Nursing Research • January/February 2007 • Vol 56, No 1, 18–27

Motivational Interviewing to Increase Physical Activity in Long-Term Cancer Survivors

A Randomized Controlled Trial

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Editor's Note

Materials documenting the review process for this article are posted at http://www.nursing-research-editor.com.

▶ ***Background:*** Physical activity can confer many benefits on cancer survivors, including relief of persistent symptoms related to cancer treatment.

▶ ***Objectives:*** To evaluate the effect of a motivational interviewing (MI) intervention on increasing physical activity (Community Healthy Activities Model Program for Seniors questionnaire) and improving aerobic fitness (6-minute walk), health (Medical Outcomes Study Short-Form 36), and fatigue (Schwartz Cancer Fatigue Scale) in cancer survivors. A secondary purpose was to evaluate whether the effect of MI on physical activities depended on self-efficacy.

▶ ***Methods:*** Fifty-six physically inactive adult cancer survivors (mean = 42 months since completion of treatment) were assigned randomly to intervention and control groups. The MI intervention consisted of one in-person counseling session followed by two MI telephone calls over 6 months. Control group participants received two telephone calls without MI content. Outcomes were measured at baseline, 3 months, and 6 months, and were analyzed using multilevel modeling.

▶ ***Results:*** The results of the MI intervention explained significant group differences in regular physical activities (measured in caloric expenditure per week), controlling for time since completion of cancer treatment ($p < .05$). Aerobic fitness, physical and mental health, and fatigue were not different between groups. In the intervention group, individuals with high self-efficacy for exercise at baseline increased their physical activity more than those with low self-efficacy ($p < .05$). In the control group, increases in physical activity did not depend on self-efficacy.

▶ ***Discussion:*** Use of MI may increase physical activity in long-term cancer survivors, especially in persons with high self-efficacy for exercise. Multilevel modeling analysis revealed individual changes that would not have been shown by analysis of group means. Future studies with larger samples or more intense MI interventions may show changes in aerobic fitness, physical and mental health, and fatigue.

▶ ***Key Words:*** adult · exercise · physical activity · randomized controlled trial

The 10 million cancer survivors in the United States range from those recently diagnosed to survivors many years beyond cancer treatment (National Cancer Policy Board, 2006). Cancer survivors report a number of emotional, physical, and cognitive symptoms that may be related to the after-effects of cancer treatment or to the disease itself (Ganz, Rowland, Desmond, Meyerowitz, & Wyatt, 1998; Nail, 2001). One of these is fatigue, a symptom that often persists well beyond the treatment period (Curt et al., 2000; Nail, 2001, 2002).

It has been demonstrated in a number of studies that physical activity decreases fatigue and improves physical functioning, health, and quality of life during, or immediately after, cancer treatment (Dimeo, 2002; Knols, Aaronson, Uebelhart, Fransen, & Aufdemkampe, 2005; Pinto, Frierson, Rabin, Trunzo, & Marcus, 2005; Schwartz, Mori, Gao, Nail, & King, 2001; Thorsen et al., 2005). Recent research suggests that physical activity may have similar beneficial effects for cancer survivors who are more than 6 months beyond cancer treatment (Courneya et al., 2003), but few randomized trials of physical activity

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interventions have been conducted in long-term cancer survivors (Courneya, 2003; Galvao & Newton, 2005; Knols et al., 2005; Schmitz et al., 2005).

Although physical activity has multiple benefits, many adults, including cancer survivors, are unable to maintain habitual physical activities. Thus, an important public health goal is to develop strategies to help people, with and without cancer, adopt physical activity habits and maintain activities long-term. Motivational interviewing (MI) may be such a strategy. It is a client-centered counseling procedure designed to help clients discover and overcome their own barriers to changing a health behavior. In contrast to many educational interventions, MI counselors maintain a neutral tone intended to help individuals explore their own solutions to implementing behavioral change, rather than offering advice or education.

The transtheoretical model, a framework for understanding behavioral change as a process of moving through stages of readiness, has played an important role in the development of MI (DiClemente & Velasquez, 2003; Prochaska & Velicer, 1997). According to the transtheoretical model, individuals cycle back and forth through several stages of change: precontemplation (not thinking about becoming more active), contemplation (considering a change), preparation (making small changes), action (actively engaging in a new behavior), and maintenance (continuing the new activity over time). A key concept of MI is that an individual's self-efficacy, or belief that he or she can accomplish a behavior change, is a predictor of treatment outcome (Emmons & Rollnick, 2001; Marshall & Biddle, 2001; Miller & Rollnick, 2002). Perceived self-efficacy, derived from the framework of social cognitive theory, refers to an individual's belief that he or she can organize and carry out actions, an essential component of undertaking a new activity and continuing to engage in that activity. Unless people believe that they can complete a task and that completing this task can produce the outcomes they desire, they have little incentive to act or to persevere in the face of difficulties (Bandura, 1977, 1986).

The primary purpose of this prospective randomized controlled trial of 56 cancer survivors was to test whether MI would help long-term cancer survivors increase their participation in self-selected regular physical activities. A secondary purpose was to evaluate whether the effect of MI on change in physical activity depended on individual levels of self-efficacy for exercise. In addition, the effect of MI was evaluated on other outcomes associated with increased physical activity: aerobic fitness, physical health status, mental health status, and fatigue. Outcomes were evaluated using multilevel modeling (MLM), which allowed analysis of individual variance that cannot be evaluated using traditional analysis of variance (ANOVA) for group means.

Methods

Participants

Participants were recruited from the community using advertising and word of mouth. Eligible participants were cancer survivors aged 18 years or older; who completed treatment at least 6 months prior to enrollment; and who were fatigued, underactive (engaged in planned exercise fewer than 3 days a week for 20 minutes per session), and willing to try to increase their regular physical activity. People were ineligible if they had prior transplant treatment for cancer, current immunosuppressive therapy, medical conditions that contraindicated moderate exercise, cognitive difficulties, or psychiatric disorders. This study was funded by the Lance Armstrong Foundation and procedures were approved by the University Institutional Review Board.

Procedures

Initial screening by telephone was followed by an individual enrollment appointment, at which each participant signed an informed consent, completed baseline surveys, and performed a 6-minute walk test. Height and weight were measured. At the completion of the baseline measurements, a physical activity counselor assigned each participant to either the intervention or the control group according to a computer-generated randomization scheme, in which assignments were placed in sealed envelopes prior to study. The physical activity counselor conducted the MI intervention and outcome measurements and was not blinded to group assignment. The target sample size of 56 participants was sufficient to detect an effect size (ES) of .83 on the outcomes with a power of .80 and an alpha level of .05, allowing for 10% attrition.

Motivational Interviewing Intervention

Participants assigned to the intervention group received a counseling session during the enrollment appointment immediately following group assignment. The session was conducted by the physical activity counselor in a private room furnished with upholstered chairs, small tables, and floor lamps, designed to create a relaxing homelike setting. Each session was approximately 30 minutes long and consisted of conversations consistent with MI (Miller & Rollnick, 2002) and tailored according to the needs of each participant. For example, if a person wanted to discuss the many reasons why beginning an exercise program was difficult, the counselor might use a decisional balance exercise, in which the participant is asked to name the pros and cons of engaging in regular physical activity. Such an exercise usually elicits recognition by the participant that the good effects of exercise outweigh the difficulties and this can be followed by encouraging the participant to find individualized ways to overcome barriers to getting started. A counselor trained in MI has a number of strategies to use, depending on the progress of the conversation with the client, but all conversation is client-centered; the counselor does not educate or offer unsolicited advice about how to change exercise behavior. Instead, the counselor uses careful listening, summarizing, feedback, and affirmation, and tries to build the participant's self-efficacy, or confidence, that barriers can be overcome. Thus, the conversations with each client may be different, but the underlying consistency with MI is maintained.

During the initial counseling session, the participant was encouraged to identify barriers to engaging in regular exercise, and the physical activity counselor and the participant worked together to develop ideas to overcome

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barriers. The overall goal was to encourage all participants to advance toward a goal of 30 minutes of moderate-intensity planned physical activity on most days of the week, but some participants started with more modest goals. Each intervention participant received a pedometer (New Lifestyles Digi-Walker, model SW 701) and was shown how to use it as a motivator for walking exercise, but participants were not required to walk if they preferred another form of moderate-intensity exercise. Pedometers were not a measure of physical activity in this trial. Instead, they were supplied because monitoring steps may motivate participants to walk for exercise (Tudor-Locke & Bassett, 2004).

Two weeks after the initial counseling session, the physical activity counselor telephoned each participant to help solve problems early in the adoption of the new physical activity program, followed by two more telephone calls at 2 months and 4.5 months after enrollment. Telephone calls were planned to last about 20 minutes, and the conversation included motivational strategies directed at solving problems, offering encouragement, and reformulating goals, if needed. Participants were asked about adverse events or problems during each call. Participants returned at 3 and 6 months for outcome measurement appointments, providing additional opportunities to speak in person to the physical activity counselor about their physical activity programs.

Participants assigned to the control group were asked to maintain their current levels of physical activity, although they were not required to do so. They did not receive pedometers or in-person counseling, but received two telephone calls from the physical activity counselor at 2 and 4.5 months. The calls were used to set times for the 3- and 6-month measurement appointments and for brief social conversations, but MI strategies were not used. Participants in both groups received yellow plastic Livestrong bracelets from the Lance Armstrong Foundation and were paid $10 at each of the three measurement sessions.

The physical activity counselor was a master's-prepared research assistant who received 8 hours of group training and 6 hours of individual training by an experienced MI trainer who had met the requirements of the Motivational Interviewing Network of Trainers (Motivational Interviewing, 2005). During the study, the trainer also evaluated a sample of recorded MI sessions with participants and discussed them with the physical activity counselor to insure that appropriate MI strategies were used consistently.

Outcome Variables

The outcomes were measured by the physical activity counselor at enrollment, at 3 months, and then at 6 months. Survey measures were sent to participants prior to the 3- and 6-month measurement appointments; participants could choose to complete surveys at home and bring to the appointments or complete the surveys during the measurement appointment, when height, weight, and the 6-minute walk test were measured.

Regular Physical Activities Physical activities were measured by the Community Healthy Activities Model Program for Seniors (CHAMPS) Physical Activity Questionnaire for Older Adults (Stewart et al., 2001), which is appropriate for sedentary adults of all ages. The CHAMPS questionnaire asks about sedentary, low, moderate, and vigorous activities during the last 4 weeks. One item about participation in an adult day center was deleted, leaving 40 items scored in hours per week. Scores were converted to caloric expenditure per week (kcal/wk) in all activities, a calculation provided by the developers of the CHAMPS instrument. The CHAMPS questionnaire has demonstrated sensitivity to change ($p < .01$) in older adults in studies with moderate (.38–.64) effect sizes (Stewart et al., 2001). Higher scores indicate higher levels of regular physical activities.

Aerobic Fitness Aerobic fitness was measured by distance (in feet) walked in the 6-minute walk test (Guyatt et al., 1985; Lipkin, Scriven, Crake, & Poole-Wilson, 1986; Meyer et al., 1997; Zugck et al., 2000), conducted on a circular measured course in an indoor exercise facility. Participants were told the object of the test was to walk as far as possible in 6 minutes, but they could stop to rest and then continue, if needed. The tester used a protocol for instructions, timing, and verbal encouragement during test. The 6-minute walk test has demonstrated retest reliability of 91% in patients with cardiopulmonary disease (Steele, 1996) and is used commonly in studies of other populations, including cancer survivors. Longer distances in the 6-minute walk test indicate higher levels of aerobic fitness.

Physical Health Status and Mental Health Status Health status variables were measured by the Medical Outcomes Study Short-Form 36 (SF-36, v.2) Physical Component Summary (PCS) and Mental Component Summary (MCS; Ware, 2005). The PCS includes scales of physical functioning, role-physical, pain, and general health. The MCS includes scales of vitality, social functioning, role-emotional, and mental health. The PCS and MCS scores were transformed to norm-based scoring, in which scores had a mean of 50 and a standard deviation of 10 in the 1998 U.S. population (Ware, 2005). Good internal consistency reliability ($\alpha > .80$) has been reported for all the SF-36 scales in a variety of populations and the instrument has been used previously in cancer survivorship studies (Ware, Kosinski, & Gandek, 2000). Scores range from 0 to 100, with higher scores indicating better physical or mental health status.

Fatigue Fatigue was measured by the Schwartz Cancer Fatigue Scale (Schwartz & Meek, 1999), a 6-item scale developed to measure cancer fatigue specifically. Good internal consistency reliability ($\alpha > .85$) and sensitivity to change have been demonstrated in cancer survivors (Schwartz et al., 2002). The summed score ranges from 6 to 30, with higher scores indicating more fatigue.

Descriptive Variables

Self-Efficacy for Regular Physical Activities Self-efficacy was measured by a 6-item measure of self-efficacy for physical activity (Nigg & Riebe, 2002). Participants indicate confidence that they can exercise on a 5-level Likert scale (from *not at all confident* to *completely confident*) for six barriers (e.g., bad weather). Internal consistency

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reliability (α = .91) was reported for a similar scale in pooled data from several studies (Wilson, Allen, & Li, 2006), indicating good consistency for all self-efficacy scales, as self-efficacy is a universal construct that measures similarly across scales (Nigg & Riebe, 2002). Summed scores range from 6 to 30, with higher scores indicating higher self-efficacy for exercise.

Descriptive Variables Descriptive variables were measured by surveys and measurements at the baseline enrollment appointment, including demographic variables, medical conditions, months since ending cancer treatment, and type of cancer. Height and weight were measured at baseline, 3 months, and 6 months. Stage of change for exercise was measured using the 6-item Physical Activity

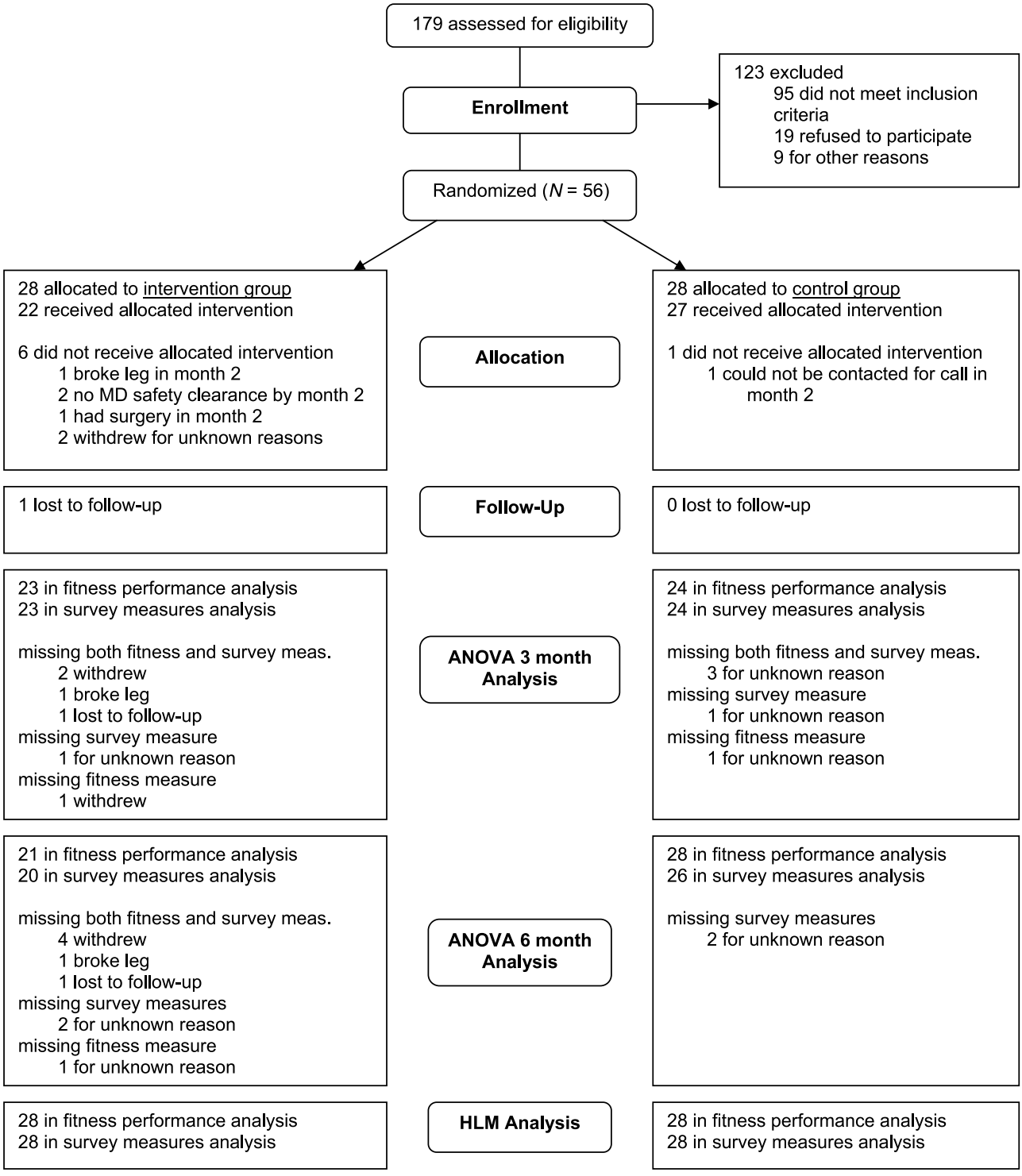

FIGURE 1. Flow of participants through the trial.

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State Assessment measure developed for the NIH Behavior Change Consortium (Behavior Change Consortium, 2005).

Statistical Analysis

The use of MLM capitalizes on multiple times of measurement to examine explicitly (a) individual variation around average trajectory over time and (b) predictors of individual change. The key statistical advantage over other methods is that it controls for the dependencies among the repeated measurements. The key design advantage is that it allows for differences in the number of times of measurement across individuals when random *missingness* exists, so cases with missing data can be included in the analyses (Raudenbush & Bryk, 2002).

In this study, MLM analysis using HLM 6 software (Raudenbush, Bryk, & Congdon, 2004) was used to examine five separate growth curve analyses, one for each outcome variable. At Level 1, each individual's change was represented by an individual intercept (baseline value) and slope (rate of change) and by whether the intercept and slope varied significantly from the population mean intercept and slope. For outcome variables with no significant individual variance around the population mean slope, ANOVA analysis was conducted because group means were the best estimate of variance. For outcome variables with significant individual variation around the population mean slope, Level 2 MLM models were run to evaluate whether group assignment explained the individual variance in rate of change (Raudenbush & Bryk, 2002).

All Level 2 analyses were conducted controlling for months since completion of cancer treatment because the broad range (1–17 years) in this sample raised the possibility that there might be a between-individual effect of recent versus remote treatment on willingness to engage in activities. In addition, for the physical activity outcome, an interaction analysis was conducted to determine whether the effect of group assignment on physical activity depended on individual self-efficacy for exercise at baseline. Additional covariates were not added to the models because three predictors—group, time since cancer treatment, and self-efficacy (for the physical activity outcome)—were reasonable for the sample size in this study, and because the randomization scheme successfully distributed key characteristics equally between the two groups.

Statistical analysis was conducted using intention-to-treat methods. For MLM analyses, maximum likelihood estimation was used to account for missing data. For ANOVA, mean imputation was used for missing data if at least 75% of items were answered on a survey measure. If fewer than 75% of items were answered on a survey, or if the measure was missing completely, cases were not included in ANOVA.

Results

Participant Flow

Fifty-six cancer survivors were enrolled between July and December 2004, and the study ended in July 2005. Figure 1 shows the flow of participants through the trial.

Description of Participants at Baseline

Participants were primarily women, White, breast cancer survivors with a mean of 42 months since completing cancer treatment (Table 1). Almost all were planning to begin an exercise program within the next 6 months,

TABLE 1. Baseline Characteristics of Participants (*N* = 56)

	Intervention Group *n* = 28	Control Group *n* = 28	Intervention vs. Control
	M (*SD*) or *n*	*M* (*SD*) or *n*	*p*
Age (years; range: 37–85)	55.5 (8.9)	60.1 (11.0)	.08
Gender			.39
Female	26	24	
Male	2	4	
Married or partnered	19	16	.81
Race or ethnicity			not calculated
White	27	28	
Latino	1	0	
Education			.83
Associate degree or above	19	22	
Employment			.15
Full-time	13	9	
Part-time	6	4	
Homemaker	2	0	
Retired or unemployed	7	15	
Body Mass Index	29.6 (6.4)	26.6 (7.2)	.93
Time since cancer diagnosis (years; range: 1–23)	4.8 (3.0)	6.9 (5.9)	.10
Type of cancer			.52
Breast	20	23	
Other	8	6	
Time since ending cancer treatment (months; range: 6–206)	33.7 (30.5)	50.3 (53.8)	.16
Intending to begin exercise in next 30–180 days (contemplation stage of change for exercise)	24	26	.69
Self-efficacy for exercise	20.3 (5.3)	20.7 (5.6)	.87

Note. t Tests were used to compare means of continuous variables and chi-square tests were used to compare categorical variables.

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indicating they were in the *contemplation* stage. There were no statistically significant differences between the groups in baseline characteristics.

Delivery of the Intervention

The physical activity counselor completed all initial counseling sessions (average length = 24 minutes, range = 14–50 minutes) and completed 98% of scheduled telephone calls. Calls were considered not completed if they did not occur within 1 day before or 7 days after the targeted date, or after 10 attempts did not result in a completed call. Telephone calls to intervention group participants averaged 10 minutes, and calls to control group participants averaged 4.5 minutes.

There were no deviations from the trial protocol as planned. However, for 1 month during the intervention period, the physical activity counselor was unable to work, and another research assistant, trained in MI, conducted 21 intervention and control telephone calls and eleven 3-month measurement appointments.

Changes in Outcomes

Group mean scores on outcome variables at baseline, 3 months, and 6 months are shown in Table 2. At baseline, the intervention and control groups had similar mean scores on all outcome measures except mean level of participation in all regular physical activity (measured in kcal/wk), which was significantly lower (p = .04) in the intervention group than in the control group. There were no outliers in the data.

Regular Physical Activities Results of the Level 1 MLM model showed that both the intercept (B = 2,331.46, p < .001) and the linear slope (B = 432.37, p < .05) were significantly different from zero. On average, the level of regular weekly physical activities for all participants was 2,331.46 kcal/wk at baseline, and increased nearly 865 kcal/wk (37%) across the 6-month study. There was significant individual variation in both the intercept and slope to be explained in a Level 2 model (Table 3). As an example of individual variances compared with group mean, 12 individual intercepts and slopes for physical activities, along with the group mean trajectory and slope, are shown in Figure 2. This figure is provided as an illustration of the importance of considering individual variation, rather than simple group means, an advantage of MLM analysis over ANOVA. The 12 trajectories were selected to show the maximum differences in our sample, and are shown for illustrative purposes only.

In the Level 2 model, group assignment accounted for 30% of the variance in the intercept and 47% of the variance in the linear slope of physical activity, controlling for months since completion of cancer treatment. As shown in Table 4, group assignment was associated significantly with regular physical activities at baseline (intercept) and rate of change (slope). Individuals in the intervention group

TABLE 2. Effects of Motivational Intervention on Outcomes in the Exercise Group and Control Group

	Baseline		3 months		6 months		Effect Size	
Outcomes	***n***	***M* (*SD*)**	***n***	***M* (*SD*)**	***n***	***M* (*SD*)**	***n***	***d***
Primary Outcomes								
All activities (kcal/wk)								.55
Exercise group	27	1,928.97 (1,232.58)	23	2,571.04 (1,872.23)	20	3,484.05 (2,445.34)	20	
Control group	28	2,855.66 (2,008.92)	24	2,651.27 (1,590.18)	26	3,252.40 (2,308.33)	26	
Secondary Outcomes								
Aerobic fitness								.09
Exercise group	28	1,607.98 (276.12)	23	1,686.53 (303.95)	21	1,798.68 (313.75)	21	
Control group	28	1,533.99 (307.98)	24	1,654.41 (277.01)	28	1,650.85 (345.85)	28	
Health status (physical)								.40
Exercise group	28	41.32 (7.97)	23	43.95 (8.71)	20	47.11 (11.08)	20	
Control group	28	44.46 (9.79)	24	46.95 (7.72)	26	45.51 (9.80)	26	
Health status (mental)								.24
Exercise group	28	40.92 (9.84)	23	44.13 (8.78)	20	44.42 (8.24)	20	
Control group	28	45.58 (10.26)	24	48.92 (8.79)	26	51.68 (5.98)	26	
Fatigue								.14
Exercise group	25	15.56 (4.64)	23	13.43 (4.23)	20	11.00 (2.90)	19	
Control group	28	15.52 (3.65)	24	11.29 (3.71)	26	11.46 (3.64)	26	

Note. Effect sizes were computed using means and standard deviations of participants with data for both baseline and 6-month surveys using the following formula: $((M_{3E} - M_{1E}) - (M_{3C} - M_{1C}))/\text{Pooled } SD_{3E,3C}$.

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TABLE 3. Multilevel Model Random-Effect Results for Level 1 Model Using Full Maximum Likelihood Estimation (*N* = 56)

	Variance Component	*df*	χ^2
Regular Physical Activities (kcal/wk)			
Intercept	893,792.96	51	81.55**
Linear slope	590,192.29	51	81.99**
Aerobic Fitness			
Intercept	78,144.59	50	925.51***
Linear slope	1,068.86	50	68.85*
Physical Health Status			
Intercept	53.13	51	195.36***
Linear slope	0.36	51	40.92
Mental Health Status			
Intercept	73.55	51	189.33***
Linear slope	6.07	51	68.55*
Fatigue			
Intercept	10.70	50	125.66***
Linear slope	0.87	50	59.66

Note. *$p < .05$. **$p < .01$. ***$p < .001$.

started with lower levels of regular physical activities but increased at a significantly faster rate over time compared with control group individuals (Figure 3).

Self-Efficacy for Engaging in Regular Physical Activities An interaction analysis was conducted on the MLM Level 2 model to determine whether the association between group assignment and regular physical activities depended on the individual level of self-efficacy for exercise at baseline. Controlling for time since completion of cancer treatment, high-efficacy individuals in the intervention group increased their physical activity levels faster over 6 months than did low-efficacy individuals in the intervention group ($B = 121.35$, $p < .05$). In the control group, self-efficacy did not affect levels of physical activity (Figure 4).

Aerobic Fitness Results of the Level 1 MLM model showed that both the intercept ($B = 1{,}542.97$, $p < .001$) and the linear slope ($B = 59.24$, $p < .001$) were significantly different from zero. On average, the number of feet walked in 6 minutes for all participants was 1,542.97 at baseline and increased nearly 120 feet (8%) across the study. There was significant individual variation in both the intercept and slope to be explained in a Level 2 model (Table 3); however, that model showed that group assignment was not associated significantly with variation around the mean slope (Table 4).

Mental Health Status Results of the Level 1 MLM model showed that both the intercept ($B = 45.65$, $p < .001$) and the linear slope ($B = 3.12$, $p < .01$) were significantly different from zero. On average, the level of mental health status for all participants was 45.65 at baseline and increased 6 points (13%) across the study. Table 3 shows that there was significant individual variation in both the intercept and the slope to be explained in a Level 2 model; however, that model showed that group assignment was not associated significantly with variation around the mean slope (Table 4).

Physical Health Status Results of the Level 1 MLM model showed that both the intercept ($B = 42.98$, $p < .001$) and the linear slope ($B = 1.57$, $p < .001$) were significantly different from zero. On average, the level of physical health status for all participants was 42.98 at baseline and increased 3 points (7%) across the study. As there was no significant individual variation in the slope to be explained in a Level 2 model, an ANOVA analysis of group mean trajectory adequately represented the data. That analysis showed that the Group × Time interaction was not significant for physical health, [Wilk's lambda $\Lambda = .89$, $F(2,38) = 2.42$, *ns*].

Fatigue Results of the Level 1 MLM model showed that both the intercept ($B = 15.20$, $p < .001$) and the linear slope ($B = -2.11$, $p < .001$) were significantly different from zero. On average, the level of fatigue status for all participants was 15.20 at baseline and declined 4.22 points (27%) across the study. As there was no significant individual variation in the slope to be explained in a Level 2 model, an ANOVA of group mean trajectory adequately represented the data. That analysis showed that the Group × Time interaction for fatigue was significant [$\Lambda = .78$, $F(2,37) = 5.24$, $p = .010$]. However, inspection of the graph showed this was an artifact of 3-month measures, whereas values at baseline and at 6 months showed no significant differences between groups, leading to the conclusion that the significant effect of the interaction was the result of measurement error.

Discussion

In this sample of long-term cancer survivors, participants in the MI intervention group increased their self-reported

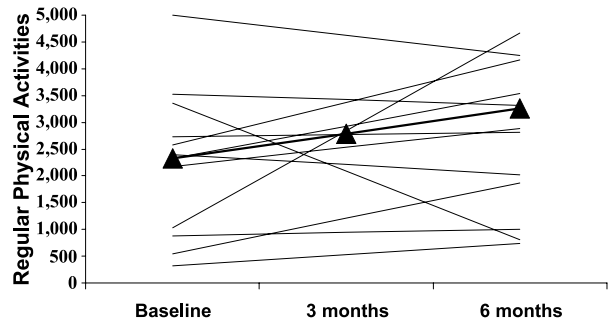

FIGURE 2. Average physical activity trajectory for the overall sample (*N* = 56) and individual trajectories for 12 participants. This figure is provided for illustrative purposes only, to show the importance of considering individual variability (using MLM), rather than an average (using ANOVA) which does not capture the variety of individual trajectories.

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TABLE 4. Multilevel Model Fixed-Effect Results for Level 2 Models Using Full Maximum Likelihood Estimation (*N* = 56)

	Regular Physical Activities		Aerobic Fitness		Mental Health Status	
	Coefficient	*SE*	Coefficient	*SE*	Coefficient	*SE*
Intercept	2,776.25***	286.07	1,542.97***	54.62	45.65***	1.84
Intervention group	−907.41*	411.61	59.73	77.97	−4.10	2.62
Linear slope	79.16	220.12	59.24***	11.77	3.12**	0.89
Intervention group	732.93*	330.11	12.62	17.99	−1.16	1.32

Note. Unstandardized coefficients are shown. Model controlled for months since cancer treatment.
*$p < .05$; **$p < .01$; ***$p < .001$.

regular physical activities by a mean 1,556 kcal/wk, compared to a mean increase of 397 kcal/wk in the control group. On average, the MI group participants were more inactive, with a mean 900 kcal/wk less activity than the control group at the beginning of the study, but were more active than the control group at the end of 6 months by about 230 kcal/wk. The mean increased activity of more than 1,500 kcal/wk in the MI group from the beginning to the end of the study could represent a clinically important change, as 1,000–1,500 kcal/wk is considered a threshold for achieving health benefits (Schairer, Keteyian, Ehrman, Brawner, & Berkebile, 2003).

The finding that MI increased physical activity in cancer survivors is similar to that of Pinto et al. (2005), who showed that once-a-week MI telephone calls increased home-based physical activity over 12 weeks in breast cancer survivors less than 2 years past treatment. The more frequent MI contacts in that study resulted in an ES = .81, larger than the ES = .55 in this study. Larger effect sizes on physical activity have been reported in studies of MI interventions in persons without cancer, ES = 1.32 (Di Loreto et al., 2003) and ES = 1.34 (Kirk, Mutrie, MacIntyre, & Fisher, 2003). The smaller effect size in this study suggests that cancer survivors may be more difficult to motivate to adopt physical activity habits, and therefore, require a more intense MI. Some prior studies have shown that survivors undergoing cancer treatment, or shortly past treatment, are willing to engage in home-based exercise programs (Angrist, Imbens, & Rubin, 1996; Schwartz, 1999, 2000a), but whether such motivation endures in long-term survivors is not known. This study shows that MI warrants further investigation as a strategy to motivate long-term cancer survivors to engage in physical activities of their own choosing.

These results provide compelling evidence for self-efficacy as a key concept in physical activity behavior change, as posited in social cognitive theory (Bandura, 1977) and the transtheoretical model (Prochaska & Velicer, 1997). In the presence of MI counseling, cancer survivors with high self-efficacy for exercise increased regular physical activities more than did those with low self-efficacy, whereas participants in the control group increased physical activity at approximately the same rate, regardless of individual self-efficacy. These findings are particularly compelling because the mean self-efficacy in the MI group was lower than that of the control group at the beginning of the study. The MI intervention appears to have supported self-efficacy, as theorized. Further, the role

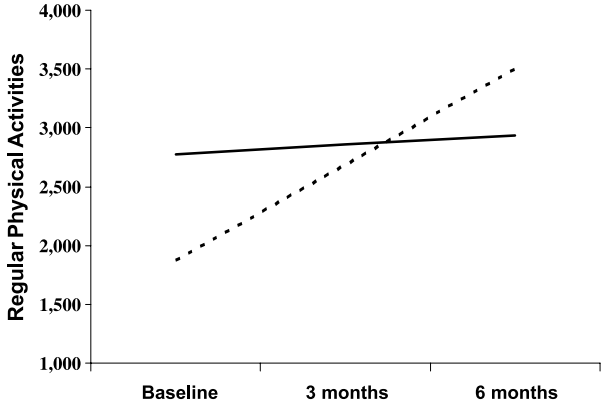

FIGURE 3. Physical activity trajectories for participants in the intervention and control groups, controlling for months since end of cancer treatment. ——, Control Group; – – –, Intervention Group.

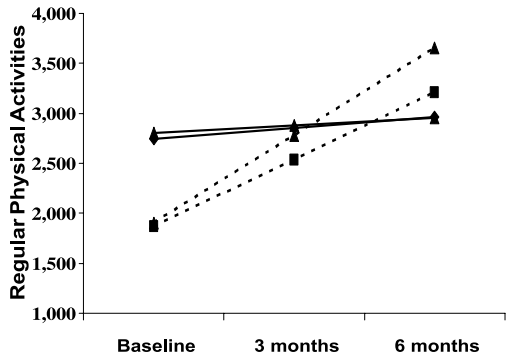

FIGURE 4. Interaction of self-efficacy on physical activity trajectories for participants in the intervention and control groups, controlling for months since end of cancer treatment. —◆—, Control Group, Low Self-Efficacy; ▪ ■ ▪, Intervention Group, Low Self-Efficacy; —▲—, Control Group, High Self-Efficacy; ▪ ▲ ▪, Intervention Group, High Self-Efficacy.

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of self-efficacy in increasing physical activity depended on MI; self-efficacy alone was not sufficient for behavior change in this sample. The synergy between self-efficacy and MI counseling has been proposed as the main mechanism by which behavior change occurs, and the findings of this study provide evidence that this is true in increasing physical activity in cancer survivors and, perhaps, in all persons.

Although participation in regular physical activities increased as a result of an MI intervention in this study, hypothesized effects on aerobic fitness, physical health status, mental health status, and fatigue were not demonstrated. The small sample size may have prevented statistically significant group differences in some, or all, of these outcomes. The nonsignificant effect on fatigue is particularly surprising, as earlier studies with small sample sizes have shown decreased fatigue associated with physical activity during cancer treatment (McKenzie & Kalda, 2003; Mock et al., 2005; Schwartz, 2000b; Schwartz et al., 2001). Perhaps a more intense MI intervention, such as more frequent telephone calls or a longer intervention period, would produce significant effects on these outcomes in future studies. It is also possible that the 6-item Schwartz Cancer Fatigue Scale was not sufficiently reliable to capture changes in persistent fatigue, although it had shown good internal consistency reliability previously ($\alpha > .80$; Schwartz & Meek, 1999).

A strength of this study was the use of MLM analysis to show significant individual changes in physical activity that would not have been detected using an analysis, such as ANOVA, that compared group means. The MLM analysis was limited to a baseline covariate—months since cancer treatment—because the study variables were measured at only three time points. With additional time points, it would be possible to examine a time-varying covariate (e.g., the change in self-efficacy over time), a powerful advantage of MLM analysis that should be considered in the design of future intervention studies.

A limitation of this study was the physical activity counselor's lack of masking to group assignments, which presents the possibility of introducing MI components into the brief telephone calls to control group participants. Future studies would be stronger if telephone calls are conducted by a different interventionist for each group. The 6-minute walk test was conducted using a strict protocol that limited dialogue between the participant and the physical activity counselor during the test, but it is somewhat possible that conversation prior to the test might have influenced performance.

Physical activity was measured by self-report in this study, a potential limitation. However, self-report of activity is used commonly in home-based exercise studies, including those in cancer survivors (Mock et al., 2005; Pinto, Frierson, Rabin, Trunzo, & Marcus, 2005; Schwartz, 1999), and some have reported difficulties with objective methods of measuring activity, such as accelerometers (Pinto et al., 2005; Schwartz, 1999). Although the results of this study are comparable to the self-reported physical activity outcomes of other studies, it may be beneficial to use both self-report and objective measures of activity in future studies.

In summary, in this study, it was demonstrated that MI can be used to increase regular choice-based physical activity in long-term cancer survivors and that self-efficacy plays a role in the success of MI. Future research is warranted to determine whether more intense MI would strengthen the effect on physical activity behavior. ▼

Accepted for publication October 4, 2006.

Funding for this study was provided by the Lance Armstrong Foundation.

The authors thank Ginger Hanson, MS, for her work in data management and ANOVA analysis.

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References

Angrist, J. D., Imbens, G. W., & Rubin, D. B. (1996). Identification of causal effects using instrumental variables. *Journal of the American Statistical Association, 91*, 444–472.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191–215.

Bandura, A. (1986). *Social foundations of thought and action*. Englewood Cliffs, NJ: Prentice-Hall.

Behavior Change Consortium. (2005). *Measures*. Retrieved November 8, 2005, from http://www1.od.nih.gov/behaviorchange/measures/measures.htm.

Courneya, K. S. (2003). Exercise in cancer survivors: An overview of research. *Medicine and Science in Sports and Exercise, 35*, 1846–1852.

Courneya, K. S., Mackey, J. R., Bell, G. J., Jones, L. W., Field, C. J., & Fairey, A. S. (2003). Randomized controlled trial of exercise training in postmenopausal breast cancer survivors: Cardiopulmonary and quality of life outcomes. *Journal of Clinical Oncology, 21*, 1660–1668.

Curt, G. A., Breitbart, W., Cella, D., Groopman, J. E., Horning, S. J., Itri, L. M., et al. (2000). Impact of cancer-related fatigue on the lives of patients: New findings from the Fatigue Coalition. *The Oncologist, 5*, 353–360.

Di Loreto, C., Fanelli, C., Lucidi, P., Murdolo, G., De Cicco, A., Parlanti, N., et al. (2003). Validation of a counseling strategy to promote the adoption and the maintenance of physical activity by type 2 diabetic subjects. *Diabetes Care, 26*, 404–408.

DiClemente, C. C., & Velasquez, M. M. (2003). Motivational interviewing and the stages of change. In W. R. Miller & S. Rollnick (Eds.), *Motivational interviewing: Preparing people for change*. New York: The Guilford Press.

Dimeo, F. (2002). Radiotherapy-related fatigue and exercise for cancer patients: A review of the literature and suggestions for future research. *Frontiers of Radiation Therapy and Oncology, 37*, 49–56.

Emmons, K. M., & Rollnick, S. (2001). Motivational interviewing in health care settings. Opportunities and limitations. *American Journal of Preventive Medicine, 20*, 68–74.

Galvao, D. A., & Newton, R. U. (2005). Review of exercise intervention studies in cancer patients. *Journal of Clinical Oncology, 23*, 899–909.

Ganz, P. A., Rowland, J. H., Desmond, K., Meyerowitz, B. E., & Wyatt, G. E. (1998). Life after breast cancer: Understanding women's health-related quality of life and sexual functioning. *Journal of Clinical Oncology, 16*, 501–514.

Guyatt, G. H., Sullivan, M. J., Thompson, P. J., Fallen, E. L., Pugsley, S. O., Taylor, D. W., et al. (1985). The 6-minute walk: A new measure of exercise capacity in patients with chronic

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heart failure. *Canadian Medical Association Journal, 132*, 919–923.

Kirk, A., Mutrie, N., MacIntyre, P., & Fisher, M. (2003). Increasing physical activity in people with type 2 diabetes. *Diabetes Care, 26*, 1186–1192.

Knols, R., Aaronson, N. K., Uebelhart, D., Fransen, J., & Aufdemkampe, G. (2005). Physical exercise in cancer patients during and after medical treatment: A systematic review of randomized and controlled clinical trials. *Journal of Clinical Oncology, 23*, 3830–3842.

Lipkin, D. P., Scriven, A. J., Crake, T., & Poole-Wilson, P. A. (1986). Six minute walking test for assessing exercise capacity in chronic heart failure. *British Medical Journal (Clinical Research Edition), 292*, 653–655.

Marshall, S. J., & Biddle, S. J. (2001). The transtheoretical model of behavior change: A meta-analysis of applications to physical activity and exercise. *Annals of Behavioral Medicine, 23*, 229–246.

McKenzie, D. C., & Kalda, A. L. (2003). Effect of upper extremity exercise on secondary lymphedema in breast cancer patients: A pilot study. *Journal of Clinical Oncology, 21*, 463–466.

Meyer, K., Schwaibold, M., Westbrook, S., Beneke, R., Hajric, R., Lehmann, M., et al. (1997). Effects of exercise training and activity restriction on 6-minute walking test performance in patients with chronic heart failure. *American Heart Journal, 133*, 447–453.

Miller, W. R., & Rollnick, S. (2002). *Motivational interviewing: Preparing people for change*. (2nd ed.). New York: Guilford Press.

Mock, V., Frangakis, C., Davidson, N. E., Ropka, M. E., Pickett, M., Poniatowski, B., et al. (2005). Exercise manages fatigue during breast cancer treatment: A randomized controlled trial. *Psycho-Oncology, 14*, 464–477.

Motivational Interviewing. (2005). Retrieved November 4, 2005, from http://www.motivationalinterview.org.

Nail, L. M. (2001). Long-term persistence of symptoms. *Seminars in Oncology Nursing, 17*, 249–254.

Nail, L. M. (2002). Fatigue in patients with cancer. *Oncology Nursing Forum, 29*, 537–544.

National Cancer Policy Board. (2006). *From cancer patient to cancer survivor: Lost in transition*. Retrieved December 13, 2005, from http://www.nap.edu/books/0309095956/html/.

Nigg, C. R., & Riebe, D. (2002). The transtheoretical model: Research review of exercise behavior and older adults. In P. M. Burbank & D. Riebe (Eds.), *Promoting exercise and behavior change in older adults: Interventions with the transtheoretical model* (pp. 147–180). New York: Springer Publishing.

Pinto, B. M., Frierson, G. M., Rabin, C., Trunzo, J. J., & Marcus, B. H. (2005). Home-based physical activity intervention for breast cancer patients. *Journal of Clinical Oncology, 23*, 3577–3587.

Prochaska, J. O., & Velicer, W. F. (1997). The transtheoretical model of health behavior change. *American Journal of Health Promotion, 12*, 38–48.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models*. (2nd ed.). Newbury Park, CA: Sage.

Raudenbush, S. W., Bryk, A. S., & Congdon, R. (2004). *Hierarchical linear and nonlinear modeling*. Lincolnwood, IL: Scientific Software International.

Schairer, J. R., Keteyian, S. J., Ehrman, J. K., Brawner, C. A., & Berkebile, N. D. (2003). Leisure time physical activity of patients in maintenance cardiac rehabilitation. *Journal of Cardiopulmonary Rehabilitation, 23*, 260–265.

Schmitz, K. H., Holtzman, J., Courneya, K. S., Masse, L. C., Duval, S., & Kane, R. (2005). Controlled physical activity trials in cancer survivors: A systematic review and meta-analysis. *Cancer Epidemiology, Biomarkers & Prevention, 14*, 1588–1595.

Schwartz, A. L. (1999). Fatigue mediates the effects of exercise on quality of life. *Quality of Life Research, 8*, 529–538.

Schwartz, A. L. (2000a). Exercise and weight gain in breast cancer patients receiving chemotherapy. *Cancer Practice, 8*, 231–237.

Schwartz, A. L. (2000b). Daily fatigue patterns and effect of exercise in women with breast cancer. *Cancer Practice, 8*, 16–24.

Schwartz, A., & Meek, P. (1999). Additional construct validity of the Schwartz Cancer Fatigue Scale. *Journal of Nursing Measurement, 7*, 35–45.

Schwartz, A. L., Meek, P. M., Nail, L. M., Fargo, J., Lundquist, M., Donofrio, M., et al. (2002). Measurement of fatigue. Determining minimally important clinical differences. *Journal of Clinical Epidemiology, 55*, 239–244.

Schwartz, A. L., Mori, M., Gao, R., Nail, L. M., & King, M. E. (2001). Exercise reduces daily fatigue in women with breast cancer receiving chemotherapy. *Medicine and Science in Sports and Exercise, 33*, 718–723.

Steele, B. (1996). Timed walking tests of exercise capacity in chronic cardiopulmonary illness. *Journal of Cardiopulmonary Rehabilitation, 16*, 25–33.

Stewart, A. L., Mills, K. M., King, A. C., Haskell, W. L., Gillis, D., & Ritter, P. L. (2001). CHAMPS Physical Activity Questionnaire for Older Adults: Outcomes for interventions. *Medicine and Science in Sports and Exercise, 33*, 1126–1141.

Thorsen, L., Skovlund, E., Stromme, S. B., Hornslien, K., Dahl, A. A., & Fossa, S. D. (2005). Effectiveness of physical activity on cardiorespiratory fitness and health-related quality of life in young and middle-aged cancer patients shortly after chemotherapy. *Journal of Clinical Oncology, 23*, 2378–2388.

Tudor-Locke, C., & Bassett, D. R., Jr. (2004). How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Medicine, 34*, 1–8.

Ware, J. E. (2005). *How to score Version 2 of the SF-36 Health Survey* (Vol. 1998). Boston: The Health Institute, New England Medical Center.

Ware, J. E., Kosinski, M., & Gandek, B. (2000). *SF-36 Health Survey: Manual & interpretation guide*. Lincoln, RI: Quality-metric.

Wilson, M., Allen, D. D., & Li, J. C. (2006). Improving measurement in behavioral sciences using item response models: Comparison with the classical test theory approach. *Health Education Research*, 21(supplement 1), i19–i32.

Zugck, C., Kruger, C., Durr, S., Gerber, S. H., Haunstetter, A., Hornig, K., et al. (2000). Is the 6-minute walk test a reliable substitute for peak oxygen uptake in patients with dilated cardiomyopathy? *European Heart Journal, 21*, 540–549.

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