Physical Activity and Mental Health Outcomes During Menopause: A Randomized Controlled Trial

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ABSTRACT

Background: *Many women experience detriments in mental health during the menopausal transition. Physical activity may attenuate these adverse outcomes but few studies investigating such effects exist.* ***Purpose:*** *This study examined the effects of a 4-month randomized controlled exercise trial on mental health outcomes in 164 previously low-active middle-aged women (M age = 49.9; SD = 3.6).* ***Methods and Results:*** *Participants completed body composition and fitness assessment and a battery of psychological measures at the beginning and end of a 4-month randomized controlled exercise trial with three arms: walking, yoga, control. The results indicated that walking and yoga were effective in enhancing positive affect and menopause-related QOL and reducing negative affect. Women who experienced decreases in menopausal symptoms across the trial also experienced improvements in all positive mental health and QOL outcomes and reductions in negative mental health outcomes. Whether menopausal symptoms increased or decreased across the trial appeared to be determined in part by whether there were increases or decreases in cardiorespiratory fitness.* ***Conclusions:*** *Physical activity appears to enhance mood and menopause-related QOL during menopause, however, other aspects of mental health may be affected only as a result of reduction in menopausal symptoms. Increasing cardiorespiratory fitness could be one way to reduce menopausal symptoms.*

(**Ann Behav Med** 2007, *33*(2):132–142)

INTRODUCTION

It is currently estimated that there are 42.2 million women over age 50 in the United States (1) with 1.5 million women reaching menopause each year (2). In the United States, the median age of menopause is 52 years (3), however, considerable individual variability exists due to lifestyle factors such as obesity and smoking (4). Menopause refers to cessation of ovarian follicular activity and is manifest by the cessation of menstrual flow lasting at least 12 months. Perimenopause is a transitional period immediately before menopause when physiological, hormonal, and clinical changes commence and last on average 3.5 to 4 years (3,4). It is estimated that 80 to 85% of all women experience unpleasant menopausal symptoms at some point during their menopausal transition (5). The most common symptoms reported are hot flashes, night sweats, irritability, moodiness, tension, anxiety, and emotional instability (6,7). These symptoms are typically clustered into three factors, vasomotor, somatic, and psychological (8). Although menopause-related symptoms are transitory (9), symptomatic menopausal women often suffer detriments in various aspects of mental health and perceived quality of life (10,11). For example, changes in mood follow a curvilinear pattern, with decreases in positive affect and increases in negative affect during the perimenopausal years and up to 2 years postmenopause and subsequent resolution of mood disturbance in later years (9,11). Vasomotor symptoms have also been associated with clinical depression and depressive symptoms during perimenopause after adjustment for a number of factors including age, race, or depression history (12,13). Empirical evidence suggests that these adverse outcomes may be attenuated by participating in physical activity (14–16). In cross-sectional studies, more physically active women report less nervousness and fewer menopausal symptoms (17,18), more positive affect regardless of menopausal status, and fewer depressive symptoms (11,16,19). However, the evidence remains inconclusive with some recent studies reporting no benefit of physical activity (20–22). Moreover, the mechanisms underlying such effects remain unclear and investigations of the extent to which physical activity may impact other mental health indicators or perceived QOL during menopause are scarce. The few randomized controlled trials that exist have generally employed very small samples or interventions of very short durations, demonstrating improvements in symptoms and QOL (23–25). However, two recent large trials provided contradictory results. Wilbur et al. (26) did not observe any effects and the results by Aeillo et al. (27) suggested

This material is based on work conducted at the University of Illinois and was supported by the National Institute of Mental Health under Award No. MH073255-01, National Institute on Aging under Award No. AG12113, American College of Sports Medicine, Life Fitness Academy, and Paul D. Doolen Scholarship for the Study of Aging.

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that differential intervention effects on mental health and QOL outcomes may be moderated by changes in symptoms across the time course of interventions. Conceivably, increases in symptoms across exercise interventions may attenuate enhancements or perhaps lead to decreases in psychological well-being outcomes as compared to women whose symptoms subside in the course of the intervention. In addition, little is known about the role of physical fitness and body composition parameters in this relationship. Aiello et al. (27) found no evidence for the role of fitness in symptom reduction while others have demonstrated that fitness improvements were associated with QOL outcomes in menopausal women (25,28). Most studies have also focused on aerobic activity (29,30), in spite of the increasing popularity of more nontraditional types of activity such as yoga, which has been also encouraged as an intervention modality for the management of menopausal symptoms (31,32). Given the increasing adoption of complementary and alternative medicine (CAM) practices, especially in women (33,34), it would appear prudent to evaluate whether alternative exercise modalities such as yoga have differential effects on mental health outcomes in menopausal women.

In this study we evaluated the effects of 4-month walking and yoga interventions on several indicators of mental health and perceived QOL in a sample of previously low-active middle-aged women. In addition, we evaluated whether changes in symptoms across the intervention moderated changes in mental health outcomes associated with exercise. Finally, we were interested in determining whether physiological factors (i.e., fitness, body composition) were implicated in any mental health effects of the exercise intervention. We hypothesized that exercise participation would result in enhanced positive affect, satisfaction with life, and menopause-related QOL and would lead to reductions in menopausal symptoms, negative affect, and depressive symptoms. We also hypothesized that women who experience decreases in symptoms across the intervention would demonstrate greater improvements in mental health outcomes than women whose symptoms increased during the study.

METHOD

Participants

Participants ($N = 164$) were sedentary or low active (i.e., exercising less than two times per week for 30 min or more at moderate intensity), middle-aged women (42–58 years) experiencing menopausal symptoms (i.e., having experienced vasomotor symptoms such hot flashes or nights sweats in the last month). Additional inclusion criteria included no history of surgical menopause and no hormone therapy (HT) use in the last 6 months. Other medication use or use of other alternative therapies for menopausal symptoms did not preclude participation in this study, however, women were asked not to initiate the use of any new therapies for the duration of the trial. The flow of participants through the trial is presented in a consort diagram in Figure 1.

Measures

Demographics and Health History

Basic demographic and health history information was collected and all participants obtained a medical release from their physicians prior to study participation.

Menopausal Status

Menopausal status was assessed based on self-reported bleeding patterns and categorized according to the Stages of Reproductive Aging Workshop (STRAW) criteria (35) into premenopausal, early and late perimenopausal, and early and late postmenopausal stages.

Menopausal Symptoms

Menopausal symptoms were assessed by the Greene Climacteric Scale (GCS) (8). The GCS assesses the degree to which a woman is bothered by psychological (11 items), somatic (7 items), vasomotor (2 items), and sexual (1 item) symptoms on a 0 to 3 scale, ranging from 0 (*not at all*) to 3 (*extremely*). Internal consistency of the scale was acceptable in this study ($\alpha = .81$–$.86$). To test our hypotheses relative to the moderating effects of symptoms on mental health outcomes, we adopted the following strategy. First, residual change scores were computed by regressing post-program values on baseline values. Such an approach in essence removes the variation in posttest scores that is accounted for by the pretest scores. Each residual change score reflects the degree and direction of change in the dependent variable across the trial, with a positive coefficient representing an increase in the variable of interest, zero value indicating no change, and a negative coefficient reflecting a decrease over time (36). Subsequently, women were classified into two categories as having either decreased symptoms or having no change/increases in symptoms.

Physical Sctivity

Physical activity outside of the program was assessed by self-report utilizing the Aerobics Center Longitudinal Study Physical Activity Survey (ACLS) (37). The ACLS questionnaire assesses frequency, duration, and intensity of 14 different physical activities and allows for calculation of metabolic equivalents of energy expenditure in reported activities.

Cardiovascular Fitness

Cardiovascular fitness was assessed by a maximal graded exercise test (GXT) in the presence of a physician

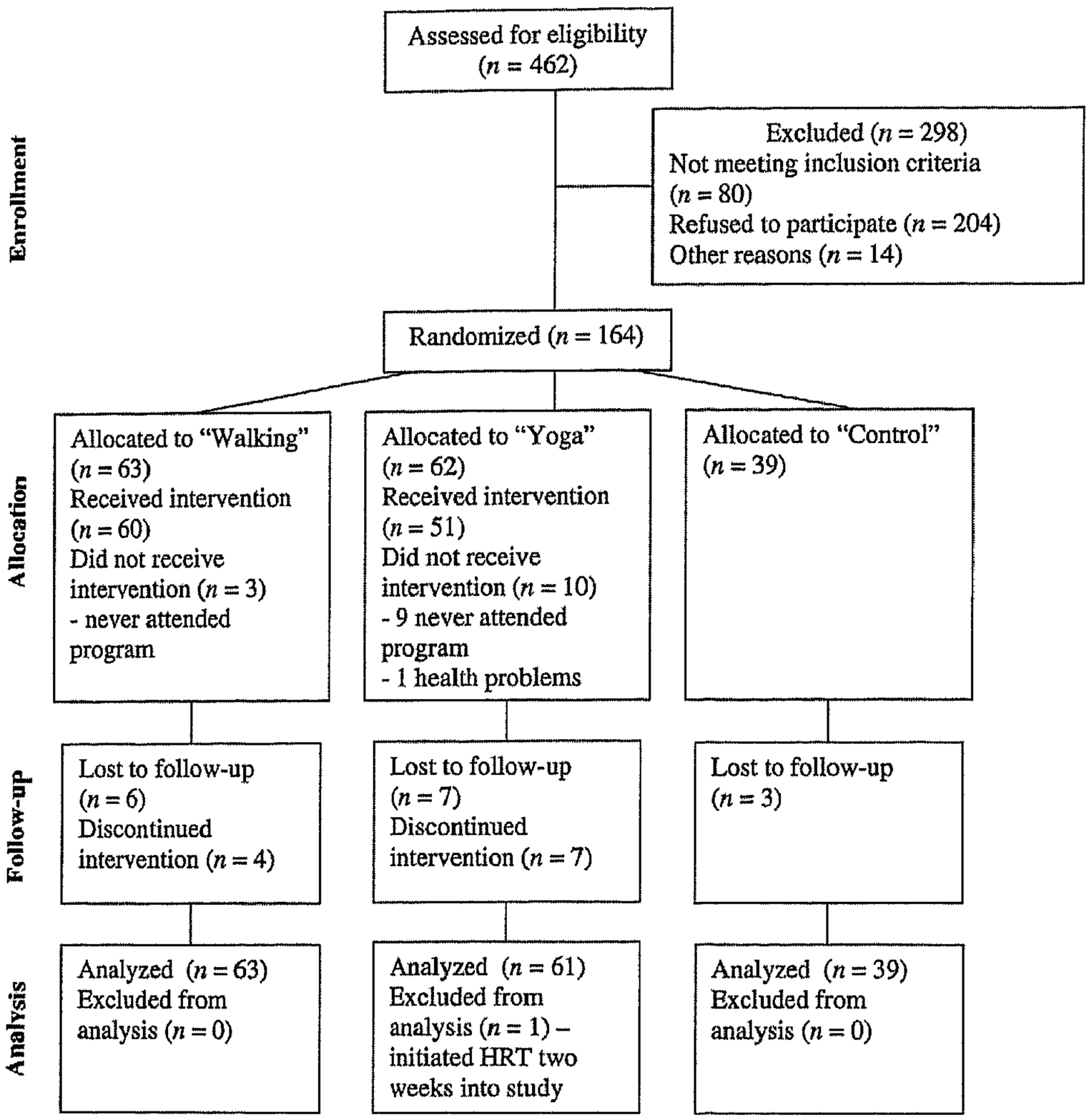

FIGURE 1 Flow of participants through the trial.

and a nurse certified in Advanced Cardiac Life Support (ACLS) following a conservative approach recommended by the American College of Sports Medicine (38). The GXT involved a standard protocol requiring the participant to walk on a treadmill at a constant brisk walking speed (3.0–4.0 mph) with the incline of the treadmill increasing every 2 min by a minimum of 2.5%. During the test, heart rate and blood pressure were monitored along with continuous ECG monitoring for signs of ischemia. Expired gases were collected and analyzed using the TrueMax2400, Parvomedics Inc., metabolic system. The test termination criteria included the occurrence of any of the following: (a) objective evidence that maximal rate or oxygen uptake (VO_2Max) has been attained, (b) participant's desire to stop the test, (c) cardiovascular abnormalities or other symptoms indicating ischemia or abnormal test response (38).

Body Composition

Trunk and total body fat were assessed by dual energy X-ray absorptiometry (DXA; Hologic QDR/W 1000, Waltham, MA; Enhanced Whole-Body Analysis software version 5.71). Low dose X-ray of two different energies are used to distinguish between bone and soft tissue, giving a measurement of bone density and estimates of trunk and total body fat percentage.

Affect

Positive and negative affect was assessed using Affectometer 2 (39). This is a 40-item self-report measure of general happiness based on the balance of positive and negative feelings in recent experience. Internal consistencies of the scale in this study ranged from $\alpha = .93–.95$.

Depression

Depressive symptoms were assessed by the Beck Depression Inventory (BDI) (40). The BDI is a 21-item scale and asks participants to indicate for each item which statement(s) best described their feeling in the past week. Statements are weighted on a scale from 0 to 3, with higher scores indicating more depressed feelings. A total score of 1 to 10 is considered normal; 11 to 16 indicates mild mood disturbance; 17 to 20 indicates borderline clinical

depression; 21 to 30 indicates moderate depression; 31 to 40 indicates severe depression; 41 to 63 indicates extreme depression. Internal consistency for the scale ranged from $\alpha = .88–.90$ in this study.

Quality of Life

The Utian Quality of Life Scale (UQOL) (41) was used to assess menopause-specific QOL in this study. The scale has 23 items targeting occupational, health, emotional, and sexual QOL domains. Each question is answered on a 5-point Likert-type scale. A total score is computed by summing all domain scores, resulting in a possible score range of 0 to 115. Internal consistency of the total scale was acceptable in this study ($\alpha = .85–.86$).

Satisfaction with Life

Satisfaction with life was measured by the Satisfaction with Life Scale (SWLS) (42). This measure was designed to assess an individual's global judgment of life satisfaction by allowing the respondent to weight the importance of life domains in accordance with his or her own values and standards. The SWLS is a 5-item scale rated on a 7-point scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*), with higher scores representing greater life satisfaction. Internal consistency in this study was very good ($\alpha = .89–.92$).

Procedure

Participants responded to promotional flyers and advertisements placed in local health departments, physicians' offices, via university e-mail list and local media outlets. Respondents were screened by telephone screening prior to inclusion. Participants completed a battery of questionnaires and a 60-min lab session during which participants' height and weight were assessed along with waist and hip circumference, a DXA scan, and a GXT. Participants then received a $20 payment for their time spent in testing. Upon the completion of the initial assessment, that is after enrollment into the study, participants were randomized into the *walking*, *yoga*, or *control* conditions and informed of their assignment by mail. Participants were randomized using the Statistical Package for Social Sciences (SPSS V 13.0; Chicago, IL) software with stratification being stratified based on menopausal symptom frequency to ensure equal representation across all three groups. Participants assigned to the wait-list control condition engaged in all testing and completed all measures during the 4-month duration of the trial but received no treatment. Upon completion of the other two arms of the trial, the wait-list control participants were offered a free 10-week exercise program of their choice (i.e., walking or yoga program). Postprogram assessment followed the same protocol as baseline evaluation. All recruitment and data collection was completed in two phases between April 2004 and July 2005. All medical and testing staff were blind to group allocation at outcome assessment.

Exercise Intervention

The exercise programs lasted 4 months. The walking program met 3 times per week for 1 hr in a large gymnasium with a track or outside on a university quad under close supervision of two trained instructors who took attendance, assisted with warm-up and cool-down and monitored participants' adherence to prescribed exercise duration and intensity. Participants received individualized exercise prescriptions and completed exercise logs on a daily basis. The prescribed duration started at 15 min of sustained exercise (i.e., following warm-up) and based on participant's abilities gradually increased to 40 to 45 min by the mid point of the 4-month program. Exercise intensity ranges were calculated using the Karvonen method and were based on the peak heart rate achieved during GXT, starting at 50% of the heart rate reserve (HRR) and increasing to 60 to 75% of HRR by the end of the program. Each participant was provided with a heart rate monitor for the duration of the program to allow for a more accurate assessment of exercise intensity and to serve as a motivational tool. Participants were also instructed to use Borg's Ratings of Perceived Exertion (43) scale to monitor and adjust their intensity and were encouraged, by instructors and through educational handouts and biweekly newsletters, to add 1 to 2 days of exercise outside of the program to reach the public health recommendations and maximize fitness gains. The yoga group met twice a week for 90 min. Iyengar YOGA, a form of Hatha Yoga (44), was practiced under supervision of experienced yoga instructors. The Iyengar tradition places special focus on developing strength, stamina, flexibility and balance, as well as concentration and meditation. Different props can be used (blocks, chairs, belts) to help beginners in adjusting to the different postures so that these can be performed in a range of motion that is safe and effective (45). Participants completed daily exercise logs and were also instructed to practice postures outside of the program according to handouts with practice sequences received on a weekly basis.

Statistical Analysis

Baseline data were examined for significant between condition differences on all variables using a series of one-way multivariate analyses of variance (MANOVA) to identify potential confounders for inclusion as covariates in the analyses. Similar analyses were conducted with those who completed the study and study dropouts, as well as between program adherers and nonadherers. The analyses used an intent-to-treat approach involving a comparison of the experimental and control groups, where participants were classified by their group assignment regardless of program compliance. A series of mixed-model

3 (condition) × 2 (symptoms) × 2 (time) repeated measures uinivariate and multivariate analyses of aariance (ANOVAs and MANOVAs) and covariance (ANCOVAs and MANCOVAs) were conducted to evaluate the effects of the intervention and symptom changes on psychological outcomes. Correlational and multiple regression analyses were used to examine the association of physical activity outside of the program, fitness, and body composition variables on menopausal symptoms.

RESULTS

Sample Description

A total of 164 menopausal women (M age = 49.9; SD = 3.6) passed initial screening and completed all testing upon entry into the study. The sample was comprised of relatively healthy and primarily White women (83%), the majority of whom were married or in significant relationships (75%). Based on classification by menstrual bleeding patterns, 17% of the participants would be considered premenopausal, 28% early perimenopausal, 23% late perimenopausal, 12% early postmenopausal, and 20% l postmenopausal.

Extent of Missing Data

Although an intent-to-treat approach was adopted the analyses, there were some missing data across asse ments due to participant refusal to answer certain qu tions, failure to return some questionnaires, or refusal participate in physiological testing or body compositi assessment using the DXA. The affect, symptom, physi activity, and body composition data were missing 3 cas menopause-related quality of life 4 cases, and depressi 12 cases.

Intervention Group Differences at Baseline

Participants in the control group were found to slightly younger than participants in the walking or yo groups ($p < .05$) and participants in the yoga group h more children ($p < .05$) and higher income ($p < .05$). The were no other baseline differences among participan Including age as a covariate in the analyses changed t

TABLE 1
Effect Sizes, Means, and Standard Deviations for Mental Health Outcomes by Total Sample, Intervention, and Symptom Group

				Baseline		*Month 4*	
Variable	*Group*	*Symptom Change Group*	*Cohen's d*	*M*	*SD*	*M*	*S*
Positive affect	Walking	−Δ	0.63	68.94	11.80	75.42	8.
		+Δ	0.25	70.73	12.11	73.46	9.
		Total	0.47	69.69	11.86	74.60	9.
	Yoga	−Δ	0.40	71.38	15.19	76.92	12.
		+Δ	−0.01	68.28	16.38	68.13	16.
		Total	0.16	69.67	15.80	72.07	15.
	Control	−Δ	0.20	75.38	10.42	77.19	7.
		+Δ	−0.07	66.82	14.81	65.86	13.
		Total	0.02	70.42	13.67	70.63	12.
Negative affect	Walking	−Δ	−0.78	41.89	14.20	32.33	10.
		+Δ	−0.52	41.46	10.82	36.12	9.
		Total	−0.68	41.71	12.80	33.92	10.
	Yoga	−Δ	−0.78	38.58	10.99	31.08	8.
		+Δ	0.01	43.28	16.75	43.53	18.
		Total	−0.21	41.17	14.53	37.95	16.
	Control	−Δ	−0.75	36.63	10.16	29.88	7.
		+Δ	−0.18	45.95	15.35	43.45	13.
		Total	−0.32	42.03	14.05	37.74	13.
Depressive	Walking	−Δ	−0.50	8.24	5.70	5.59	4.
		+Δ	−0.16	8.38	7.40	7.42	4.
		Total	−0.34	8.30	6.43	6.38	4.
	Yoga	−Δ	−0.40	7.19	5.51	5.12	4.
		+Δ	0.01	9.07	6.80	9.11	8.
		Total	−0.15	8.17	6.22	7.19	7.
	Control	−Δ	−0.23	5.31	5.06	4.13	5.
		+Δ	0.08	10.65	8.09	11.30	7.
		Total	−0.02	8.28	7.33	8.11	7.

Note. −Δ = group experiencing decreases in symptoms across the intervention; +Δ = group experiencing no change or increases in sympto across the intervention.

TABLE 2

Effect Sizes, Means, and Standard Deviations for QOL Outcomes and Menopausal Symptoms by Total Sample, Intervention, and Symptom Groups

Variable	*Group*	*Symptom Change Group*	*Cohen's d*	*Baseline*		*Month 4*	
				M	*SD*	*M*	*SD*
Life satisfaction	Walking	−Δ	0.46	23.53	5.64	26.06	5.27
		+Δ	0.20	23.11	6.57	24.30	5.59
		Total	0.34	23.35	6.01	25.30	5.44
	Yoga	−Δ	0.46	21.78	7.04	25.04	7.18
		+Δ	0.08	20.58	7.67	21.21	8.66
		Total	0.23	21.12	7.36	22.93	8.19
	Control	−Δ	0.37	24.25	4.30	25.88	4.59
		+Δ	0.00	21.00	7.19	21.00	7.58
		Total	0.10	22.37	6.28	23.05	6.87
UQOL Total	Walking	−Δ	0.88	75.71	12.24	85.91	11.05
		+Δ	0.01	80.15	12.30	80.23	9.74
		Total	0.51	77.61	12.36	83.49	10.81
	Yoga	−Δ	0.76	76.52	12.45	85.33	10.64
		+Δ	0.12	73.21	14.63	75.06	16.12
		Total	0.35	74.70	13.68	79.68	14.75
	Control	−Δ	0.23	80.38	13.76	83.13	10.63
		+Δ	0.08	74.77	12.87	75.86	13.60
		Total	0.14	77.13	13.37	78.92	12.81
UQOL Occupation	Walking	−Δ	0.25	23.34	6.42	24.89	5.87
		+Δ	−0.21	25.54	5.61	24.42	4.95
		Total	0.07	24.28	6.14	24.69	5.46
	Yoga	−Δ	0.24	24.30	5.79	25.56	4.72
		+Δ	0.02	22.36	6.89	22.52	7.19
		Total	0.10	23.23	6.44	23.88	6.34
	Control	−Δ	0.11	25.13	6.35	25.81	5.68
		+Δ	0.13	22.41	6.69	23.32	6.85
		Total	0.13	23.55	6.60	24.37	6.42
UQOL Health	Walking	−Δ	1.05	19.49	5.68	25.06	4.95
		+Δ	0.24	22.00	5.66	23.19	4.08
		Total	0.71	20.56	5.76	24.26	4.65
	Yoga	−Δ	0.80	19.56	4.82	23.15	4.12
		+Δ	0.30	18.48	4.12	19.88	5.12
		Total	0.51	18.97	4.44	21.35	4.94
	Control	−Δ	0.39	21.38	3.81	22.81	3.60
		+Δ	0.19	20.32	4.40	21.18	4.66
		Total	0.26	20.76	4.14	21.87	4.27
UQOL Emotional	Walking	−Δ	0.82	22.83	3.86	25.63	2.97
		+Δ	0.13	23.77	3.73	24.19	2.95
		Total	0.52	23.23	3.81	25.02	3.02
	Yoga	−Δ	0.97	23.37	3.41	26.33	2.69
		+Δ	0.03	22.94	4.49	23.06	4.50
		Total	0.34	23.13	4.01	24.53	4.12
	Control	−Δ	0.43	23.81	3.97	25.31	2.96
		+Δ	0.06	22.82	3.80	23.05	3.91
		Total	0.20	23.24	3.85	24.00	3.68
UQOL Sexual	Walking	−Δ	0.08	10.06	3.40	10.34	3.49
		+Δ	−0.14	8.85	3.23	8.42	3.14
		Total	−0.01	9.54	3.35	9.52	3.45
	Yoga	−Δ	0.24	9.30	4.19	10.30	4.03
		+Δ	0.05	9.42	3.58	9.61	3.96
		Total	0.14	9.37	3.83	9.92	3.97

(*Continued*)

TABLE 2
Continued

Variable	*Group*	*Symptom Change Group*	*Cohen's d*	*Baseline*		*Month 4*	
				M	*SD*	*M*	*SD*
	Control	−Δ	−0.25	10.06	3.38	9.19	3.6
		+Δ	−0.28	9.23	3.18	8.32	3.3
		Total	−0.27	9.58	3.24	8.68	3.4
Total symptoms	Walking		−0.61	14.61	7.92	10.27	6.2
	Yoga		−0.37	15.32	8.11	12.25	8.4
	Control		−0.30	13.71	6.88	11.71	6.5
Psychological	Walking		−0.68	8.40	4.79	5.56	3.5
	Yoga		−0.41	9.12	5.44	6.88	5.5
	Control		−0.35	8.34	4.26	6.79	4.5
Somatic	Walking		−0.38	3.40	2.51	2.50	2.1
	Yoga		−0.11	3.03	2.66	2.75	2.4
	Control		−0.12	3.08	2.94	2.76	2.4
Vasomotor	Walking		−0.19	1.89	1.82	1.56	1.6
	Yoga		−0.21	2.05	1.52	1.72	1.6
	Control		−0.06	1.37	1.22	1.29	1.2
Sexual	Walking		−0.33	0.92	0.89	0.65	0.7
	Yoga		−0.21	1.12	1.06	0.90	1.0
	Control		−0.05	0.92	0.97	0.87	0.9

Note. −Δ = group experiencing decreases in symptoms across the intervention; +Δ = group experiencing no change or increases in symptoms across the intervention.

pattern of results only for menopause-related QOL and menopausal symptoms. All remaining analyses are presented unadjusted.

Retention and Program Adherence

There were no differences in demographic characteristics, psychosocial or physical activity variables based on retention or dropout status. However, dropouts differed from those who completed the study relative to baseline body mass index (dropouts 35.5 vs. 28.9, $p = .001$), trunk fat (dropouts 41.4% vs. 35.5%, $p < .01$), waist-to-hip ratio (dropouts .88 vs. .81, $p = .001$), and total body fat (dropouts 40.5% vs. 37.3%, $p < .05$). There were no statistically significant differences between adherers (i.e., attended ^{3}50% of sessions) and nonadherers (attendance < 50%) on any of the baseline characteristics. Program attendance did not differ between the walking and yoga groups ($p = .079$) although adherence was higher in the walking group (M adherence = 70%) than in the yoga group (M adherence = 63%).

Intervention Effects Relative to Mental Health Outcomes

As noted, a series of mixed-model repeated measures ANOVAs were conducted to examine intervention effects on the mental health outcomes in women who experienced decreases versus no change/increases in menopausal symptoms. For positive affect, there were statistically significant Time × Group, $F(2, 152) = 2.984$, $p = .05$, and Time × Symptoms interactions, $F(1, 152) = 9.029$, $p < .01$, with increases in positive affect in the walking and yoga groups but not the control group. Women who experienced decreases in symptoms also experienced increases in positive affect. As for negative affect, there were also statistically significant Time × Group, $F(2, 152) = 3.468$,

TABLE 3
Fitness, Physical Activity, and Body Composition Correlates of Residual Change in Menopausal Symptoms

Dependent Variable	*Predictor*	R^2	β	*F for change*	*p*
Symptoms	VO_2	.036	−0.19	5.963	.016
	Physical activity	.019	−0.14	3.116	.080
	Trunk fat	.001	0.09	0.223	.638
	Total body fat	.001	0.08	0.171	.680

Note. β indicates relationships between residual change in menopausal symptoms and changes in fitness, physical activity outside of the program, trunk and total body fat.
Total $R^2 = .074$, $F(4, 149) = 4.077$, $p < .01$.

$p < .05$, and Time × Symptoms interactions, $F(1, 152) = 16.358$, $p < .001$. The walking group experienced significant reductions in negative affect whereas the yoga and control groups experienced little or no change. Women experiencing decreases in symptoms also reported significant reductions in negative affect. Finally, there was a statistically significant Time × Symptoms interaction for depressive symptoms, $F(1, 144) = 7.001$, $p < .01$, with women who experienced decreases in symptoms also experiencing decreases in depressive symptoms across the study. Effect sizes, means, and standard deviations are shown in Table 1.

Intervention Effects on QOL Outcomes

A mixed-model repeated measures ANOVA revealed a statistically significant Time × Symptoms interaction for life satisfaction, $F(1, 155) = 8.668$, $p < .01$, with women experiencing decreases in symptoms also experiencing enhancements in life satisfaction regardless of group assignment. A mixed-model repeated measures MANCOVA with age as a covariate was conducted to evaluate intervention and symptom category effects on menopause-related QOL. There was a statistically significant Time × Symptoms interaction, $F(4, 149) = 7.886$, $p < .001$, and a significant Time × Group interaction, $F(8, 300) = 2.121$, $p < .05$. Women who experienced decreases in symptoms also reported improvements in all QOL domains. In particular, participants in the walking group showed greater improvements in the health domain ($p = .019$) whereas the yoga group reported greater improvements in the sexual domain ($p = .049$). Table 2 shows the effect sizes, means, and standard deviations for all QOL outcomes across intervention and symptom groups.

Menopausal Symptoms

A mixed-model repeated measures MANCOVA adjusted for age did not reveal any significant Time × Group interaction or main effects for any aspect of symptoms, however, the pattern of effect sizes indicated a trend toward decreases in all aspects of symptoms over time across all three groups. Effects sizes, means, and standard deviations are shown in Table 2. In order to examine whether changes in symptoms may have been determined by differential responses in fitness or body composition outcomes across the intervention or by different physical activity levels outside of the program, correlational and hierarchical multiple regression analyses were conducted. Although changes in trunk % fat ($r = .20$, $p < .05$), total body % fat ($r = .20$, $p < .05$), fitness ($r = -.22$, $p < .01$), and physical activity outside of the program ($r = -.16$, $p < .05$) were all correlated with residual change in symptoms at the bivariate level, only change in fitness ($\beta = -.19$, $p = .016$) explained significant unique variance in symptoms (Table 3).

DISCUSSION

In this study we evaluated the effects of walking and yoga interventions on several indicators of mental health and perceived QOL in a sample of previously low-active middle-aged women. The results relative to the enhancement of affect are consistent with the general physical activity literature. Different modes of exercise have been shown to enhance positive affect and reduce negative affect in both healthy and diseased populations, although the strongest evidence is available for the effects of aerobic exercise such as walking (46). Few studies exist that document the affective beneficence of alternative exercise modalities such as yoga, although qualitative reports suggest that yoga practice improves mental or emotional well-being, reduces stress, and increases energy (47). This study demonstrated strongest effects on affect in the walking group and small effects in the yoga group, providing some support for the mood enhancing effect of yoga. Interestingly, changes in symptoms were also associated with affective responses across the trial, providing some support for the link between menopausal symptoms and mood (16).

The walking and yoga programs had positive effects on menopause-specific QOL, improvements which appeared to be driven primarily by improvements in the health and emotional domains. Interestingly, yoga participants also appeared to benefit in the sexual domain compared to the walking and control groups. Whether this pattern represents an activity-specific effect warrants further investigation. The UQOL as a menopause-related QOL measure was developed to assess "sense of well-being" in areas of life perceived by menopausal women as important (41). Thus, the observed associations between all UQOL domains and menopausal symptoms support the scale' validity. The observed association between menopausal symptoms and QOL however also highlights the importance of differentiating between these two constructs. In the majority of existing studies, menopause-specific QOL is still measured predominantly in terms of menopausal symptomology. We would argue that such an approach is restrictive and inappropriate as it suggests that women experiencing menopausal symptoms must also have compromised QOL. The correlation between residual changes in symptoms and menopause-specific QOL was moderate ($r = -.58$) suggesting that although symptoms are one of the primary factors influencing menopause-related QOL, these two constructs are not isomorphic and should be evaluated separately.

In this study, menopausal symptoms appeared to decrease across all groups over time. Cross-sectional studies typically report positive effects of physical activity on menopausal symptoms, with active women reporting fewer or less severe symptoms (17,48,49). However, longitudinal and prospective studies remain inconclusive (20,21). Aeillo et al. (27) reported increases in severity of vasomotor symptoms with exercise in some women

whereas we found no increases in any aspects of symptoms based on mean and group variance change. Interestingly, on average, both the walking and yoga groups appeared to have decreases in vasomotor symptoms of similar magnitude, with little change in the control group, providing some support for the fact that these changes did not occur simply due to the passage of time.

Although menopausal symptoms decreased on average across all groups, some women actually experienced increases in menopausal symptoms across the intervention. We hypothesized that women with different symptom change trajectories would benefit differentially with respect to mental health outcomes across the intervention. There is extant evidence linking increased reporting of menopausal symptoms with adverse mental health outcomes including increased negative affect (9,11) and depressive symptoms (12,13), and decreased positive affect (9) and quality of life (10,11). Thus, one might expect women experiencing increases in symptoms to exhibit diminished improvements as a result of the intervention. Indeed, the results have shown that symptom change moderated the effects of the intervention on all outcomes. It should be noted however that our design does not allow us to draw definitive conclusions regarding the casual direction of such effects. A recently published report from the Harvard Study of Moods and Cycles (50) has indicated that physical activity may be associated with decreased risk of vasomotor symptoms only in women with history of depression. Menopausal symptoms have been associated with increased reporting of depressive symptoms and it is therefore possible that the differential intervention effects observed in this study may have resulted either from increased symptom reporting or from depression status which may underlie the reporting of symptoms. There was a significant association between residual changes in menopausal symptoms and depression ($r = .43$, $p < .01$). Unfortunately, the distribution of baseline depression scores did not allow us to adequately replicate the analyses with depression status as a moderating variable, calling for more studies evaluating the relationships among menopausal symptoms, depression, and physical activity.

Whether menopausal symptoms increased or decreased appeared to be partly determined by whether there were increases or decreases in fitness across the intervention. This is contrary to the Aiello et al. (27) study which reported no effect of fitness on symptoms. Our sample, like Aiello et al.'s was sedentary or low-active, overweight, exhibiting vasomotor-like symptoms within a month of entry into the study. Consequently, further examination of the fitness-symptoms relationship is warranted.

The increases in fitness in the walking and yoga groups were modest on average, with some women having improved more than others. The walking group improved on average by 6% in intent-to-treat analyses and by 7% when only those who completed both pre- and posttests were considered. In their systematic review of randomized controlled trials (RCTs) in early postmenopausal women, Asikainen et al. (29) identified 41 RCTs, most of which employed walking as the primary mode of exercise. The reviewed studies that employed direct measurement of VO_2Max, similar exercise prescriptions, and were of similar durations (12–24 weeks) reported increases in fitness anywhere from 8 to 15%, suggesting that the average training effect in this study fell short of the expected range. The rather small improvements in fitness may be attributed to the relatively short duration of the walking program (i.e., 16 weeks) and in some women perhaps to the failure to adhere to their exercise prescriptions or due to inappropriate exercise prescriptions. Although further studies are needed, the observed association between changes in fitness and changes in symptoms is an encouraging finding, as cardiorespiratory fitness represents a factor that can be modified by physical activity interventions.

There are several limitations in this study. First, the sample comprised of volunteers recruited to participate in a free exercise program involving either a walking, yoga, or control group. Thus, only those who agreed to be randomized and those at least contemplating to become more physically active participated in the study, which may have biased our sample. Similarly, additional exclusionary criteria were implemented which excluded women with surgical menopause or women using hormone therapy, that is, samples of women likely to experience the most severe symptoms, warranting further investigation of these clinically vulnerable groups. The representation of minorities was low in spite of our best efforts to recruit underrepresented groups. Future studies with menopausal women should market their exercise interventions to minority individuals based on the specific needs of individual minority groups and should incorporate more incentives for underserved populations to participate. Such incentives might include reimbursement for referrals and provision of medical clearance for uninsured individuals, transportation and childcare, or should utilize existing community resources which do not require participants to commute to the study site and make childcare arrangements.

Physical activity interventions of longer durations would also be desirable for elicitation of more pronounced and longer-lasting intervention effects. When possible, postprogram follow-up assessments should be completed to assess the impact the intervention had for increasing physical activity levels among participants after structured programs end. Success of any physical activity intervention also depends on optimal program adherence and minimal study attrition. This study was successful at retaining 90% of the sample. The majority of participants who did not return for postprogram assessments refused to do so because of the maximal graded exercise testing. Thus, future studies in which the accurate assessment of cardiorespiratory fitness is not a critical component should consider alternative methods of assessing this physical parameter or perhaps assess more functional aspects of

fitness instead. Program attendance in both the walking and yoga groups was slightly lower than the average reported attendance rates in other exercise studies with menopausal women in spite of employing strategies which have previously been shown to improve program attendance (e.g., exercise contracts, goal setting, or provision of feedback). Future studies should continue employing these strategies to boost program attendance and whenever possible schedule exercise classes at different times of the day to provide more flexibility for women with conflicting family and work schedules. Finally, although the study involved 164 women, making it the third largest randomized controlled exercise trial (RCT) with menopausal women to date (26,27), the study lacked sufficient statistical power to detect intervention effects relative to certain outcomes (i.e., menopausal and depressive symptoms and life satisfaction). Thus, future studies should employ larger and more representative samples to yield more reliable and generalizable results.

The importance of our findings lies in the demonstration of positive effects of physical activity on affect and menopause-specific QOL and that differential intervention effects may be a function of changes in menopausal symptoms, which appear to be partially determined by changes in cardiorespiratory fitness. The largest intervention effects were demonstrated in the walking group, although yoga elicited similar but smaller changes. As more American women reach menopause every day, understanding the impact of this stage of life on mental health and QOL in this population and identifying effective therapeutic strategies for the enhancement of menopausal well-being, such as physical activity, is an important public health goal.

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