain metastases sample, versus only 4% of our previous sample of advanced cancer patients, had an initial Palliative Performance Status level of >80%. A Palliative Performance Status level of 50% may be more reflective of the activPAL™-recorded median time of 20.7 h spent sitting or supine per day for our sample; this suggests an increase in sedentary behavior during the 7 days encompassing palliative whole brain radiotherapy treatments. These clinical characteristics may indicate that our brain metastases sample may be at an earlier point on the cancer trajectory than our previous sample of advanced cancer patients; future longitudinal studies may elucidate these differences.

In the current study, participants who were <60 years of age, recorded less time spent sitting or supine per day on their activPAL™ accelerometers, compared with those participants who were ≥60 years of age. This corresponds to previous research in bladder cancer patients [27], as well as our previous sample of advanced cancer patients, wherein participants who were <60 years of age reported greater levels of total physical activity than those who were ≥60 years of age [16]. Older patients may not feel as much control over, or attribute the same value to their ability to participate in physical activity, given their comorbidities and perceptions of frailty [30]. Larger prospective studies are required to delineate the potential associations between age and physical activity determinants in this population.

Overall, this is the first study to examine correlates of objectively measured sedentary behavior in cancer patients with brain metastases. Strengths of this study include the objective measurement of sedentary behavior, and the application of a validated social-cognitive theory to physical activity in this understudied population. On the other hand, study weaknesses included the fact that this was a cross-sectional study with a small sample size. Larger studies in this population are required in order to establish standards by which effect sizes can be compared, as well as to examine age-related covariates, such as frailty, which may impact potential recommendations specific to this population. There may be bias in that participants who are interested in physical activity may be more likely to participate in our study. Third, this study did not identify the salient underlying beliefs about physical activity, which may be unique in patients with brain metastases who are undergoing palliative whole brain radiotherapy. The exploratory nature of this pilot study precludes drawing direct clinical implications to this population.

Nevertheless, these findings indicate that instrumental attitude and affective attitude toward physical activity were the strongest correlates of objectively measured sedentary behavior in this sample of advanced cancer patients with brain metastases. Older age was associated with greater levels of objectively measured sedentary behavior. Through emphasizing the potential benefits and enjoyment of physical activity, this information could inform future behavioral interventions in cancer patients with brain metastases. As highlighted by the Physical Activity and Cancer Control framework [3], further pilot studies are warranted to determine the role of physical activity in this understudied population.

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Conflict of interest

The authors have declared no conflicts of interest.

References

1. Mishra SI, Scherer RW, Snyder C, Geigle PM, Berlanstein DR, Topaloglu O. Exercise interventions on health-related quality of life for people with cancer during active treatment. *Cochrane Database Syst Rev* 2012; **8**: CD008465. DOI: 10.1002/14651858.CD008465.pub2
2. Mishra SI, Scherer RW, Geigle PM, *et al*. Exercise interventions on health-related quality of life for cancer survivors. *Cochrane Database Syst Rev* 2012; **8**:CD007566. DOI: 10.1002/14651858.CD007566.pub2
3. Courneya KS, Friedenreich CM. Physical activity and cancer control. *Semin Oncol Nurs* 2007; **23**(4):242–252.
4. Lowe SS, Watanabe SM, Courneya KS. Physical activity as a supportive care intervention in palliative cancer patients: a systematic review. *J Support Oncol* 2009; **7**(1):27–34.
5. Koo K, Zeng L, Chen E, *et al*. Do elderly patients with metastatic cancer have worse quality of life scores? *Support Care Cancer* 2012; **20**(9):2121–2127.
6. Patchell RA. The management of brain metastases. *Cancer Treat Rev* 2003; **29**(6):533–540.
7. Chow E, Fan G, Hadi S, Wong J, Kirou-Mauro A, Filipczak L. Symptom clusters in cancer patients with brain metastases. *Clin Oncol* 2008; **20**:76–82.
8. Dorman S, Hayes J, Pease N. What do patients with brain metastases form non-small cell lung cancer want from their treatment? *Palliat Med* 2009; **23**:594–600.
9. Wood ME. Theoretical framework to study exercise motivation for breast cancer risk reduction. *Oncol Nurs Forum* 2008; **35**(1):89–95.

10. Basen-Engquist K, Carmack CL, Perkins H, *et al.* Design of the steps to health study of physical activity in survivors of endometrial cancer: testing a social cognitive theory model. *Psychol Sport Exerc* 2011; **12**(1):27–35.
11. Milne HM, Wallman KE, Guilfoyle A, Gordon S, Courneya KS. Self-determination theory and physical activity among breast cancer survivors. *J Sport Exerc Psychol* 2008; **30**(1):23–38.
12. Courneya KS, Friedenreich CM, Sela RA, Quinney HA, Rhodes RE, Jones LW. Exercise motivation and adherence in cancer survivors after participation in a randomized controlled trial: an attribution theory perspective. *Int J Behav Med* 2004; **11**(1):8–17.
13. Trinh L, Plotnikoff RC, Rhodes RE, North S, Courneya KS. Correlates of physical activity in a population-based sample of kidney cancer survivors: an application of the theory of planned behavior. *Int J Behav Nutr Phys Act* 2012; **9**:96.
14. Peddle-McIntyre CJ, Bell G, Fenton D, McCargar L, Courneya KS. Changes in motivational outcomes after a supervised resistance exercise training intervention in lung cancer survivors. *Cancer Nurs* 2013; **36**(1):E27–E35.
15. Belanger LJ, Plotnikoff RC, Clark AM, Courneya KS. Determinants of physical activity in young adult cancer survivors. *Am J Health Behav* 2012; **36**(4):483–494.
16. Lowe SS, Watanabe SM, Baracos VE, Courneya KS. Determinants of physical activity in palliative cancer patients: an application of the theory of planned behavior. *J Support Oncol* 2012; **10**:30–36.
17. Lowe SS, Danielson B, Beaumont C, Watanabe SM, Baracos VE, Courneya KS. Associations between objectively-measured physical activity and quality of life in cancer patients with brain metastases. *J Pain Symptom Manage*. 2014. DOI: 10.1016/j.jpainsymman.2013.10.012
18. Ajzen I. The theory of planned behavior. *Organ Behav Hum Decis Process* 1991; **50**:179–211.
19. Danielson B, Fairchild A. Beyond palliative radiotherapy: a pilot multidisciplinary brain metastases clinic. *Support Care Cancer* 2012; **20**(4):773–781.
20. Crum RM, Anthony JC, Bassett SS, Folstein MF. Population-based norms for the Mini-Mental State Examination by age and educational level. *JAMA* 1993; **269**:2391.
21. Anderson F, Downing GM, Hill J, Casorso J, Lerch N. Palliative Performance Scale (PPS): a new tool. *J Palliat Care* 1996; **12**:5–11.
22. Ryan CG, Grant PM, Tigbe WW, Granat MH. The validity and reliability of a novel activity monitor as a measure of walking. *Br J Sports Med* 2006; **40**:779–784.
23. Bouchard C, Shephard RJ. Physical activity, fitness, and health: the model and key concepts. In Physical Activity, Fitness and Health – International Proceedings and Consensus Statement (1st edn), Bouchard C, Shephard RJ, Stephens T (eds.). Human Kinetics Publishers: Champaign, 1994; 77–88.
24. Gorman E, Hanson HM, Yang PH, Khan KM, Liu-Ambrose T, Ashe MC. Accelerometry analysis of physical activity and sedentary behavior in older adults: a systematic review and data analysis. *Eur Rev Aging Phys Act* 2014; **11**:35–49.
25. Cohen J. Statistical Power Analysis for the Behavioral Sciences. Lawrence Erlbaum Associates: Philadelphia, 1988.
26. Jones LW, Courneya KS, Vallance JK, *et al.* Understanding the determinants of exercise intentions in multiple myeloma cancer survivors: an application of the theory of planned behavior. *Cancer Nurs* 2006; **29**(3):167–175.
27. Karvinen KH, Courneya KS, Plotnikoff RC, Spence JC, Venner PM, North S. A prospective study of the determinants of exercise in bladder cancer survivors using the Theory of Planned Behavior. *Support Care Cancer* 2009; **17**(2):171–179.
28. Karvinen KH, Courneya KS, Campbell KL, *et al.* Correlates of exercise motivation and behavior in a population-based sample of endometrial cancer survivors: an application of the Theory of Planned Behavior. *Int J Behav Nutr Phys Act* 2007; **4**:21.
29. Courneya KS, Vallance JKH, Jones LW, Reiman T. Correlates of exercise intentions in non-hodgkin's lymphoma survivors: an application of the Theory of Planned Behavior. *J Sport Exerc Psychol* 2005; **27**(3):335–349.
30. Brassington GS, Atienza AA, Perczek RE, DiLorenzo TM, King AC. Intervention-related cognitive versus social mediators of exercise adherence in the elderly. *Am J Prev Med* 2002; **23**(2 Suppl):80–86.