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Effects of Aquatic Exercise and Walking in Sedentary Obese Women Undergoing a Behavioral Weight-Loss Intervention

Elizabeth F. Nagle, Robert J. Robertson, John J. Jakicic, Amy D. Otto, Julie R. Ranalli, and Laurel B. Chiapetta

Background: The effects of the non-weight-bearing method of aquatic exercise as a modality for weight loss have not been established. The purpose of this study was to examine the effects of a combined aquatic-exercise and walking program compared with walking alone on body weight and selected variables in obese women undergoing a 16-week standard behavioral treatment program. ***Methods:*** Forty-four obese (body-mass index 34.9 ± 3.8 kg/m^2) sedentary women age 40.3 ± 6.8 years were randomly assigned to one of two groups: aquatic and walking exercise (AE) or walking only (W). In addition, both groups were required to complete three sessions of home-based walking per week and were instructed to reduce energy intake to facilitate weight loss. ***Results:*** In the AE group, total body weight, cardiorespiratory fitness, flexibility, strength, and health-related quality of life significantly improved over time similarly to the W group. Slightly greater nonsignificant losses in body weight, improvements in flexibility, greater attendance rates, and significantly greater enjoyment scores also occurred in the AE group. ***Conclusion:*** These observations suggest that aquatic exercise in combination with walking can serve as an alternative to walking exercise alone for overweight women during periods of weight loss, and this can improve functional health status.

Key Words: water exercise, weight loss

Having reached epidemic proportions, obesity is considered a major health concern and, in particular, a primary risk factor for cardiovascular disease. The most recent National Health and Nutritional Examination Survey indicated that more than 65% of American adults are overweight or obese (National Heart, Lung, and Blood Institute, 1998). Overweight and obesity have been associated with an increased prevalence of chronic diseases and decreased levels of physical well-being and quality of life (QOL; Doll, 2000; Fontaine & Barofsky, 1999; Jakicic & Marcus, 2003). Improvements in health outcomes including reduced ratings of

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bodily pain and increased quality of life have been observed in adults who lose weight (Fontaine & Barofsky; Fries, 1996). Although most weight loss occurs as a result of decreased caloric intake, exercise is an important component of a weight-loss intervention and is critical to preventing weight regain (Kruger & Galuska, 2005; National Heart, Lung, and Blood Institute, 1998). Nonetheless, despite the established benefits of physical activity as a key component of a successful weight-loss or -maintenance program, poor compliance and barriers associated with adopting an exercise program continue to exist (Kruger & Galuska). Therefore, it is important to explore effective exercise strategies for improving health outcomes associated with obesity.

Finding the most effective form of exercise to aid weight loss depends on an individual's preferences, needs, and capabilities. Previous studies have shown that strength training and land-based aerobic exercise (i.e., walking) can be important components of a successful weight-loss regime (Zachweiga, 1996). Although these exercise protocols have resulted in weight loss, problems such as decreased exercise adherence, increased muscle pain, and musculoskeletal injuries have been reported (Zachweiga). These negative consequences of exercise protocols can result in a reluctance to participate or low adherence to exercise as a weight-loss behavior (Fries, 1996).

Unlike land-based forms of physical activity, the unique hydrodynamic properties of water suggest that aquatic exercise can be both beneficial and enjoyable for clinical or obese populations (Takeshima & Roberts, 2002). Improvements in aerobic power, endurance, functional capacity, and upper body strength have been observed in clinical patients (i.e., rheumatoid and osteoarthritis) participating in aquatic exercise programs (Belza & Topolski, 2002). Although not all adults are able to swim, alternative water activities can involve whole-body movements similar to aerobic dance, calisthenics, or circuit resistance training. Water is a comparatively high-density medium (12 times more resistant than air). As such, the effort required for propulsion when attempting to overcome water's resistive forces increases heart rate and energy expenditure and makes it a challenging form of aerobic activity (Brancazio, 1984; Takeshema & Roberts). Aquatic exercise has also been shown to increase bone-mineral density, particularly when shallow-water exercise is implemented (Yurkuran, 2005), yet the ability of body weight to be supported in water results in less musculoskeletal stress than do traditional weight-bearing activities (Sheldahl, 1986). Furthermore, because of water's higher specific heat and thermoregulatory characteristics, obese individuals suffer less heat stress, permitting a more efficient heat dissipation and allowing training intensity or duration to progress at a greater rate than with land-based exercises (Sheldahl). This suggests that aquatic exercise might be perceived as comparatively less strenuous and might serve as an ideal method to improve the functional health status and reduce body weight of obese individuals.

To date, no known study has examined the use of an aquatic exercise intervention to reduce body weight and improve physiological components of overall health-related fitness. Therefore, the purpose of the present study was twofold: (a) to determine whether aquatic exercise combined with walking could decrease total body weight and increase cardiorespiratory fitness, total body strength, and flexibility and (b) to investigate whether exercise adherence, exercise enjoyment, and quality of life in obese women was greater for those participating in a combined aquatic exercise and walking program than for those participating in a traditional walking program alone.

Methods

Participants

Participants were 44 sedentary, obese, but otherwise healthy women recruited from the greater Pittsburgh metropolitan area. Written informed consent was obtained from all participants, and the research protocol was approved by the institutional review board of the University of Pittsburgh. All participants were between 25 and 50 years of age, had body-mass indexes between 30 and 45 kg/m^2 (National Heart, Lung, and Blood Institute, 1998), and were considered sedentary (reported exercising <20 min/day on <3 days/week for the preceding 6 months (National Heart, Lung, and Blood Institute). Participants were excluded if they (a) had a serious or unstable medical illness within the past 12 months, (e.g., myocardial infarction); (b) had any musculoskeletal, metabolic, or cardiovascular contraindication to exercise; (c) had undergone treatment for a serious psychological disorder within the preceding 6 months; (d) were pregnant; or (e) were taking any weight-loss or obesity drugs, were involved in an organized weight-loss program, or had reduced their body weight by >5 kg (10 lb) within the preceding 6 months.

Treatment

All participants received the same 16-week behavioral weight-loss program that included behavioral techniques for weight loss and reductions in dietary intake. Participants were randomly assigned to one of two groups: aquatic exercise plus walking (AE) or walking only (W). The total duration of exercise sessions and contact with instructors were matched between groups. Both groups were instructed to participate in 5 days of exercise per week. Each week, three possible supervised walking or aquatic exercise sessions were held simultaneously and at the same time of day for each group. Participants were required to perform two supervised and three unsupervised exercise sessions per week for the 16-week treatment, as shown in Table 1.

According to the results of Jakicic and Winters (1999), individuals required to attend five supervised exercise sessions per week have poorer adherence than individuals given the opportunity to engage in exercise in a “home-based” format. In light of these findings, the supervised AE and W sessions were supplemented with 3 days of home-based walking sessions. All sessions (supervised and unsupervised) employed the same duration and intensity.

Table 1 Exercise Sessions per Week Performed by the Participants

Experimental group	Control group
2 supervised aquatic exercise sessions	2 supervised walking sessions
3 unsupervised walking sessions	3 unsupervised walking sessions

The total time spent during each session was gradually increased each week in accordance with the American College of Sports Medicine (ACSM) recommended 200–300 min/week for weight loss and maintenance of weight loss (Doll, 2000; Fontaine & Barofsky, 1999). The aerobic-conditioning portion of exercise sessions increased from 20 to 40 min of exercise per day by the 9th week of the study. For both groups, exercise intensity was prescribed at a moderate level, that is, 60–70% of age-predicted maximum heart rate (Jakicic & Marcus, 2003). Heart rates were used to monitor exercise intensity for all exercise sessions. In addition, ratings of perceived exertion were used as a complementary procedure to guide exercise intensity and self-regulation during exercise sessions (Robertson & Goss, 2003). All sessions included a 5- to 10-min warm-up and 5- to 10-min cool-down composed of flexibility and range-of-motion exercises. Periodically, participants' exercise goals were revised to maintain the prescribed target heart-rate zones and duration of aerobic-conditioning sessions.

The AE sessions were performed in shallow and deep water and included rhythmic movements involving whole-body muscle groups with a focus on both cardiorespiratory and muscular endurance (i.e., water aerobics, calisthenics, and circuit training). The walking sessions took place outdoors on campus with periodic changes in incline throughout each session. Behavioral sessions were conducted weekly for a period of 16 weeks and addressed behavioral principles related to weight management (e.g., stimulus control, motivation, principles of reinforcement, tools for overcoming barriers, etc.), using the Lifestyle, Exercise, Attitudes, Relationships, and Nutrition (LEARN) weight-loss program (Brownell, 1997). All participants followed daily dietary caloric requirements indexed to pretreatment body mass (i.e., 1,200 kilocalories for <90 kg [200 lb], 1,500 kilocalories for > 90 kg). An individualized fat-gram-reduction goal of approximately 20% of daily caloric intake was also prescribed (ACSM, 2001). Participation diaries were reviewed on a weekly basis by investigators. Participants were provided feedback regarding these dietary and physical activity reports as part of the standard behavioral treatment program (Brownell).

Assessments

Assessments were performed at baseline and immediately after 16 weeks of treatment. Standing height was measured using a calibrated stadiometer, and weight was measured without shoes using a calibrated balance-beam scale. Percentage body fat was assessed using a Tanita Bioelectrical Impedance Analysis (BIA) system (Arlington Height, IL). A sit-and-reach test was used to measure flexibility (mm) in the shoulder, posterior thigh, and low-back area (ACSM, 2004a). The chair sit-to-stand test was used to assess lower body strength and function by measuring the number of times a participant could repeatedly stand up from and sit down on a standard-height chair without using her arms (King, 2000). Cardiorespiratory fitness was estimated using a submaximal treadmill graded exercise test (modified Stanford protocol; ACSM, 2004b) in which the speed of the treadmill was held constant at 4.8 km/hr (3.0 miles/hr), with the initial grade being 0% and progressing by 2.5% at 3-min intervals. Oxygen uptake was measured using a Sensor Medics Horizon metabolic cart (Yorba Linda, CA) with gas volumes and concentrations calibrated before each test according to manufacturer specifications. Heart rate was monitored using a 12-lead electrocardiogram, with heart rate assessed at 1-min intervals and at the point of termination using the R-R technique proposed by Dubin (ACSM, 2004a). Blood pressure and ratings of perceived exertion were assessed at each exercise stage and at the point of test termination (Utter & Robertson, 2004). The test was terminated at 85% of age-adjusted maximal heart rate using ACSM criteria for test termination (ACSM, 2004b). Pre- to postintervention changes in fitness were determined in the following manner: change in time to achieve 85% of age-predicted maximal heart rate and change in measured oxygen uptake at 85% of age-predicted maximal heart rate (Jakicic & Marcus, 2003).

Attendance at the supervised AE and W classes for the full 16-week intervention served as a measure of exercise adherence. A mean percentage was calculated for each participant by dividing the total number of classes attended by the 32 possible sessions conducted (Gyurcsik, & Estabrooks, 2003). Data from supervised exercise sessions were used to determine the number of weeks the participants attended once or the recommended two times per week. The self-report diaries were used to calculate the number and duration of unsupervised exercise sessions per week and combined total of supervised and unsupervised minutes exercised each week.

Exercise enjoyment during the supervised sessions (AE vs. W) was assessed using the Physical Activity Enjoyment Scale (PACES), which indicates the extent to which an individual experiences a particular physical activity as enjoyable at a given point in time (Kendzierski & DeCarlo, 1991).

Health-related quality of life was assessed using the 36-item short form of the Medical Outcomes Study Questionnaire (SF-36). This questionnaire measured the following eight dimensions: physical functioning, role limitations caused by physical health problems, bodily pain, social functioning, general mental health, emotional problems, vitality, and general health perceptions (Ware & Sherbourne, 1992).

Total daily intake and percentage of calories consumed as fat were calculated at baseline and after 16 weeks of treatment using the Block food frequency questionnaire (Block et al., 1986; Block & Woods, 1990).

Statistics

All data were statistically analyzed using SPSS (version 13.0). Group comparisons at baseline were performed using independent *t* tests. Using intent-to-treat analyses, a separate two-factor analysis of variance (ANOVA) for each of the dependent variables was used to determine within- and between-group differences in all assessments from baseline to 16 weeks. Significant main and interaction effects were analyzed using Tukey's post hoc procedure.

Results

Descriptive characteristics of the participants before the intervention are presented in Table 2. Independent *t* tests revealed no significant differences between the treatment groups on any of the baseline measures. Thirty-four of the 44 participants participated in the posttreatment assessments, 18 from the AE group and 16 from the W group. Two were excluded from the study for health reasons, 1 participant became pregnant, and 7 participants were lost to attrition.

Table 2 Baseline Characteristics

Variable	All (*N* = 44)	Aquatic group (*n* = 22)	Walking group (*n* = 22)	*p*
Age (years)	40.34 ± 6.86	39.6 ± 6.6	41.1 ± 7.2	NS
Race (% White)	77.3	81.8	72.7	NS
Height (cm)	165.6 ± 6.9	165.1 ± 6.9	166.1 ± 7.1	NS
Weight (kg)	96.3 ± 13.2	95.0 ± 12.5	97.3 ± 14.0	NS
Waist (cm)	99.2 ± 11.6	98.0 ± 11.2	100.3 ± 12.2	NS
Waist:hip ratio	0.82 ± 0.08	0.8 ± 0.07	0.8 ± 0.08	NS
Body-mass index (kg/m^2)	34.99 ± 3.83	34.9 ± 3.7	35.1 ± 4.1	NS
% Body fat	44.9 ± 3.3	44.7 ± 4.4	45.0 ± 4.4	NS
Flexibility (cm)	3.8 ± 7.2	4.3 ± 9.0	3.4 ± 5.0	NS
Strength (repetitions)	14.7 ± 2.8	15.4 ± 2.9	14.0 ± 2.5	.10
VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$)	19.1 ± 3.5	19.3 ± 3.7	18.9 ± 3.4	NS
VO_2 (L/min)	1.8 ± 0.4	1.8 ± 0.3	1.8 ± 0.4	NS
Time to termination (s)	580.3 ± 167.5	598.7 ± 179.7	561.8 ± 156.4	NS
Diet				
calories	2,134.9 ± 965.7	2,269.0 ± 1,162.1	1,974.0 ± 663.7	NS
fat	39.1% ± 6.8%	40.2% ± 6.3%	37.7% ± 7.3%	NS
protein	15.2% ± 2.9%	15.3% ± 3.4%	15.1% ± 2.4%	NS
carbohydrate	46.6% ± 6.8%	45.3% ± 6.1%	48.2% ± 7.3%	NS
sweets	17.6% ± 9.4%	16.7% ± 11.4%	18.7% ± 6.6%	NS

Total Body Weight, Cardiorespiratory Fitness, Lower Body Strength, and Flexibility

Changes (post – pre) in outcome measures by exercise group are shown in Table 3. Total body weight and body-mass index decreased significantly across 16 weeks of treatment in both groups ($p < .001$; Figure 1). Although the AE group lost more weight than the W group (6.8 ± 3.2 kg [–7.2%] vs. 5.6 ± 4.7 kg [–5.8%]), there was no significant effect of exercise group on change in body weight between groups.

Significant improvements occurred for exercise time to termination and oxygen consumption after 16 weeks of treatment for both groups ($p < .001$). Time taken to achieve 85% of age-predicted maximal heart rate during the submaximal treadmill test increased in the AE group by 149.9 ± 194.3 s (25.8%) postintervention, whereas the W group increased it by184.1 + 123.0 s (30%). For VO_2 corresponding to 85% of maximum heart rate, the AE group increased 2.4 ± 2.5 (12%) $ml \cdot kg^{-1} \cdot min^{-1}$, whereas the W group increased 2.8 ± 3.1 (14.8%) $ml \cdot kg^{-1} \cdot min^{-1}$ for the same assessment periods (Figure 2). No significant Group × Time interaction was found.

Table 3 Change (post – pre) in Outcome Measures by Exercise Group

Variable	Aquatic group (*n* = 22)	Walking group (*n* = 22)	*p* (Group × Time)
Weight (kg)	6.8 ± 3.2	5.6 ± 4.7	NS
Waist (cm)	6.63 ± 4.0	7.23 ± 8.7	NS
Waist:hip ratio	0.02 ± 0.02	0.04 ± 0.08	NS
Body-mass index (kg/m^2)	2.6 ± 1.2	2.2 ± 1.7	NS
% Body fat	5.7 ± 3.4	6.5 ± 5.5	NS
Flexibility (cm)	3.4 ± 4.4	1.9 ± 5.8	NS
Strength (repetitions)	2.2 ± 3.6	2.2 ± 2.7	NS
VO_2 kg (ml · kg^{-1} · min^{-1})	2.4 ± 2.5	2.8 ± 3.1	NS
VO_2 L (L/min)	0.06 ± 0.2	0.1 ± 0.3	NS
Time to termination (s)	149.9 ± 194.3	184.1 ± 123.0	NS
% of sessions attended	72.0 ± 25.4	61.5 ± 26.7	NS
Enjoyment scale (PACES)	115.6 ± 13.9	103.6 ± 14.5	.03
Diet			
calories	798.5 ± 824.1	518.6 ± 621.4	NS
fat	11.4% ± 6.3%	11.6% ± 5.7%	NS
protein	3.1% ± 2.7%	2.7% ± 4.7%	NS
carbohydrate	9.5% ± 6.4%	9.6% ± 4.0%	NS
sweets	9.5% ± 6.4%	9.6% ± 4.0%	NS
MOS-SF36			
physical functioning	0.93 ± 1.7	1.1 ± 2.9	NS
role physical	0.2 ± 0.6	0.00 ± 0.71	NS
bodily pain	4.9 ± 2.2	3.9 ± 2.5	.16
general health	2.0 ± 2.4	1.8 ± 3.0	NS
social functioning	0.7 ± 2.2	0.6 ± 1.6	NS
role emotional	0.1 ± 0.4	0.4 ± 1.2	.09
mental health	3.1 ± 3.5	3.3 ± 4.7	NS

Note. MOS-SF36 = Medical Outcomes Study Questionnaire, Short Form 36.

Analysis of data on lower body strength determined by the chair-sit-to-stand test showed a significant improvement ($p < .001$) for both groups over the 16-week treatment period. Although the AE group showed less improvement in lower body strength than did the W group (AE 2.2 ±3.6 repetitions [+14%] vs. W 2.2 ± 2.7 repetitions [+15.7%]), the Group × Time interaction was nonsignificant.

Analysis of flexibility data from the sit-and-reach test showed a significant time effect ($p < .006$) for both groups. The AE group showed a greater, though

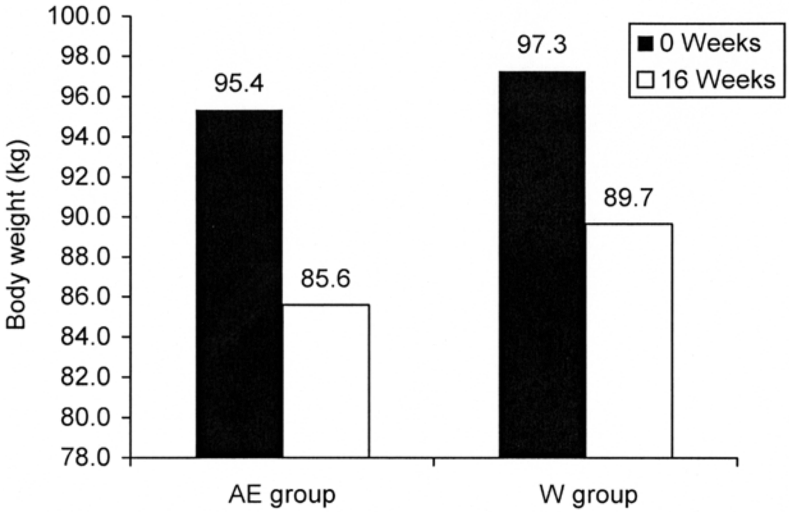

Figure 1 — Changes in body weight from 0 to 16 weeks. AE = aquatic and walking exercise; W = walking only.

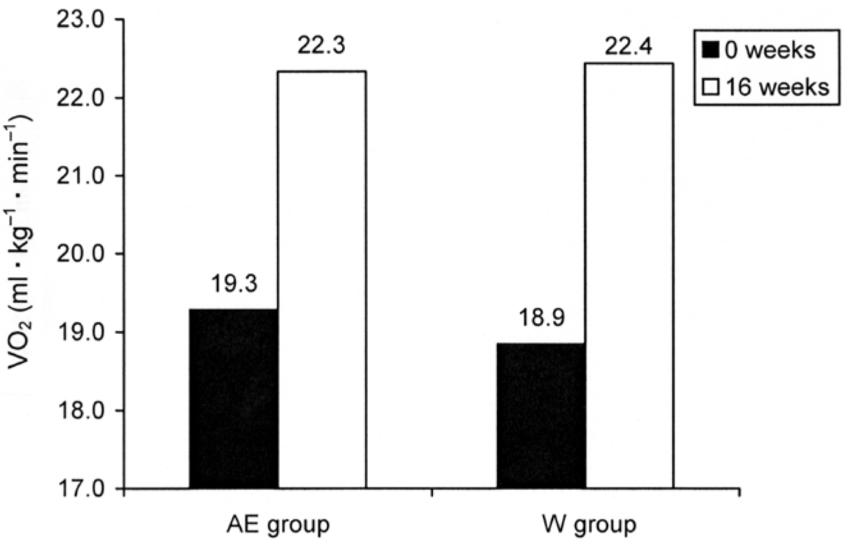

Figure 2 — Change in VO_2 at 85% HR_{max} from 0-16 weeks. AE = aquatic and walking exercise; W = walking only.

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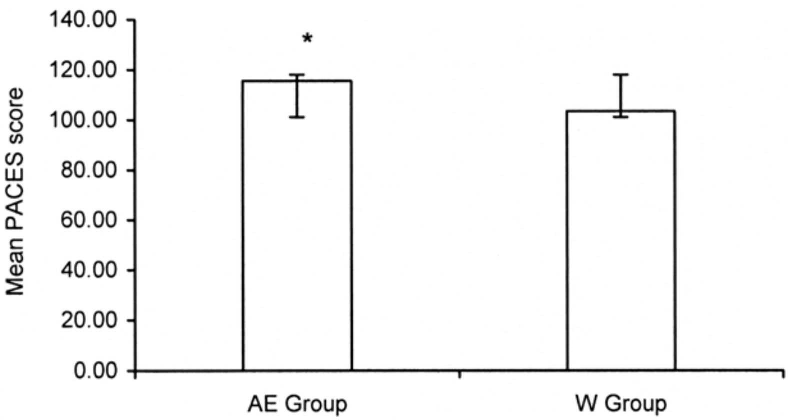

Figure 3 — Comparison of mean Physical Activity Enjoyment (PACES) scores. AE = aquatic and walking exercise; W = walking only.

*The AE group scored significantly greater on the PACES scale vs. W only group ($p < .03$).

nonsignificant, improvement in flexibility than that of the W group (3.4 ± 4.4 [+14%] cm vs. 1.9 ± 5.8 cm [7.0%]). The Group × Time interaction was nonsignificant.

Exercise Attendance, Enjoyment Scale, and Health-Related Quality of Life

There was no significant difference in attendance rate between the two groups (AE = 72 ± 25.40%, W = 61.5 ± 26.74%).

Exercise enjoyment measured from the PACE scale indicated that the AE group had significantly ($p < .03$) greater enjoyment scores (115.6 ± 13.9) than the W group (103.6 ± 14.5) after the 16-week intervention (Figure 3).

The AE and W groups both increased overall SF-36 scores over 16 weeks. The AE group had slightly greater nonsignificant improvements on four out of seven SF-36 domains (role physical, bodily pain, general health, and social functioning) than the W group, but the Group × Time interaction was nonsignificant.

Dietary Intake

Analysis of data from the Food Frequency Questionnaire showed that the caloric intake of the AE group significantly decreased from 2,269 ± 1,162 to 1,470 ± 824 kJ/day, and the W group significantly decreased from 1,974 ± 664 to 1,455 ± 621 kJ/day over the 16-week intervention. In addition, both groups significantly decreased the percentage of calories consumed as fat. A nonsignificant Group × Time interaction indicated that the decrease in caloric and percentage of fat intake was similar for both groups.

Discussion

The 6.8-kg (–7.2%) and 5.6-kg (–5.8%) weight loss for the AE and W groups, respectively, are consistent with the approximate 5–10% weight loss reported for behavioral treatment programs using low-calorie, low-fat diets (Anderson, 1999). Similar to other studies, the recommended dietary intake and behavioral changes likely contributed to weight loss in both groups (Anderson; Jakicic & Marcus, 2003; Jakicic & Winters, 1999). Furthermore, there were no significant differences in decreases in caloric and fat requirements between the AE and W groups after the 16-week intervention. Of interest was the slightly greater nonsignificant weight loss that occurred in the AE group. It is possible that higher enjoyment scores and attendance rates contributed to higher overall caloric expenditure and greater weight losses in the AE group than in the W group. As in other investigations, cardiorespiratory fitness improved significantly in the AE and W groups during the 16-week intervention (Takeshima & Roberts, 2002). Despite similar gains in cardiorespiratory fitness for both groups, a smaller percentage of improvement was shown in the AE than in the W group (12% vs. 14%). It should be noted that a more mode-specific measurement of maximal oxygen consumption might have resulted in a correspondingly higher cardiorespiratory-fitness level; this is considered a limitation of the current study. In this regard, Costill and Maglischo (1992) observed that in order to accurately measure physiological effects of aquatic training, a mode-specific test must be employed. A protocol that measures oxygen consumption when the participant is submerged in water typically yields higher values than traditional treadmill tests conducted in a laboratory setting. Therefore, future studies examining aquatic exercise should assess cardiorespiratory fitness using an aquatic test environment.

Improvements in lower body strength and flexibility were expected considering the modes of physical activity used in the treatment groups. A group effect indicated that the W group had slightly but not significantly greater lower body strength than the AE group after the 16-week intervention. This might result in part from the greater weight-bearing effects of land walking, because this program incorporated hills into weekly conditioning sessions. Despite the belief that exercise in water lacks a weight-bearing component, shallow-water exercise involving foot contact with the bottom of the pool has been shown to improve bone-mineral density compared with traditional weight-bearing exercise in postmenopausal women (Yurkuran, 2005). Increasing time periods spent in shallow water (waist deep or less) where weight-bearing effects are greater can accomplish this requirement (28% of weight bearing occurs at the xiphoid process, versus 47–68% at the anterior superior iliac spine; Thein & Brody, 1998). Consequently, to improve lower body strength and weight-bearing effects, aquatic exercise sessions should include a segment focused on activity in water waist-deep or less.

There were significant improvements in flexibility for both groups, with the AE group showing slightly greater nonsignificant gains than the W group. Although the training programs were consistent in adding flexibility components to both water and walking workouts, it is likely that the effects of water and buoyancy helped improve flexibility more than in the walking group. This supports previous investigations that reported improvements in joint flexibility, muscle torque, and neuromuscular performance in healthy and clinical samples of women undergoing aquatic-based exercise programs (Templeton & Booth, 1996).

On the PACE scale, the AE group had significantly greater enjoyment scores than did the W group. Despite potential issues surrounding body image and self-consciousness while wearing a bathing suit, it appears participants enjoyed the aquatic exercise program more than the walking-only program. Although this might also have resulted from the novelty of participating in a new form of exercise, the average attendance rates remained higher over the 16-week intervention. Because positive affect and increased enjoyment have been established as key determinants of exercise behavior, it seems reasonable to suggest that participation in aquatic exercise should be encouraged for those undergoing a weight-loss program. It should be mentioned, however, that for the current study all AE sessions were held exclusively with direct access to the women's locker room. Community-based aquatic programs typically serve the greater public, with a likelihood of multiple aquatic activities occurring concurrently. As such it is possible that an obese individual participating in aquatic exercise might not feel as comfortable participating in this type of class setting compared with the more "private" conditions in the current study.

Enjoyment scores were also related to exercise attendance. Spearman rank–order correlation coefficients showed significant correlations between enjoyment scores and total activity sessions attended ($r = .50$, $p < .05$) in the AE but not the W group. Although the AE group attended a greater percentage of required sessions, groups also differed in attendance at all three possible sessions offered each week. With participants required to attend two sessions per week, it was surprising that 67% of AE participants attended all three sessions for a minimum of 1 week compared with 38% in the W group. This suggests that enjoyment of

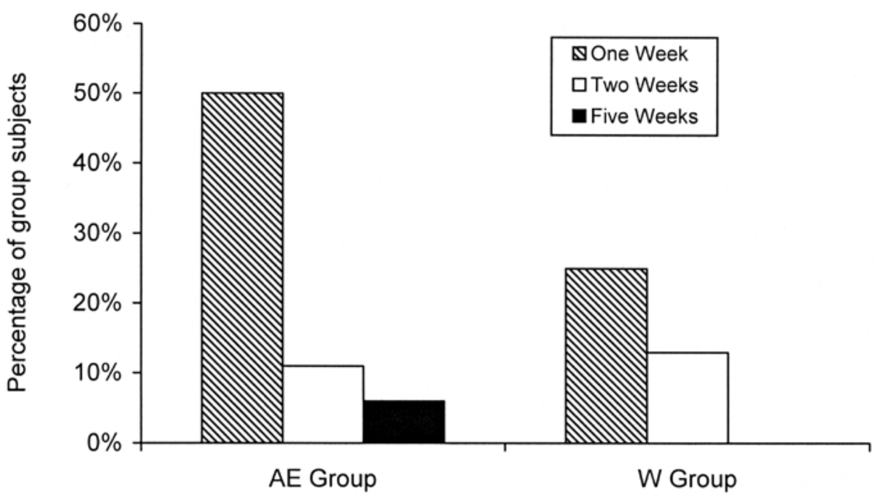

Figure 4 — Number of weeks participants attended three times per week. AE = aquatic and walking exercise; W = walking only.

aquatic exercise might have affected exercise participation throughout the 16-week intervention (Figure 4).

In the current study, participants in the AE group felt less bodily pain and increased role physical scores from the SF-36 questionnaire. Subjective outcome measures in those who suffer from musculoskeletal disorders indicate that aquatic exercise is effective in decreasing pain. The proposed mechanism underlying this response is an increased sensory input and muscle relaxation from the hydrodynamic and thermoregulatory properties of water. As a result of this increased physical and mental stimulation, it has been suggested that aquatic exercise distracts individuals from pain sensation (Belza & Topolski, 2002). It would seem reasonable that aquatic exercise produces less of a perceived weight-bearing impact on muscles and joints than does traditional weight-bearing exercise alone. In an overweight or obese population, these benefits might translate to increases in ability to perform additional tasks (i.e., activities of daily living) and potentially enhance a person's quality of life (Volek & VanHeest, 2005). In addition, increased exercise adherence and group support have been shown to beneficially influence quality-of-health outcomes in individuals who participate in aquatic exercise. Belza and Topolski found that osteoarthritis patients who adhered to a community-based aquatic-exercise program showed greater improvements in quality of well-being, physical function, and quality of life than did nonadherers, suggesting that those who consistently attended class received greater health benefits. The effects of exercise adherence on health-related outcomes were not investigated in the current study. Future aquatic interventions that track exercise adherence should examine additional contributory factors such as effects of group support and extrinsic motivation (i.e., positive encouragement from an instructor) on health outcomes for obese individuals.

In this study, it should be noted that the effects attributed to the AE training program involved both aquatic and at-home walking exercise. The difference in gains observed between the two programs (AE vs. W) was likely a result of the independent effects of aquatic exercise. It is possible, however, that the combined effect of the two exercise modalities contributed to outcomes measured in the present study, so an aquatic-exercise-only group should be included in future investigations.

Conclusions

This investigation appears to be the first to demonstrate that, as an alternative form of physical activity, aquatic exercise combined with an at-home walking program is as effective as traditional land-based forms of exercise when used as part of a standard behavioral treatment program for weight loss. Total body-weight loss, cardiorespiratory fitness, flexibility, and strength significantly improved over time for both groups, with slightly greater nonsignificant losses in body weight and improvements in flexibility in the AE group. Of clinical significance, however, are the factors that support aquatic exercise as a potentially better modality for promoting exercise adherence. The perception of a less strenuous yet challenging new form of activity combined with a greater enjoyment supports aquatic exercise as a viable tool to aid weight loss, especially in obese women. Physical activity has been shown to play a key role in long-term weight loss and prevention of weight regain.

Therefore it seems reasonable to recommend aquatic exercise as part of adopting physical activity behaviors that will promote exercise adherence. Furthermore, future studies that examine the effect of long-term outcomes of aquatic exercise on health-related fitness outcomes and exercise adherence should be considered.

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