The Effect of a Diet and Exercise Program With a Mini Medicine Ball on Cardiovascular Fitness, Weight Loss, and Strength

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ABSTRACT

Excess body fat is an increasing problem in the world today. In a single-blinded, randomized study, we investigated 70 subjects in the age range of 20-65 years who underwent a 10-day diet and physical exercise program (35 controls, 35 active subjects). Subjects ranged from overweight to obese. All subjects were free of diabetes, neurological, or cardiovascular disease. The diet was a dietary recommendations program involving a reduction in caloric intake. The diet was a mixed calorie diet with approximately one third protein, one third carbohydrates, and one third fats. Foods included salads, eating fruits and grains for breakfast, and broiled meats to reduce the fat content for lunch and dinner. Weight, girth, and body fat measurements were taken at baseline, 3 days, 10 days, and 2 weeks. The exercise program consisted of 3 different videos performed at home for up to 1 hour, 6 days per week. The first video involved 60 minutes of aerobic exercises. The second video involved 50 minutes of medicine ball exercises including reaching, twisting, and bending exercises through full range of motion. The third video was a 10-minute mini ball abdominal workout video. Muscle strength of the biceps, hamstrings, quadriceps, and abdominal muscles was measured at baseline, 3 days, 7 days, and 10 days into the study. The results showed that, for most people, loss of 1 pant or dress size (1-inch loss in girth) could be achieved in 3 days. The top 10% of participants lost 2.6 cm of girth in the first 3 days at the waist. The average loss in girth at the waist at 3, 7, and 10 days was 1.84, 2.91, and 3.06 cm, respectively. The average weight loss over 10 days was 3.5 kg. The

Table 1. General characteristics of the subjects at the beginning of the study.

		Age (years)	Height (cm)	Weight (kg)	Body Mass Index (kg/m^2)
Exercise group	Mean	39.5	167.1	87.8	31.4
	SD	10.8	10.6	15.0	4.5
Controls	Mean	36.0	168.0	82.9	29.3
	SD	11.3	9.3	19.7	6.4

average 3-day weight loss was 2.5 kg. Strength increased on an average of 11.21% for these muscles. Compliance for the diet and exercise averaged 89.1% and 75.9%, respectively. Thus the program saw large gains in fitness and weight loss.

INTRODUCTION

Global obesity has risen significantly over the past 20 years. In particular, more than 60 million adults in the United States are obese. This amounts to 30% of the US population over the age of 20 years who are obese.[1] The secondary effects of obesity include low-grade systemic infection,[2] hypertension, coronary heart disease, stroke, hyperlipidemia, type II diabetes, gallbladder disease, osteoarthritis, sleep apnea, other respiratory and orthopedic conditions, and some cancers.[1,3,4]

Various types of diets such as soy-based diets,[5,6] low-fat and low-carbohydrate diets,[7] high-fat diets,[8] a combination of surgical and diet programs,[9] and high-protein diets have been tested in people who are overweight.[10]

High-fat diets are limited by the fact that they have a tendency to increase overall body inflammation and increase C-reactive protein during weight loss.[8] Further, high-carbohydrate diets do not work well for weight control as there is evidence to suggest that people are likely to regain weight over time.[11] Thus treatments for obesity have made limited progress to date.[12]

However, dietary programs involving lifestyle changes with exercise together are much more effective. For example, exercise alone does not improve adipokines and oxidative stress in overweight people without a dietary weight loss program being combined.[13] A combination of exercise and dietary restriction have the ability to increase total body metabolism.[14] Another advantage of regular exercise is that it increases lean body mass as well as energy.[15-17] It is widely understood that endurance in abdominal musculature and strength of abdominal muscles is essential for posture, injury prevention, and health and fitness. Weak abdominals are directly associated with incidence of low back pain.[18-20] Strengthening the core muscles is one of the key components toward alleviating and preventing low back pain.[21] Poor posture is common for those who lead a sedentary lifestyle causing a tremendous strain on the lower back and inter-vertebral discs.[21,22]

One type of exercise designed to strengthen and increase muscle flexibility is the use of medicine balls. Medicine balls have been studied by a wide variety of populations including school age children,[23] for increasing motor ability and aerobic fitness in athletes,[24] for increasing strength of upper body muscles,[25] and for strengthening abdominal core muscles in rowers.[26] Thus, there are numerous benefits to medicine balls in an exercise program. The purpose of this investigation was to determine the effectiveness of a combined diet and core muscle strengthening program with mini

Table 2. Diet composition for men and women.

	Day	Kcal	Protein (%)	Carbohydrates (%)	Fat (%)	Sodium (mg)	Fat (g)	Saturated Fat (g)
Men	1	1327	37	39	24	1234	36	6
	2	1384	37	28	35	1485	56	18
	3	1374	41	42	17	1308	27	7
	4	1502	37	36	27	1496	46	13
	5	1552	37	35	28	1575	48	13
	6	1540	37	31	32	1412	57	19
	7	1547	35	33	32	1565	57	15
	8	1528	38	38	24	1393	42	16
	9	1592	40	39	21	1752	38	12
	10	1544	39	38	23	670	41	10
	Mean	1489.0	0.4	0.4	0.3	1389.0	44.8	12.9
	SD	91.7	0.0	0.0	0.1	291.8	10.0	4.3
Women	1	1192	35	39	26	1160	36	6
	2	1147	36	33	31	1370	41	13
	3	1164	40	45	15	1265	20	6
	4	1345	37	37	26	1291	40	11
	5	1339	38	31	31	1537	47	12
	6	1379	38	29	33	1349	52	18
	7	1363	36	36	28	1422	43	11
	8	1376	37	41	22	1354	34	13
	9	1364	38	40	22	1528	34	11
	10	1367	40	35	25	472	39	9
	Mean	1303.6	0.4	0.4	0.3	1274.8	38.6	11.0
	SD	95.2	0.0	0.0	0.1	304.3	8.6	3.5

medicine balls to determine the effects on compliance, strength, body weight, and body fat.

SUBJECTS AND METHODS

Subjects

Seventy subjects in the age range of 20-65 years participated in the study. Thirty five were in the active group and 35 were controls. Subjects were recruited over a wide range of body masses. Subjects were free of cardiovascular disease or neurological injury at the time of the experiment. Subjects were randomly allocated into either the control group or a combined diet and exercise group. There were no differences in gender between the groups. All subjects signed a consent form and all procedures were approved by the Human Review Committee of Azusa Pacific University. The general characteristics of the subjects are given in Table 1. There was no significant difference in the age, height, weight, or body mass index of the 2 groups of subjects. The range of ages and body mass index was wide as shown by the standard deviations in Table 1.

Measurement of Strength

Strength was measured with a 350-ohm strain gage Wheatstone bridge. The output of the bridge was amplified with an instrumentation amplifier whose fre-

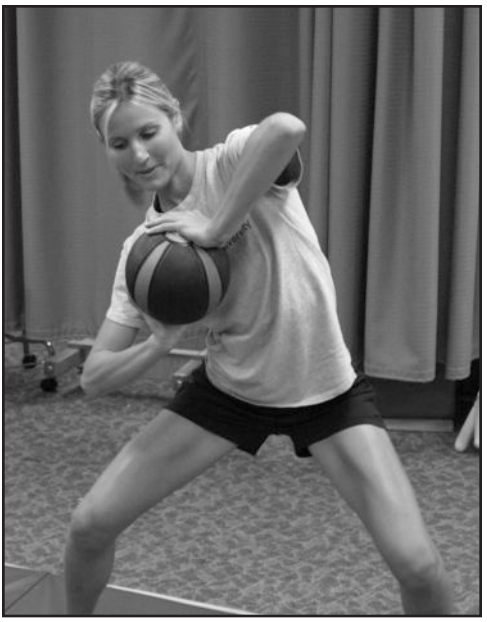

Figure 1. A subject engaging in exercise with the mini medicine balls.

quency response was flat from DC to 10,000Hz. The output was calibrated and displayed on a Weston 1971 panel meter. Strength was measured as the greater of 2 maximum efforts of each muscle group recorded from the 2-inch cotton strap. Subjects were placed in a position to isolate each muscle group.

Compliance

For the experimental group, a compliance scale was used. Subjects were asked to complete log sheets on a daily basis for both the diet and exercise programs so that any additional food eaten was recorded.

The diet compliance scale is as follows: If they did not deviate on a meal, they scored 1/3 point. Thus for total compliance on a given day, the maximum score was 1.0. This score was added for the 10 days. If they were 100% complaint, the score would be 10 points.

Figure 2. Strength being measured in the triceps muscle in a typical subject.

The exercise compliance scale as follows: If they exercised the full 60 minutes, they scored 1 point each day. If they worked out 15 minutes they scored 0.25 points. If they worked out 30 minutes they scored 0.5 points. If they worked out 45 minutes, they scored 0.75 points. On the early part of the study, if they could not complete 1 hour due to fatigue, they still received 1 point.

Diet

The diet consisted of a low-fat, low-carbohydrate, low-protein, and low-sodium diet. The average calories were approximately 1,300 calories for women and 1,500 calories per day for men. The diet involved a reduction in calories and glycemic index. The diet is listed in Table 2.

Blood Pressure

Blood pressure was measured by auscul-

Table 3. Videos used in the studies.

Day	1	2	3	4	5	6	7	8	9	10
Cardio		X		X		off	X		X	
Total Body Sculpting	X		X		X	off		X		X
Abs	X		X		X	off		X		X

Table 4. Strength (kg) at the beginning and end of the study in the control subjects.

		Rectus	Back Extensors	Biceps	Triceps	Quads	Hamstrings
Start	Mean	18.6	23.7	16.6	10.1	27.4	18.2
	SD	6.2	5.6	3.6	3.6	6.8	6.1
End	Mean	18.3	24.5	15.3	9.3	25.4	16.8
	SD	6.3	7.5	4.3	2.8	6.6	4.1

tation of the left arm. An automatic blood pressure cuff was used on the wrist (Omron Hem 621, Schaumburg, Illinois, USA).

Heart Rate
Heart rate was determined by the radial pulse by the blood pressure cuff mentioned above.

Body Fat Content
Body fat content was measured by an impedance plethysmograph (RJL Systems, Clinton Twp, Michigan USA).

Girth Measurement
Girth measurements were made by a measuring tape with a tensionometer that applies 3 grams of force during the measurements (Vital signs model 67020, Country Technology, Gays Mills, Wisconsin, USA). To improve reliability, the same person made all of the measurements (a senior student in the doctor of physical therapy program).

Video Exercises
A 2-lb mini medicine ball of 8-inch diameter was given to the subjects along with 3 exercise videos. A typical exercise is shown in Figure 1 using the ball. One was a 60-minute fat-burning cardio video, which was predominantly aerobic consisting of upper and lower body exercise, in place jogging, walking, hopping, and squats. In addition, a 50-minute total body sculpting video was provided and involved more dynamic exercise including stretching and rotational exercise aimed to strengthen the core muscles, the upper arm muscles, and leg muscles. The final video provided was a 10-minute accelerated abdominal video. Each day, different videos were assigned so that the active group was exercising 6 days/week as illustrated in Table 3.

Procedures
This study was a single-blinded randomized design. The subjects were randomly assigned to either the control group or the active group. All measurements were taken by personnel who did not know if the subjects were in the active or the control group (the measurement technicians were blinded). At the onset of the study, demographic data were obtained for each subject including age, height, weight, body mass index, resting heart rate, blood pressure, and total body fat by impedance. Strength was measured by obtaining the better of 2 maximum efforts for each muscle group (Figure 2). Girth of the waist (at the umbilicus and 2.5 cm above and below the umbilicus) and thighs (half of the distance between the hip and knee) was also measured as described in the methods section. All measures were obtained at baseline, 3 days, 7 days, 10 days, and at the completion of the study.

RESULTS

Strength
The results of the strength determinations over the course of the study are represented in the bar graphs in Figures 3-8 for the subjects in the diet and exercise group. Strength in the control sub-

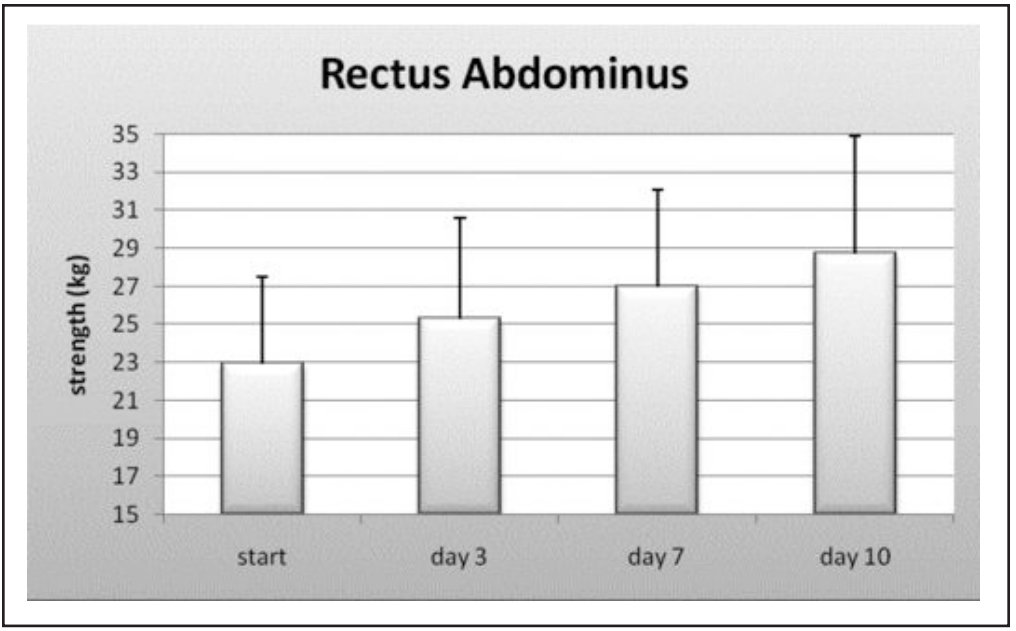

Figure 3: The average strength in the rectus abdominus for the exercise group as the mean ± SD at beginning, 3 days, 7 days, and end of the study.

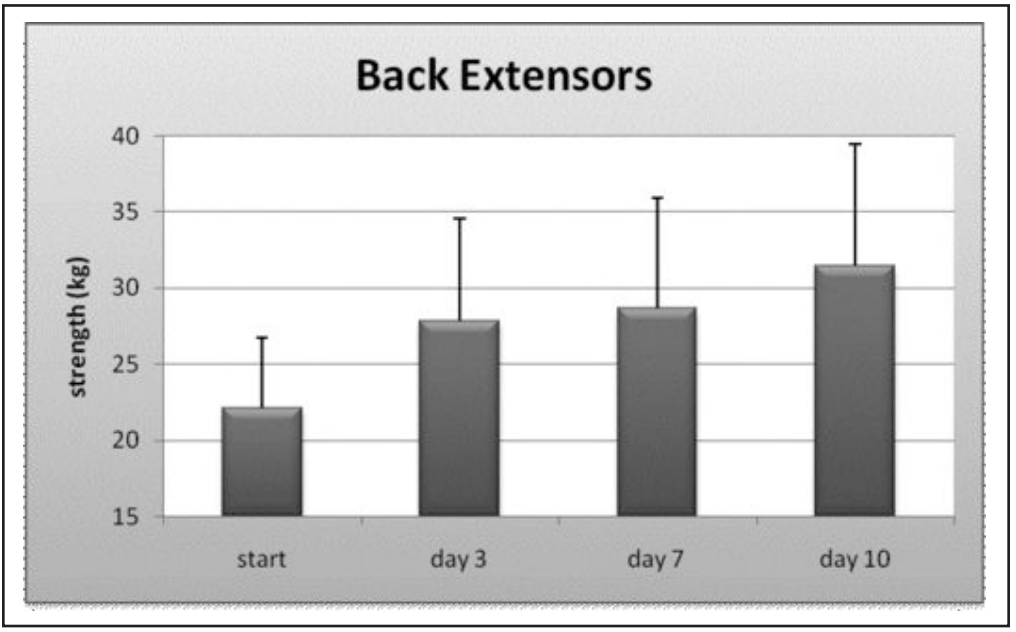

Figure 4. The average strength in the back extensors for the exercise group as the mean ± SD at beginning, 3 days, 7 days, and end of the study.

jects did not vary significantly throughout the 10-day period ($P > 0.05$; Table 4). However, as shown in Figures 3-8, strength increased significantly ($P < 0.01$) in the active group for the rectus abdominus, back extensors, biceps, triceps, quadriceps, and hamstrings. For example, on average, rectus abdominus strength started at 22.9 ± 4.9 kg and increased to 28.7 ± 6.2 kg by the end of

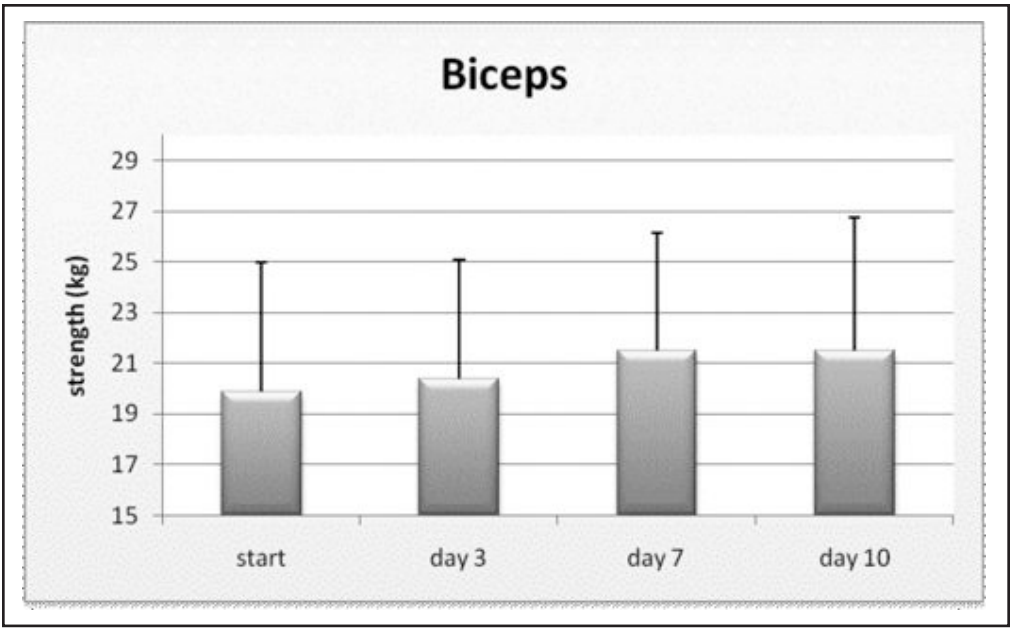

Figure 5. The average strength in the biceps for the exercise group as the mean ± SD at beginning, 3 days, 7 days, and end of the study.

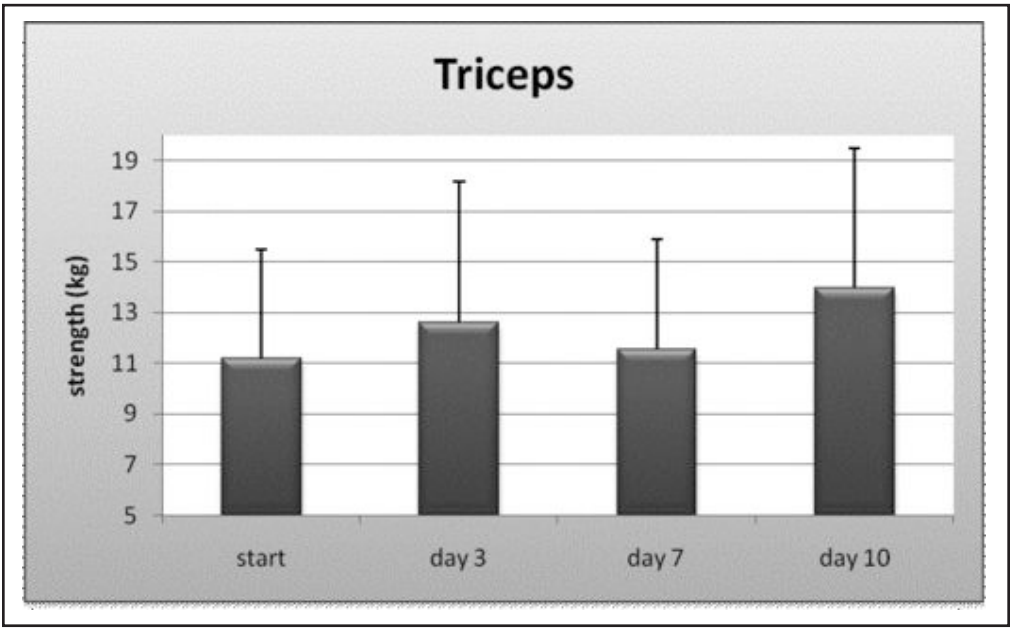

Figure 6. The average strength in the triceps for the exercise group as the mean ± SD at beginning, 3 days, 7 days, and end of the study.

the 10-day period. For the biceps, strength started at 19.8 ± 5.1 kg at the onset of the study and, after 10 days, increased to 21.5 ± 5.3 kg, also a significant increase ($P < 0.01$). At 3 and 7 days, the strength increased progressively from baseline through the 10-day period. The same was true for the other muscles as shown in these figures. The average strength increase for the mus-

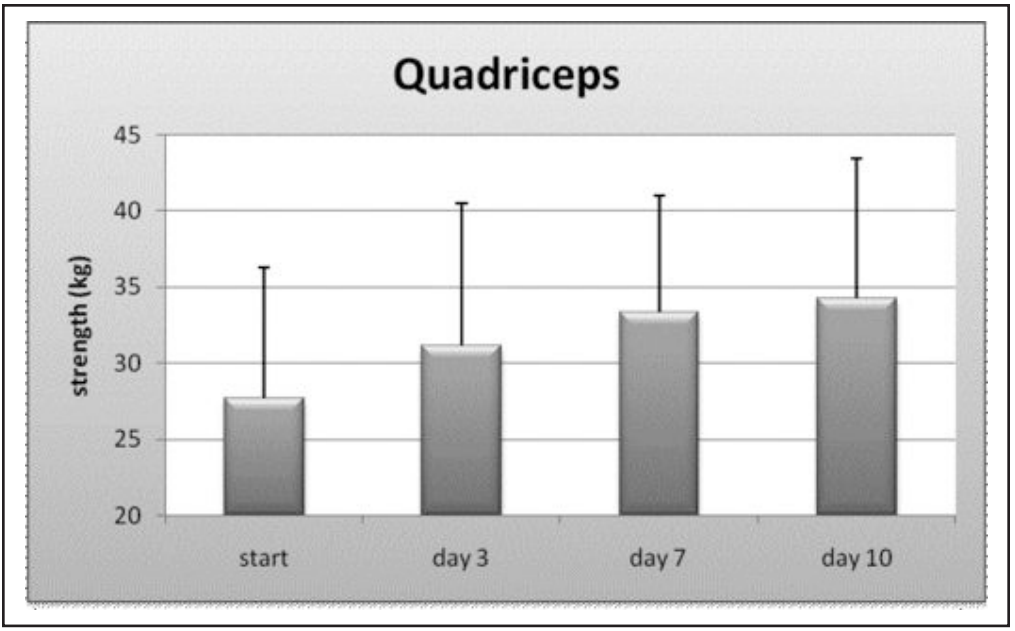

Figure 7. The average strength in the quadriceps for the exercise group as the mean ± SD at beginning, 3 days, 7 days, and end of the study.

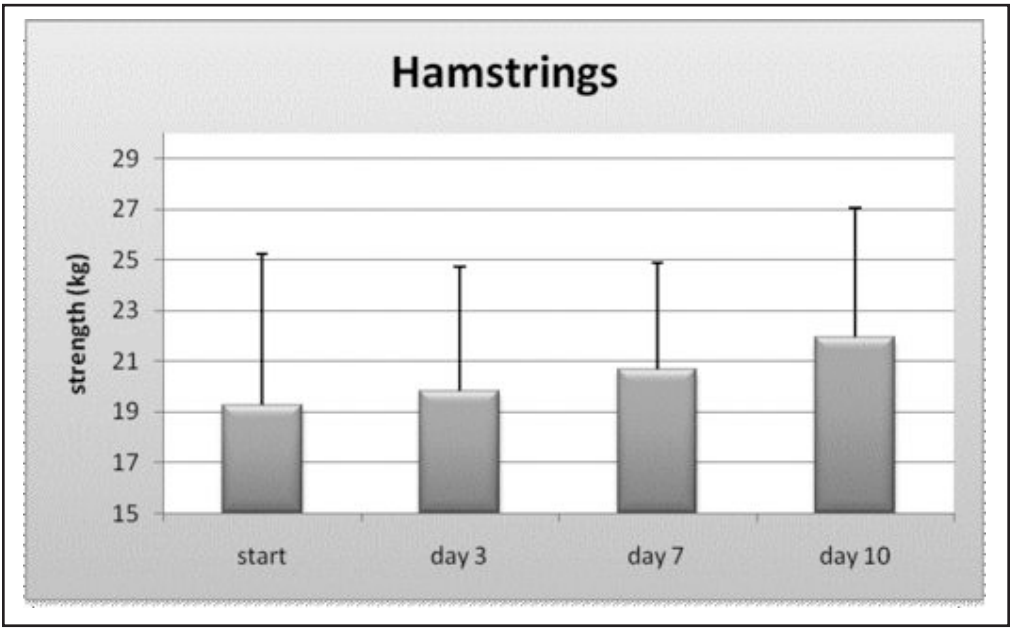

Figure 8. The average strength in the hamstring muscles for the exercise group as the mean ± SD at beginning, 3 days, 7 days, and end of the study.

cles at 3, 7, and 10 days is shown in Table 5.

Weight

For the control subjects, the average weight of the onset of the test period was 82.9 ± 13.6 kg. At the end of the 10-day period, the average weight was 83.4 ± 19.2 kg. These differences were not significant ($P > 0.05$). However, for the

Table 5. Change (%) in muscle strength at 3, 7, and 10 days in the exercise group.

	Rectus Abdominus	Back Extensors	Biceps	Triceps	Quads	Hamstrings
Start to 3 days	10.3	25.7	2.6	12.9	12.7	3.1
Start to 7 days	17.6	29.4	8.1	3.4	20.6	7.4
Start to 10 days	25.1	42.1	8.0	24.7	23.9	14.1

Table 6. Girth (cm) in control group over the 10-day period.

		Umbilicus	Plus 1	Minus 1	Thigh
Start	Mean	101.7	100.3	104.9	63.1
	SD	14.4	14.9	13.9	7.6
End	Mean	101.6	100.2	104.7	62.9
	SD	14.1	14.6	13.8	8.2

Table 7. The change in girth (cm) at 3, 7, and 10 days after the onset of the diet.

	Umbilicus	Plus 1	Minus 1	Thigh
Start to 3 Days	-1.83	-1.29	-1.94	-0.47
Start to 7 Days	-2.91	-2.61	-2.38	-1.13
Start to 10 days	-3.06	-3.15	-3.33	-1.75

subjects in the combined exercise and diet group, the average weight, which started at 87.8 ± 15.0 kg, significantly decreased by 3.5 ± 1.2 kg (Figure 9). The range of weight loss was from 1.1 kg to 7.5 kg. For 10% of the subjects, the weight loss was 7.1 kg and for 20% of the subjects, the weight loss was 6.0 kg. Thus, in summary, the diet caused a large weight loss over the 10-day period. Over the 3-day period, the weight loss for the exercise group was 2.5 kg. This weight loss was significant ($P < 0.01$). Further, for 10% of the group, after 3 days, the change in weight was 3.0 kg and the group lost 7.1 kg in 10 days.

Girth

For the control group, girth did not change during the 10-day period as shown in Table 6. There were no significant differences in any measurement.

For the diet and exercise group, the change in girth of the waist as shown in Figure 9 was comparable to the change in weight in Figure 10. The average girth at the waist was 104.2 ± 12.1 cm at the onset of the study and, after 10 days, was reduced by 3.06 cm. This reduction was significant ($P < 0.01$). Interestingly, even at 3 days, the waist was reduced by 1.84 cm. At 7 days, initial girth was reduced by 2.91 cm. Thus, the overall reduction showed a loss of approximately 1 pant or dress size after 3 days. The change in girth is shown in Table 7. The change in girth at the waist for the top 10%, 20%, and 30% of the group is shown in Table 8.

Heart Rate and Blood Pressure

Figures 11 and 12 show the heart rate and blood pressure responses of the exercise and diet group. There was no

Table 8. The change in girth (cm) in the top 10%, 20%, and 30% of the diet and exercise group.

	3 Days	7 Days	10 Days
Top 10%	6.7	9.0	8.7
Top 20%	5.0	7.1	7.1
Top 30%	4.5	6.6	6.5

significant difference in heart rate for the control group over the 10-day period. The initial resting heart rate for the control group was 73.6 ± 11.3 beats per minute and after 10 days was 77.6 ± 9.8 beats per minute ($P > 0.05$). Blood pressure fell in this group by 3.22 mmHg, but this change was not significant.

For the exercise and diet group, as shown in Table 9, blood pressure fell throughout the study ($P < 0.01$). Heart rate showed no statistical change.

Table 9. The blood pressure (mmHg) and heart rate (beats per minute) in the diet and exercise group throughout the study.

Diet	Systolic	Diastolic	Heart Rate (bpm)
Start	126.41	80.18	76.29
	15.25	12.03	13.24
Day 3	124.44	79.91	79.09
	12.65	8.04	12.21
Day 7	124.28	79.47	76.09
	10.23	7.58	11.69
Day 10	123.17	75.91	76.17
	13.07	8.63	11.39

Compliance

For the diet and exercise program, the average compliance was 89.9% ± 10.8% for the diet and 75.1% ± 23.1% for the exercise. This is shown with the coefficient of variation in Figure 13.

Body Fat and Body Mass

In the active group, body fat was reduced by 0.4%, 1.7%, and 3.2% after 3, 7, and 10 days, respectively. Body water increased by 1.43% over this period, showing that the subjects were not dehydrated. Further, when computing the loss in fat over the 10-day period, 87% of the weight loss was fat. Finally, the increase in strength made the weight loss less than what it really was. Subjects here gained lean body mass ($P < 0.01$).

DISCUSSION

To combat the global increase in obesity,[1,2] interest has grown for an effective combined diet and exercise program.[5,6,10,27,28] Because high-fat diets have a tendency to increase whole body inflammation,[8] a mixed diet was implemented in this study with a low glycemic index. By adding a change in lifestyle through exercise and diet modifications, it was hoped that this program would be effective in reducing body fat while increasing lean body mass.

Several results supported the hypothesis of this study. First, compliance was very high with an average of 89.9% ± 10.8% compliance for the diet and 75.1% ± 23.1% for exercise. This is especially interesting because in this study, rather than using standard 20-minute videos as in many studies,[27] this program actually was 1 full hour each day for 6 days per week. Thus, in an exercise program combined with a low-calorie diet, the compliance was still high; this speaks to the nature of the program in promoting people to adhere and enjoy participating at the same time.

In the present investigation, the weight loss was dramatic. With a caloric reduction each day and an exercise program, increasing both energy expenditure and reducing intake will have a dramatic impact on body weight. Even in 3 days, there was a rapid drop in weight loss amounting to a loss of 1 inch in waist size in most of the subjects. Twenty percent of the subjects lost 2 or more inches in 3 days. Some of the drop

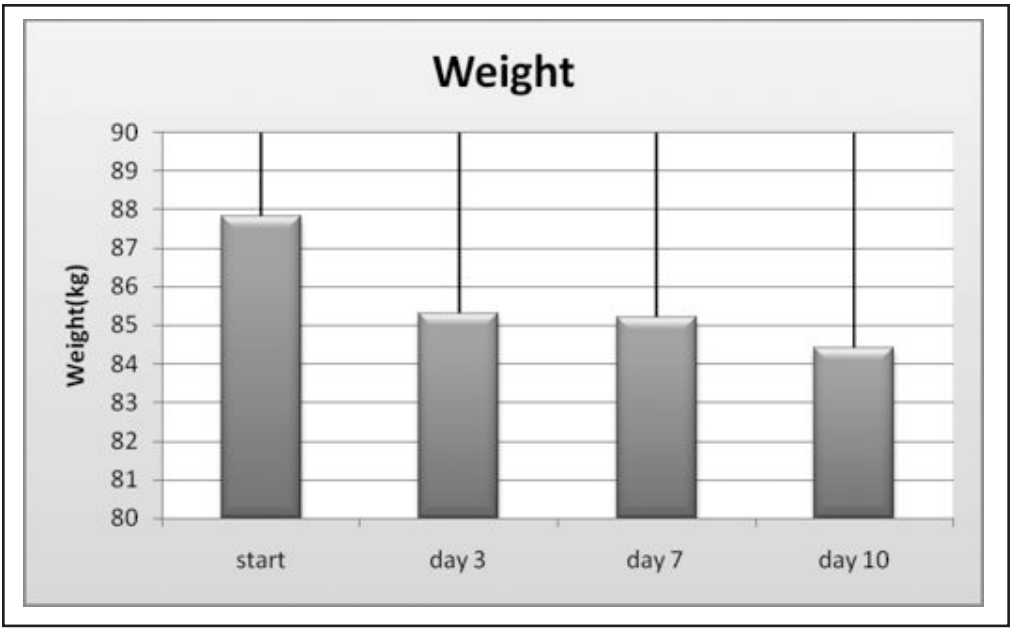

Figure 9. The average weight in the subjects in the exercise group at onset and after 3 days, 7 days, and 10 days of the exercise and diet program. All data as shown for all subjects ± SD.

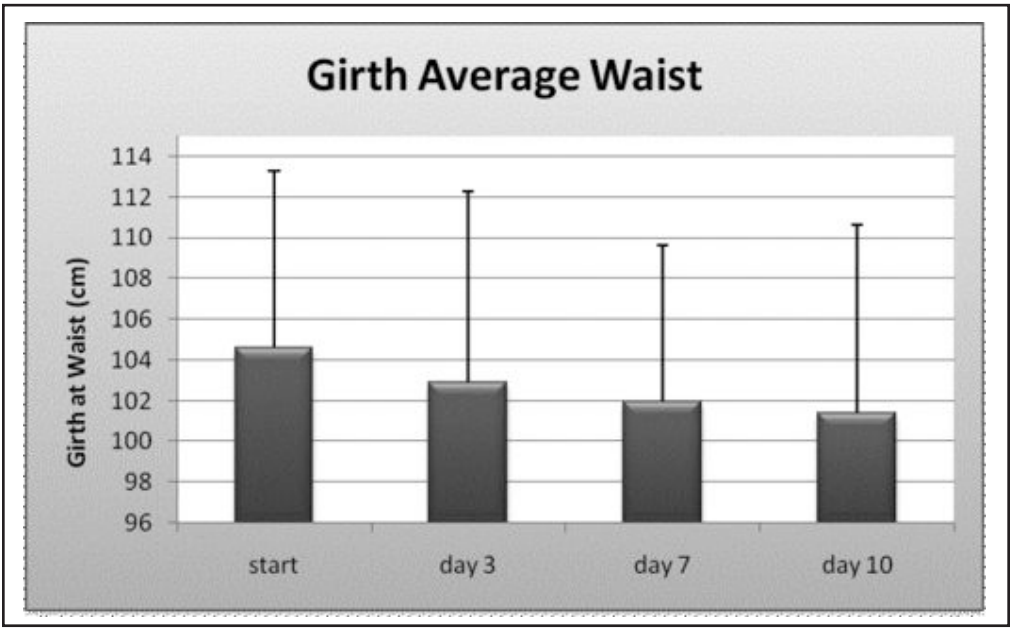

Figure 10. The average girth of the exercise group and onset and after 3 days, 7 days, and 10 days of diet and exercise program. All data as shown as the mean ± SD for this group as the average of all 3 waist measures.

in weight is usually attributed to water shifts associated with beginning a stringent diet. Thus, subjects were encouraged to drink water and therefore not to dehydrate. In spite of this, they lost weight even in 3 days. While body fat was reduced by 0.4%, 1.7%, and 3.2% after 3, 7, and 10 days, respectively, body

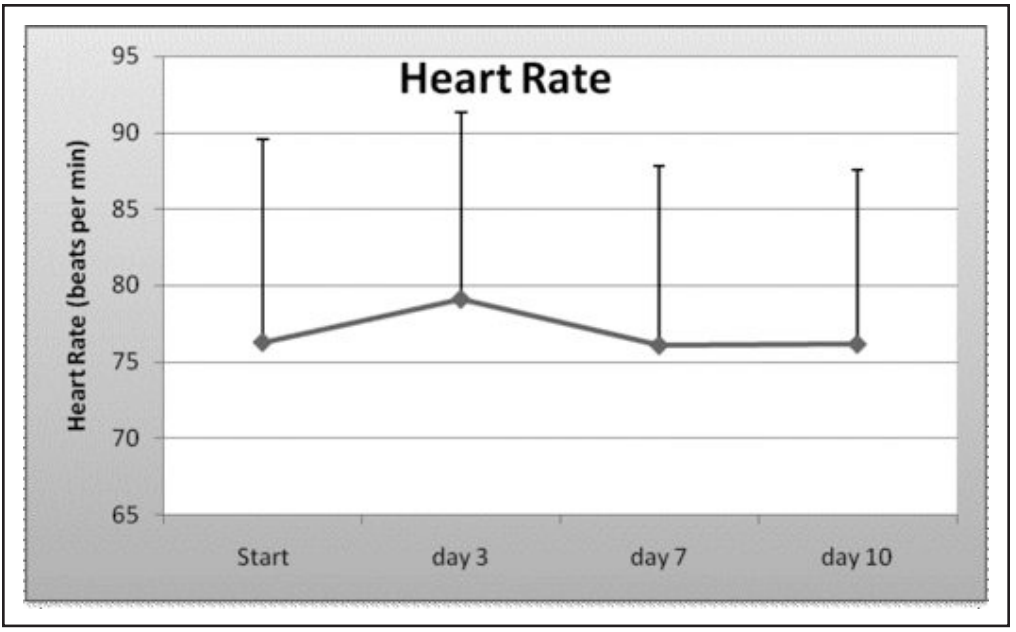

Figure 11. The average heart rate of the diet and exercise group at onset and 3 days, 7 days, and 10 days after the start of the study. All data as shown for all subjects ± SD.

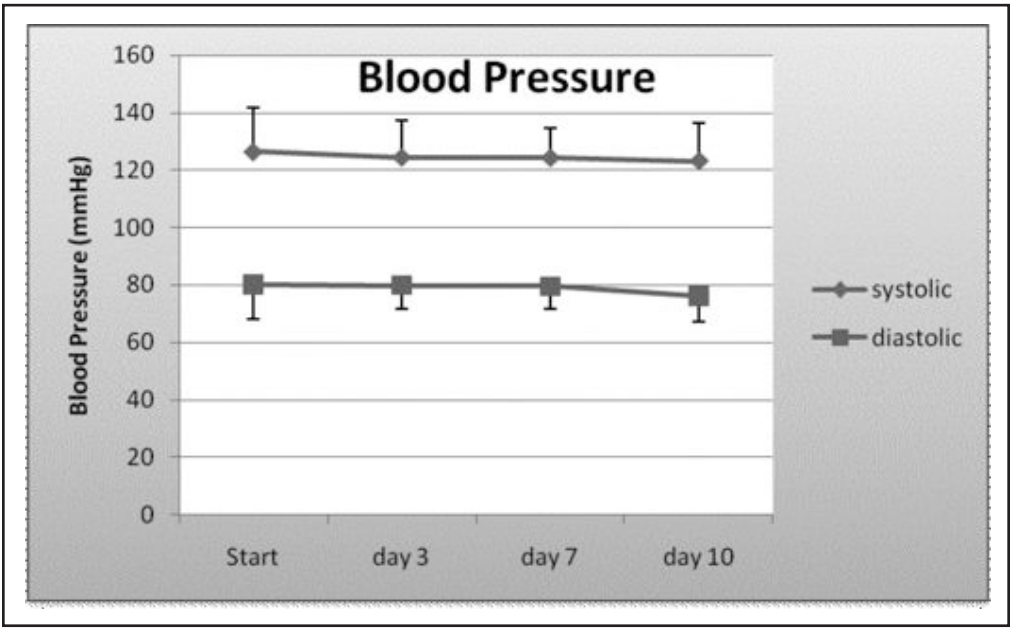

Figure 12. The average blood pressure of the diet and exercise group at onset and 3 days, 7 days, and 10 days after the start of the study. All data as shown for all subjects ± the appropriate standard deviations.

water increased by 1.43% over this period showing that they were not dehydrated. Further, when computing the loss in fat over the 10-day period, 87% of the weight loss was fat. Increasing lean body mass provides an additional long-term benefit of increasing resting metabolism, which, in turn further supports weight

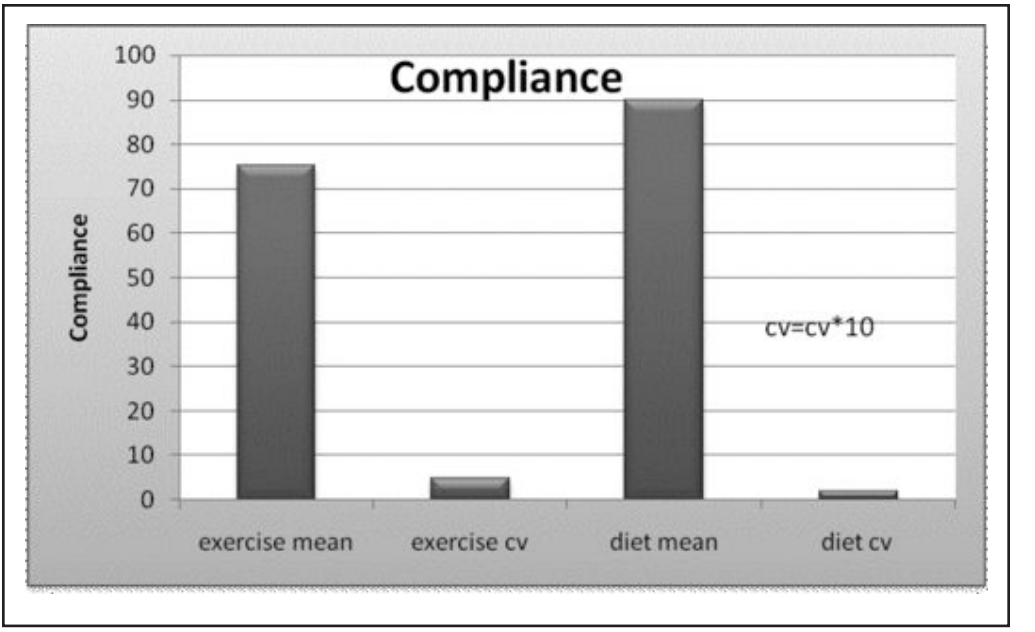

Figure 13. The compliance of the subjects for the diet and exercise program

loss and weight management. Finally, the increase in strength made the weight loss less than what it really was. Subjects here gained lean body mass ($P < 0.01$).

The fact that more than 1 inch was lost from the waist in just a few days shows that this diet is very effective when someone is trying to slim down rapidly, as seen in the present investigation.

Strength also increased. The large increase in strength, especially in the core muscles, would probably decrease some of the weight loss and reduction in girth normally seen. Thus, simply engaging in the dietary program, you would expect to see a greater loss in waist size because here, strength increased thereby muscle mass thickened. However, girth was reduced regardless.

The results showed that, for most people, loss of 1 pant or dress size (1-inch loss in girth) was achieved in 3 days. The average loss in girth at the waist at 3, 7, and 10 days was 1.84, 2.91, and 3.06 cm, respectively. The average weight loss over 10 days was 3.5 kg. Strength increased an average of 11.21% for these muscles. Compliance for the diet and exercise averaged 89.1% and 75.9%, respectively. Thus the program saw large gains in fitness and weight loss. It can be anticipated that the increase in muscle strength, especially in the core areas of the body, will lead to help individuals maintain weight low and reduce cardiovascular and marked risks associated with heart disease.

REFERENCES

1. Centers for Disease Control and Prevention (CDC): Overweight and Obesity. 2005. http://www.cdc.gov/nccdphp.dnpa/obesity/.
2. Ramos EJ, Xu Y, Romanova I, et al: Is obesity an inflammatory disease? *Surgery* 2003;134:329-335.
3. Moran R: Evaluation and treatment of childhood obesity. *Am Fam Physician* 1999;59:861-873.
4. Troiano RP, Flegal KM: Overweight children and adolescents: description, epidemiology, and demographics. *Pediatrics* 1998;101:497-504.
5. Liao FH, Shieh MJ, Yang SC, Lin SH, Chien YW: Effectiveness of a soy-based compared with a traditional low calorie diet on weight

loss and lipid levels in overweight adults. *Nutrition* 2007;23:551-556.

6. Anderson WA, Greene GW, Forse RA, Apovian CM, Istfan NW: Weight low and health outcomes in African Americans and whites after gastric bypass surgery. *Obesity (Silver Spring)* 2007;15:1455-1463.

7. Ello-Martin JA, Roe LS, Ledikwe JH, Beach AM, Rolls BJ: Dietary energy density in the treatment of obesity: a year-long trial comparing 2 weight-loss diets. *Am J Clin Nutr* 2007;85:1465-1477.

8. Rankin JW, Turpyn AD: Low carbohydrate, high fat diet increases C-reactive protein during weight loss. *J Am Coll Nutr* 2007;26:163-169.

9. Dixon JB, Strauss BJ, Laurie C, O'Brien PE: Changes in body composition with weight loss: obese subjects randomized to surgical and medical programs. *Obesity (Silver Spring)* 2007;15:1187-1198.

10. Gately PJ, King NA, Breatwood HC, et al: Does a high-protein diet improve weight loss in overweight and obese children? *Obesity (Silver Spring)* 2007;15:1527-1534.

11. Williams CL, Strobino BA, Brotanek J: Weight control among obese adolescents: a pilot study. *Int J Food Sci Nutr* 2007;58:217-230.

12. Giri M: Medical management of obesity. *Acta Clin Beig* 2006;61:286-294.

13. Kelly AS, Steinberger J, Olson TP, Dengel DR: In the absence of weight loss, exercise training does not improve adipokines or oxidative stress in overweight children. *Metabolism* 2007;56:1005-1009.

14. Petrofsky, JS, Batt J, Morris A: Weight loss and cardiovascular fitness during a one week diet and exercise program. *J Appl Res* 2006;6:51-61.

15. Haskel WL: Health consequences of physical activity: Understanding and challenges regarding does response. *Med Sci Sports Exerc* 1994;26:649-660.

16. Petrofsky JS, Bonacci J, Bonilla T, et al: Comparison between an abdominal curl with timed curls on a portable abdominal machine. *J Appl Res* 2003;3:402-415.

17. Boegli Y, Gremion G, Golay S, et al: Endurance training enhances vasodilation induced by nitric oxide in human skin. *J Invest Dermatol* 2003;121:1197-1204.

18. Hildenbrand K, Noble L: Abdominal muscle activity while performing trunk flexion exercises using the Ab Roller, Ab Slide, FitBall, and Conventionally Performed Trunk Curls. *J Athl Train* 2004;39:37-43.

19. Lahad A, Malter AD, Berg AO, et al: The effectiveness of four interventions for the prevention of low back pain. *JAMA* 1994;272:1268-1291.

20. McNeil T, Warwick D, Anderson GB, et al: Trunk strengths in attempted flexion, extension, and lateral bending in healthy subpatients with low back disorders. *Spine* 1980;5:529-538.

21. van Tulder M, Malmivaara A, Esmail R, et al: Exercise therapy for low back pain: A systemic review within the framework of the Cochrane collaboration back review group. *Spine* 2000;25:2784-2796.

22. Willett G, Hyde J, Uhrlaub M, Wendel C, Karst G: Activity of abdominal muscles during commonly prescribed strengthening exercises. *J Strength Cond Res* 2001;15:480-485.

23.. Faigenbaum AD, McFarland JE, Johnson L, et al: Preliminary evaluation of an after school resistance training program for improving physical fitness in middle school-age boys. *Percept Mot Skills* 2007;104:407-415.

24. Korsten-Reck U, Kaspar T, Korsten K, et al: Motor abilities and aerobic fitness of obese children. *Int J Sports Med* 2007;28:762-767.

25. de Oliveira AS, de Morais Carvalho M, de Brum DP: Activation of the shoulder and arm muscles during axial load exercises on a stable base of support and on a medicine ball. *J Electromyogr Kinesiol* 2008;18:472-479.

26. Tse MA, McManus AM, Masters RS: Development and validation of a core endurance intervention program: implications for performance in college-age rowers. *J Strength Cond Res* 2005;19:547-552.

27. Petrofsky JS, Bonacci J, Bonilla T, et al: Can a one-week diet and exercise program cause significant changes in weight, girth and blood chemistry? *J Appl Res* 2004;4:369-375.

28. Petrofsky JS, Morris A, Bonacci J, Jorritsma R, Hanson A: Combined diet and low-impact aerobic exercise program: impact on body weight, body girth, and muscular strength. *J Appl Res* 2005;5:123-135.