Internet-Based Physical Activity Intervention Targeting Young Adult Cancer Survivors

Carolyn Rabin, PhD,¹ Shira Dunsiger, PhD,¹ Kirsten K. Ness, PT, PhD,² and Bess H. Marcus, PhD³

Purpose: Young adults who have been treated for cancer face several health and psychosocial risks. To minimize these risks, it is imperative that they address any modifiable risk factors, such as sedentary lifestyle. Unfortunately, more than half of young adult cancer survivors remain sedentary. To facilitate the adoption of physical activity (PA) in this population—potentially reducing health and psychosocial risks—we developed and pilot tested an internet-based PA intervention for young survivors. **Patients and methods:** Eighteen young adults, aged 18 to 39, who had been diagnosed with cancer in the past 10 years were recruited. Participants were randomized to receive access to the PA website for 12 weeks or information about other cancer-related websites. Intervention feasibility and acceptability was assessed only among those in the PA website group; PA and psychosocial outcomes (mood, fatigue) were assessed in both groups. **Results:** Findings revealed that 86% of participants in the PA website group would recommend the intervention to others and most (71%) were “satisfied” or “very satisfied” with it. Further, 100% rated getting onto the website as “very easy” and 86% rated the information on the site as “very easy” to understand. The logging feature, followed by the goal-setting feature, were most often accessed by participants. Participants also rated the graphing and stage-matched manual features as helpful. Estimates of effect sizes for between-group differences at 12 weeks were medium for PA outcomes and large for psychosocial outcomes. **Conclusions:** This internet-based PA intervention targeting young adult cancer survivors is feasible and acceptable and may benefit this population.

Key words: survivorship, physical activity, exercise, internet

YOUNG ADULT CANCER SURVIVORS are a medically vulnerable population who may benefit from behavioral interventions to improve and maintain their health. Those diagnosed with cancer during childhood, adolescence, or young adulthood are at increased risk for adverse health outcomes including cardiovascular disease,^{1–5} second cancers,^{5,6} fatigue,^{7–9} and, in some cases, treatment-related weight gain.^{5,10} Young adult cancer survivors are also more likely than older survivors to report emotional distress^{11,12} and some report difficulty relating to peers because of their cancer experience.¹³ To avoid compounding these risks, it is important that young survivors adopt healthy behaviors.

One key behavioral strategy for promoting health and reducing a range of medical and psychosocial risks is to increase levels of physical activity (PA). Sedentary lifestyle, and associated weight gain, increase risk for cardiovascular disease and certain cancers.^{14–16} Lack of PA, or insufficient PA, is also associated with increased fatigue¹⁷ and reduced quality of

life¹⁸ among survivors. In contrast, survivors participating in PA interventions report reduced fatigue, improved mood, and a greater sense of well-being or quality of life.^{19–21} Physical activity interventions offered to survivors of adult-onset cancers contribute to improved cardiovascular fitness.^{20,21} Even brief home-based interventions focused on increasing moderate-intensity PA yield important benefits.^{22–24} Further, prospective research indicates that PA following the diagnosis of certain forms of cancer reduces risk of recurrence and improves survival.^{25,26} Unfortunately, PA interventions for cancer survivors have not yet targeted young adults.^{19,21} As nearly 60% of young adults diagnosed with cancer during childhood, adolescence, or young adulthood in the United States remain sedentary,²⁷ a sizable percentage of this population could benefit from a PA intervention.

As a first step toward addressing sedentary behavior among young adult cancer survivors, we modified an evidence-based PA website intervention and pilot tested the

¹Centers for Behavioral and Preventive Medicine, The Miriam Hospital and Alpert Medical School of Brown University, Providence, Rhode Island.

²Epidemiology and Cancer Control, St. Jude Children's Research Hospital, Memphis, Tennessee.

³Department of Family and Preventive Medicine, University of California, San Diego, San Diego, California.

intervention with young survivors. Our primary aim was to assess intervention feasibility and acceptability. Secondary aims were to assess key outcomes (PA, mood, fatigue) in order to generate effect-size estimates for use in designing a larger efficacy trial.

Methods

Recruitment

Potentially eligible participants were recruited using both active strategies (e.g., contacting young survivors by telephone and in-person recruitment at oncology clinics in Rhode Island and the long-term follow-up clinic at St. Jude Children's Research Hospital) and passive strategies (e.g., mailings to tumor registry, patients distributing brochures in community locations and advertising on websites targeting survivors). Interested individuals were screened by a research assistant, in-person or by telephone, to determine eligibility. Eighteen survivors were recruited.

Individuals were eligible for the study if they: were aged 18 to 39; were diagnosed with any form of cancer (except non-melanoma skin cancer) in the past 10 years; had completed all surgery, chemotherapy, and radiation therapy; were in cancer remission (i.e., currently no evidence of cancer); spoke and wrote fluently in English; could access the internet regularly; and reported having a sedentary lifestyle. Potential participants were considered sedentary if they participated in vigorous-intensity activity less than once a week for 20 minutes and moderate-intensity activity less than twice a week for 30 minutes each session—that is, if they fell significantly short of the American College of Sports Medicine (ACSM) recommendation to engage in at least 150 minutes of moderate-intensity exercise each week.²⁸ Survivors were excluded from participation if they were pregnant or had any medical condition or severe psychiatric illness (e.g., psychotic disorder) making participation dangerous or very difficult. Those who were eligible based on the screening were asked to supply the name of a physician who could verify that they were in cancer remission and could safely participate in the study.

Procedures

Eligible participants were scheduled for two on-site assessment sessions, though two participants recruited through St. Jude Children's Research Hospital completed assessments by telephone. At the first session, a researcher explained the study, and participants were encouraged to ask questions. After informed consent was obtained, participants received questionnaires to complete. One week later, at the second assessment, participants returned the completed questionnaires and completed a Seven Day Physical Activity Recall²⁹ interview. Following this, participants were randomized into the PA website (Intervention) or comparison (Control) condition.

Intervention. Those randomized to the Intervention condition were given 12 weeks of website access. The intervention website was based on the Step into Motion (SIM) website developed by Dr. Bess Marcus *et al.*³⁰ The original SIM website, grounded in the Transtheoretical model³¹ and social cognitive theory,³² was designed to promote PA among sedentary adults in the general population. This website individually tailors the

intervention to users by providing a PA manual matched to their stage of readiness to adopt PA (i.e., stage-matched manual) and individually tailored, theoretically grounded feedback reports based on users' responses to questionnaires integrated into the website. The website also includes features allowing participants to set weekly PA goals and "log" (i.e., record) PA performed, PA-related information (e.g., strategies to avoid injury), lists of PA resources (e.g., information on hiking trails), and responses to frequently asked questions.

The SIM website was adapted over a period of 6 months for young adult cancer survivors. We collected qualitative feedback on the SIM website from a sample of 10 young survivors and, based on these data, added two features: a link with information on the benefits to and precautions for young survivors increasing their PA and an online discussion forum. The forum allowed participants to communicate with one another about any issues concerning them and was included as young survivors have reported a desire to connect with one another.³³

Participants in the Intervention group were given an introduction to the PA website and each website feature by a researcher. The researcher stressed the importance of entering weekly PA goals, logging PA performed, and completing the monthly questionnaires on the website to trigger the generation of feedback reports. Participants were also encouraged to contribute to the online forum. To ensure that participants were exercising safely, they were instructed to take their heart rate during PA and decrease PA if their heart rate exceeded 70% of their maximum predicted heart rate.^{34,35} In addition, Intervention participants responded to weekly emails asking if they experienced specific physical symptoms (e.g., chest pain) during or after PA, injury, or other medical issues that might impact PA. A researcher contacted participants who endorsed any of these items and instructed them to stop exercising until medical clearance was obtained.

Control. Participants in the Control condition were given information about three publicly available websites for cancer survivors or young survivors: I'm Too Young For This! (www.stupidcancer.com), Planet Cancer (www.planetcancer.org), and Cancer Care (www.cancercare.org). These websites provide useful resources, including online peer support, but not PA information.

Intervention and Control participants completed a follow-up outcome assessment 12 weeks after randomization.

Measures

Demographics. Demographic information was obtained from participants at baseline.

Participant evaluation. Participants in the Intervention group completed a Participant Evaluation of the PA website at the 12-week assessment. Participants rated their overall satisfaction with the intervention and website features. Participants also rated the helpfulness of various website aspects and identified barriers to using the website or exercising.

The following measures were completed at both baseline and 12-week assessments:

Seven-day Physical Activity Recall (PAR). The PAR is a validated, widely used interviewer-administered measure of

TABLE 1. BASELINE CHARACTERISTICS OF THE SAMPLE

	<i>Intervention</i> (<i>n</i> = 8)	<i>Control</i> (<i>n</i> = 10)	<i>All</i> (<i>N</i> = 18)
Gender (% female)	62.50%	50.00%	55.56%
Years Since Diagnosis (<i>SD</i>)	3.26 (2.06)	4.65 (2.78)	4.03 (2.52)
Marital Status (% married)	62.50%*	30.00%*	44.44%
Race (% white)	100%	90.00%	94.44%
Employment (% full-time)	62.50%	70.00%	66.67%
Education (% at least some college)	87.50%	90.00%	94.44%
Income (% \$50,000 or above)	62.50%	33.33%	47.06%
Age (<i>SD</i>)	32.88 (4.88)	31.60 (6.28)	32.17 (5.58)
Number of Children (% at least 1)	62.50%	30.00%	44.44%
Cancer Diagnosis (% of sample)			
Testicular	2 (11.1)	2 (11.1)	4 (22.2)
Thyroid	1 (5.6)	3 (16.7)	4 (22.2)
Leukemia or Lymphoma	2 (11.1)	2 (11.1)	4 (22.2)
Breast	2 (11.1)	1 (5.6)	3 (16.7)
Other	1 (5.6)	2 (11.1)	3 (16.7)
BMI	30.11(10.78)	29.41(6.99)	29.72(8.59)
Baseline PAR (minutes/week)	58.75(44.54)	39.00(35.65)	47.48(39.90)

*Denotes significant between-group differences ($p < 0.05$).

BMI, body mass index; PAR, Seven-day Physical Activity measure; *SD*, standard deviation.

PA.²⁹ Participants report hours spent in sleep, moderate activity, hard activity, and very hard activity. Minutes of at least moderate-intensity PA per week was our primary PA outcome. The PAR has been used in prior research with cancer survivors^{23,24} and validated in several populations, including young adults (without cancer).³⁶

Profile of Mood States (POMS). The POMS is a valid and reliable 65-item measure of mood (i.e., anger, depression, tension/anxiety, vigor, confusion) and fatigue³⁷ that has been used in prior PA intervention studies with cancer survivors.^{23,24} Subscale scores can be summed (with the vigor subscale weighted negatively) to create a “total mood disturbance” score; thus higher scores indicate less favorable mood.

Statistical analysis

Descriptive analyses were conducted on feasibility and acceptability data from Participant Evaluations. Between-group differences in baseline characteristics of participants were assessed using analysis of variance (ANOVA) for continuous outcomes and chi-square tests for categorical outcomes. Means (standard deviations) and percentages are reported for the sample within and across study arm. Data analysis focused on testing differences in mean minutes/week of at least moderate intensity PA at 12 weeks as measured by the PAR. Analysis was conducted on the intent-to-treat sample and thus included all randomized participants. We present the results under which missing outcomes at 12 weeks were imputed by carrying forward baseline values. However, additional analyses were run under various missing data assumptions (completers only, mean imputation, and likelihood-based estimation) and compared to this very conservative approach of imputation. We chose to present this set of results in order to make it comparable to previous PA interventions conducted by this research team.^{30,38} Using a linear regression, we regressed minutes/week at 12 weeks on treatment assignment, controlling for baseline values of the

outcome. Parameter estimates are presented along with unadjusted means at each time point (baseline, 12 weeks). Using a logistic regression model, we assessed whether there were between-group differences in the probability of meeting the ACSM criteria for PA (at least 150 minutes/week of at least moderate-intensity PA). Models were again adjusted for baseline levels of activity and potential confounders of treatment effect (defined as any difference between treatment arms with respect to baseline variables). Furthermore, we assessed whether those randomized to the Intervention condition reported greater changes in key psychosocial outcomes measured in this study (mood, fatigue), using a linear regression model controlling for baseline values of the outcome and potential confounders of the treatment effect (as defined previously). For these analyses, we used only complete cases ($n = 17$). Finally, among Intervention participants, we present summaries of objective website use and most-visited website pages. Website use was defined as number of days in which participants logged on at least once to the study website. Use of the individual website features was defined as the number of days in which participants accessed some part of the feature at least once. Statistical analysis was carried out using SAS 9.3 with the exception of analysis of feasibility and acceptability data, which was conducted using SPSS 14.0.

Results

Fifty-two participants were screened, of which 27 were ineligible (44% too active, 19% medical contraindication, 11% not in remission, 11% diagnosed >10 years prior, 15% other reasons), and seven were not interested in participating. Eighteen participants were randomized—8 to the Intervention and 10 to the Control arm. One Intervention participant withdrew from the study prior to the 12-week assessment, yielding a 94% retention rate. Participant demographic data are summarized in Table 1. The percentage of participants who were currently married (44%) was the only between-group difference between treatment arms at baseline ($p < 0.05$).

TABLE 2. HELPFULNESS RATINGS OF EACH WEBSITE FEATURE BY INTERVENTION GROUP ON PARTICIPANT EVALUATION

Feature	Not at all helpful 1	2	3	4	Very helpful 5
	<i>P</i>				
Goal setting	0	28.6	14.3	28.6	28.6
Logging exercise	0	14.3	14.3	28.6	42.9
Exercise tips	28.6	0	28.6	14.3	28.6
Feedback reports	0	0	42.9	14.3	42.9
Graphs of goals and PA completed	0	14.3	14.3	42.9	28.6
Lists of local exercise resources	14.3	0	28.6	42.9	14.3
Information about exercise issues specific to cancer survivors	14.3	0	28.6	28.6	28.6
Stage-based manual	14.3	0	14.3	57.1	14.3

P, Percentage; PA, physical activity.

Data from Intervention group participants who completed the follow-up assessment ($n=7$) suggest that the PA intervention was feasible and acceptable. With respect to acceptability, 86% said they would recommend the intervention to others, 71% said they were "satisfied" or "very satisfied" with the PA program overall, and the same percentage was satisfied with the information on the PA website. Table 2 details the helpfulness ratings for each website feature. PA logging, graphing, and stage-based manual features were considered most helpful. With respect to intervention feasibility, 100% of Intervention group participants said that getting on the website was "very easy" and most (86%) said the information on the website was "very easy" to understand. When asked about barriers to logging onto the website, 43% reported "none," while others reported lack of time, other commitments (e.g., work), or a slow internet connection. Likewise, Intervention group participants reported that lack of time, and work and family responsibilities interfered with meeting

PA goals. Only one Intervention group participant reported physical symptoms in response to weekly symptom check emails; these were minor (e.g., viral symptoms) and unrelated to the intervention.

Table 3 presents weekly unadjusted minutes of at least moderate-intensity PA at baseline and 12 weeks. Estimates of effect size (based on unadjusted means) for between-group differences at 12 weeks were considered medium (Cohen's $d=0.64$). Furthermore, at 12 weeks, 37.5% of Intervention participants were meeting ACSM criteria for PA compared to 10% of Control participants, corresponding to a medium effect size (effect size for proportions, $h=0.67$). However, regression models did not suggest a significant between-group difference in minutes of at least moderate-intensity PA at follow-up [when controlling for baseline value and marital status, b (regression coefficient)=48.78, SE (standard error)=69.55, $p=0.48$, effect-size (Cohen's $f^2=0.04$), nor in the percentage meeting ACSM criteria for PA (odds ratio (OR)=1.17, 95% confidence interval (CI): 0.96–1.44).

The unadjusted changes in psychosocial outcomes (mood, fatigue) over 12 weeks is also shown in Table 3. Estimates of effect size (based on unadjusted means) for between-group differences at 12 weeks were considered large ($d \geq 0.80$). Regression analyses do not suggest significant between-group differences in mean scores over 12 weeks on the POMS-total mood disturbance scale. However, there was a nearly significant difference in fatigue subscale scores between Intervention and Control group participants ($b = -7.42$, SE=3.70, $p=0.06$), with Intervention participants showing greater reductions in fatigue from baseline to 12 weeks compared to controls.

Among the eight Intervention participants, the average number of website logins was 14.75 ($SD=8.46$). Table 4 details the average number of days Intervention participants accessed each website feature. The PA logging feature was accessed most frequently, followed by goal setting and stage-based manuals.

Discussion

This individually tailored internet-based PA intervention represents one of the first behavioral interventions targeting young adult cancer survivors. The internet was selected for delivering the intervention in part because young adults are

TABLE 3. UNADJUSTED ESTIMATES OF PHYSICAL ACTIVITY LEVELS AND PSYCHOSOCIAL OUTCOMES AT BASELINE AND 12 WEEKS

	Intervention	Control
MVPA (minutes/week)		
Baseline	58.75 (44.54)	39.00 (35.65)
12 weeks	161.25 (221.79)	55.50 (77.48)
Change	102.50 (200.11)	16.50 (54.77)
POMS ^c		
Baseline	29.43 (20.23)	25.88 (29.93)
12 weeks	3.57 (10.03)	20.88 (33.94)
Change ^a	-25.86 (23.42)	-5.00 (27.75)
Fatigue ^c		
Baseline	18.71 (13.66)	15.50 (14.14)
12 Weeks	7.28 (7.61)	12.20 (11.29)
Change ^b	-11.43 (11.65)	-3.30 (5.68)

^aChange < 0 reflects decrease in POMS (i.e., less mood disturbance) at 12 weeks relative to baseline.

^bChange < 0 reflects decrease in fatigue at 12 weeks relative to baseline.

^cData are presented for complete cases only (i.e., complete baseline and 12-week data).

MVPA, Moderate to Vigorous Intensity Physical Activity; POMS, Profile of Mood States.

TABLE 4. AVERAGE NUMBER OF DAYS ON INTERVENTION PARTICIPANTS ACCESSED EACH WEBSITE FEATURE

Website feature	M	SD
PA logging	11.38	7.93
Goal setting	5.25	4.17
Stage-based manual	3.13	2.17
PA-related information	1.25	1.28
PA resources	0.88	1.13
PA tips	0.50	1.07

M, Mean; PA, physical activity; SD, standard deviation.

so familiar with this technology; 93% of 18 to 29 year olds and 81% of 30 to 49 year olds are internet users.³⁹ Further, the internet can be accessed anytime, rendering internet-based interventions more feasible for and appealing to busy young adults.⁴⁰ Most Intervention participants reported satisfaction with the PA intervention and would recommend it to others. Likewise, most found the PA website to be user-friendly with easily understood information. Participants did identify barriers—lack of time, competing work and family demands—to using the intervention website and exercising. These findings are consistent with survey studies in which young survivors cited lack of time as a primary barrier to participating in a PA intervention.^{41,42}

Both objective and self-reported data shed light on which aspects of the intervention participants found most useful. The PA logging feature was most often accessed by participants, and 71.5% gave it one of the two highest helpfulness ratings. These findings are consistent with prior research in which sedentary adults in the general population found the logging feature to be the most helpful aspect of the SIM website.⁴³ The goal-setting feature was the second most frequently accessed. Although not all participants rated this feature as helpful, most found it helpful to graph their PA goals alongside PA performed. Self-monitoring strategies such as goal-setting are known to promote PA,⁴⁴ so it is possible that participants had some awareness they were more likely to exercise if they set weekly goals. Finally, participants accessed the stage-matched manuals more frequently than some other features and most rated the manuals as helpful. This is consistent with prior research in which participants who received information tailored to their motivational readiness to adopt PA became more physically active.^{23,45}

Given our sample size, we did not anticipate finding significant between-group differences for outcomes; nonetheless, our findings suggest that this internet-based PA intervention may benefit young survivors. By the 12-week follow-up, participants in the Intervention group increased their PA by just over 100 minutes/week on average, whereas the Control group increase was far more modest (16.5 minutes/week). These outcomes are similar to those achieved by a telephone-based PA intervention targeting breast cancer survivors.²³ Although the difference in PA between Intervention and Control groups was not significant, it represents a moderate effect size. This effect size is larger than that found in the original SIM trial ($d=0.22$, small effect) and a home-based, moderate-intensity PA intervention for gynecologic cancer survivors (small-to-moderate effect⁴⁶). The

effect sizes for mood and fatigue outcomes were large (whereas a prior intervention found small-to-moderate effects for these outcomes⁴⁶). Findings suggest that a larger, adequately powered study of this intervention is likely to demonstrate efficacy in helping young survivors increase PA, with corresponding reductions in fatigue and improved mood also likely.

There are some study limitations, with small sample size being the primary limitation. Although we believe our sample was adequate to achieve the primary study goals—determine intervention feasibility and acceptability and generate effect-size estimates for key outcomes—a larger trial is needed to draw conclusions about intervention efficacy. In addition, although the sample was fairly balanced with respect to gender, it was composed primarily of well-educated, white individuals (despite recruiting from St. Jude Hospital which serves a lower socioeconomic population) and may not represent the young survivor population as a whole. For example, young survivors who are not as well educated or whose first language is not English may not find the website user-friendly. This emphasizes the need for additional research with a larger and more diverse sample. Additional research is also needed to determine why certain website features were not frequently accessed by participants. For example, although young adult cancer survivors report the desire for increased opportunities to connect with one another,^{33,42} only one participant posted a message in the online forum. However, in this small study, there may not have been enough Intervention participants enrolled at any given time to sustain a dialog online. Other limitations are that we were unable to track overall internet use by Intervention and Control participants or whether Controls accessed the suggested cancer-related websites. Despite these limitations, this study represents the first step toward developing an intervention with the potential to increase PA among young adults previously diagnosed with cancer. We hope to extend this research by conducting a larger efficacy trial with young survivors and testing the intervention with other cancer populations.

Acknowledgments

This research was funded by an award from the National Cancer Institute (R03 CA134197). We express our gratitude to Fred Schiffman, MD, Santina Horowitz, Beverly Procopio, and Carrie Howell, MS, for their valuable contributions to the study.

Disclosure Statement

No competing financial interests exist.

References

- Meacham LR, Chow EJ, Ness KK, *et al.* Cardiovascular risk factors in adult survivors of pediatric cancer—a report from the Childhood Cancer Survivor Study. *Cancer Epidemiol Biomarkers Prev.* 2010;19:170–181.
- Swerdlow AJ, Higgins CD, Smith P, *et al.* Myocardial infarction mortality risk after treatment for Hodgkin disease: a collaborative British cohort study. *J Natl Cancer Inst.* 2007; 99:206–214.

3. van den Belt-Dusebout AW, Nuver J, de Wit R, *et al.* Long-term risk of cardiovascular disease in 5-year survivors of testicular cancer. *J Clin Oncol.* 2006;24:467–475.
4. Huddart RA, Norman A, Shahidi M, *et al.* Cardiovascular disease as a long-term complication of treatment for testicular cancer. *J Clin Oncol.* 2003;21:1513–1523.
5. Shapiro CL, Recht A. Side effects of adjuvant treatment of breast cancer. *N Engl J Med.* 2001;344:1997–2008.
6. Travis LB, Hill D, Dores GM, *et al.* Cumulative absolute breast cancer risk for young women treated for Hodgkin lymphoma. *J Natl Cancer Inst.* 2005;97:1428–1437.
7. Greenfield DM, Walters SJ, Coleman RE, *et al.* Prevalence and consequences of androgen deficiency in young male cancer survivors in a controlled cross-sectional study. *J Clin Endocrinol Metab.* 2007;92:3476–3482.
8. Langeveld N, Ubbink M, Smets E. “I don’t have any energy”: the experience of fatigue in young adult survivors of childhood cancer. *Eur J Oncol Nurs.* 2000;4:20–28.
9. Thewes B, Butow P, Girgis A, Pendlebury S. The psychosocial needs of breast cancer survivors; a qualitative study of the shared and unique needs of younger versus older survivors. *Psychooncology.* 2004;13:177–189.
10. Dickerman JD. The late effects of childhood cancer therapy. *Pediatrics.* 2007;119:554–568.
11. Burgess C, Cornelius V, Love S, *et al.* Depression and anxiety in women with early breast cancer: five year observational cohort study. *Br Med J.* 2005;330:702.
12. Parker PA, Baile WF, de Moor C, Cohen L. Psychosocial and demographic predictors of quality of life in a large sample of cancer patients. *Psychooncology.* 2003;12:183–193.
13. Reuben SH. Living beyond cancer: finding a new balance. Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute; May 2004.
14. Thune I, Brenn T, Lund E, Gaard M. Physical activity and the risk of breast cancer. *N Engl J Med.* 1997;336:1269–1275.
15. United States Department of Health and Human Services. Physical activity and health: a report of the Surgeon General. Atlanta, GA: United States Department of Health and Human Services, Centers for Disease Control and Prevention; 1996.
16. Wilson PW, D’Agostino RB, Sullivan L, *et al.* Overweight and obesity as determinants of cardiovascular risk: the Framingham experience. *Arch Intern Med.* 2002;162:1867–1872.
17. Ng AK, Li S, Recklitis C, *et al.* A comparison between long-term survivors of Hodgkin’s disease and their siblings on fatigue level and factors predicting for increased fatigue. *Ann Oncol.* 2005;16:1949–1955.
18. Courneya KS, Karvinen KH, Campbell KL, *et al.* Associations among exercise, body weight, and quality of life in a population-based sample of endometrial cancer survivors. *Gynecol Oncol.* 2005;97:422–430.
19. Courneya KS. Exercise in cancer survivors: an overview of research. *Med Sci Sports Exerc.* 2003;35:1846–1852.
20. Galvao DA, Newton RU. Review of exercise intervention studies in cancer patients. *J Clin Oncol.* 2005;23:899–909.
21. Knols R, Aaronson NK, Uebelhart D, *et al.* Physical exercise in cancer patients during and after medical treatment: a systematic review of randomized and controlled clinical trials. *J Clin Oncol.* 2005;23:3830–3842.
22. Courneya KS, Friedenreich CM, Sela RA, *et al.* The group psychotherapy and home-based physical exercise (GROUP-HOPE) trial in cancer survivors: physical fitness and quality of life outcomes. *Psychooncology.* 2003;12:357–374.
23. Pinto BM, Frierson GM, Rabin C, *et al.* Home-based physical activity intervention for breast cancer patients. *J Clin Oncol.* 2005;23:3577–3587.
24. Rabin C, Pinto B, Dunsiger S, *et al.* Exercise and relaxation intervention for breast cancer survivors: feasibility, acceptability and effects. *Psychooncology.* 2009;18:258–266.
25. Holmes MD, Chen WY, Feskanich D, *et al.* Physical activity and survival after breast cancer diagnosis. *JAMA.* 2005;293:2479–2486.
26. Meyerhardt JA, Giovannucci EL, Holmes MD, *et al.* Physical activity and survival after colorectal cancer diagnosis. *J Clin Oncol.* 2006;24:3527–3534.
27. Coups EJ, Ostroff JS. A population-based estimate of the prevalence of behavioral risk factors among adult cancer survivors and noncancer controls. *Prev Med.* 2005;40:702–711.
28. Haskell WL, Lee IM, Pate RR, *et al.* Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc.* 2007;39:1423–1434.
29. Blair SN, Haskell WL, Ho P, *et al.* Assessment of habitual physical activity by a seven-day recall in a community survey and controlled experiments. *Am J Epidemiol.* 1985;122:794–804.
30. Marcus BH, Lewis BA, Williams DM, *et al.* A comparison of internet and print-based physical activity interventions. *Arch Intern Med.* 2007;167:944–949.
31. Prochaska JO, DiClemente CC. Stages and processes of self-change of smoking: toward an integrative model of change. *J Consult Clin Psychol.* 1983;51:390–395.
32. Bandura A. Social Foundations of Thought and Action: A Social Cognitive Theory. Englewood Cliffs, NJ: Prentice-Hall; 1986.
33. Zebrack B, Bleyer A, Albritton K, *et al.* Assessing the health care needs of adolescent and young adult cancer patients and survivors. *Cancer.* 2006;107:2915–2923.
34. Gulati M, Shaw LJ, Thisted RA, *et al.* Heart rate response to exercise stress testing in asymptomatic women: the St. James Women Take Heart Project. *Circulation.* 2010;122:130–137.
35. Fox S, Naughton JP, Haskell WL. Physical activity and the prevention of coronary heart disease. *Ann Clin Res.* 1971;3:404–432.
36. Dishman RK, Steinhardt M. Reliability and concurrent validity for a 7-d re-call of physical activity in college students. *Med Sci Sports Exerc.* 1988;20:14–25.
37. McNair DM, Lorr M, Droppelman LF. Profile of Mood States: Manual. San Diego: Educational and Testing Service; 1971.
38. Marcus BH, Napolitano MA, King AC, *et al.* Telephone versus print delivery of an individualized motivationally tailored physical activity intervention: Project STRIDE. *Health Psychol.* 2007;26:401–409.
39. Pew Research Center. Internet User Profiles Reloaded. Washington, DC: Pew Research Center; 2010.
40. Marcus BH, Owen N, Forsyth LH, *et al.* Physical activity interventions using mass media, print media, and information technology. *Am J Prev Med.* 1998;15:362–378.
41. Arroyave WD, Clipp EC, Miller PE, *et al.* Childhood cancer survivors’ perceived barriers to improving exercise and dietary behaviors. *Oncol Nurs Forum.* 2008;35:121–130.

42. Rabin C, Simpson N, Morrow K, Pinto B. Behavioral and psychosocial program needs of young adult cancer survivors. *Qual Health Res.* 2011;21:796–806.
43. Lewis B, Williams D, Dunsiger S, *et al.* User attitudes towards physical activity websites in a randomized controlled trial. *Prev Med.* 2008;47:508–513.
44. Rovniak LS, Anderson ES, Winett RA, Stephens RS. Social cognitive determinants of physical activity in young adults: a prospective structural equation analysis. *Ann Behav Med.* 2002;24:149–156.
45. Marcus BH, Bock BC, Pinto BM, *et al.* Efficacy of an individualized, motivationally-tailored physical activity intervention. *Ann Behav Med.* 1998;20:174–180.
46. Donnelly CM, Blaney JM, Lowe-Strong A, *et al.* A randomized controlled trial testing the feasibility and efficacy of a physical activity behavioural change intervention in managing fatigue with gynaecological cancer survivors. *Gynecol Oncol.* 2011;122:618–624.

Address correspondence to:
Carolyn Rabin, PhD
Coro Building West, Suite 309
1 Hoppin Street
Providence, RI 02903
E-mail: crabin@lifespan.org