Combined Diet and Low-Impact Aerobic Exercise Program: Impact on Weight, Girth, and Muscular Strength, Part 1

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ABSTRACT

Fifty-six subjects were studied in a single blinded randomized study to assess the impact of a 10-day weight-loss program with low-impact aerobics on weight, girth, and muscular strength. Exercises were performed for appropriately 60 minutes a day, and upper and lower body girth, strength changes of the quadriceps, hamstrings, and gluteus maximus muscles were measured. The subjects were broken into 2 unequal groups. One group of 25 subjects did not engage in any exercise or diet programs but were used for reliability of test measurements made at the beginning and end of the 10-day period. The second group, the active group (n = 33), exercised 1 hour a day in an exercise program following video tapes and maintained a 1200 calorie per day diet for a period of 10 days. The results of the experiments showed significant losses in girth, especially around the waist and gluteal areas, which is associated with this diet and exercise program. Control subjects, who did not engage in the exercise program, showed no significant difference in these repeat measurements, verifying that the loss demonstrated in the active group was due to the diet and not examiner error. Muscle strength increases were statistically significant, especially in the abdominal, hamstring, and quadriceps muscles. Blood pressure and heart rate were reduced after the 10-day diet and exercise program. Weight loss, for the active (diet and exercise) group, averaged 2.4 ± 1.4 kg. Thus, even a 10-day diet and exercise program can result in significant losses in girth, increases in strength, and an increase in cardiovascular fitness.

INTRODUCTION

Obesity is an ever-increasing problem in the United States.[1,2] The increase in obesity is highly correlated with both an increase in cardiovascular disease and the incidence of diabetes.[3] Body fat is normally regulated through two hormones, leptin, and adipoleptin.[4] These hormones circulate in the blood and regulate appetite and the intermediary

metabolism of the cells.[5] When body fat is high due to either diet or an increase in adiposity, leptin is released into the blood. This normally would reduce hunger and increase burning of lipids. The trigger between carbohydrate and lipid metabolism is a nuclear transmitter, PPAR alpha and gamma. PPAR gamma activates at least 35 genes in the cell to change metabolism between lipids and carbohydrates.[6,7] When PPAR is activated, body metabolism is lowered and enzymes are produced to metabolize carbohydrates as a fuel.[1] High carbohydrate and low lipid diets, therefore, through their effect on leptin, promote carbohydrate metabolism, lower metabolism in general, and increase hunger throughout the day.[8,9] It is believed that a defect in the leptin receptor causes obesity.[10] Thus in people who have a defect in the leptin receptor, the body is continually fooled into believing that there is little fat storage in the body and hunger is high, satiety low, and carbohydrate metabolism proceeds at a high rate to produce additional fat.[10] Eating high lipid diets therefore, increases thermogenesis causing more calories to be burned during the day.[4] Diets such as the Atkins diet promote low glucose and are high fat diets.

The effect of diet and exercise together can increase oxidation of lipids, reduce body weight, reduce LDL cholesterol in the blood, fasting glucose, and lower resting blood pressure.[1,2,7,8,11,12] While low lipid diets reduce basil metabolism in the body and activate glucose use, diet and exercise together will further increase basil metabolism causing the body to burn more calories per hour.[1,13] However, the exercise must be conducted for more than 30 minutes. Individuals with a higher aerobic capacity are able to have a larger thermogenic response than people with lower aerobic capacities.[14] This increased thermogenesis can last 12 hours or more.[15] Therefore, those who exercise and diet at the same time can benefit greatly from the diet.[14,16-18]

In general, then, an aerobic exercise and diet program seem to work well together. Diet and exercise then have positive benefits in terms of reducing blood pressure, heart rate, toning the cardiovascular system, reducing fasting glucose and blood lipids, and decreasing LDL particle size, which can lead to less plaque deposits in the arteries.[19-21] Thus, the answer seems to be simple, exercise and diet together are beneficial.

While no one disputes the advantage of exercise for fitness and weight reduction, diet has been the subject of controversy. Diets such as the Atkins diet encourage high fat and high salt food.[22] Such a diet, without exercise, goes against conventional advice and can have serious consequences, since the breakdown of fat liberates acid radicals, which cause ketoacidosis.[22] Such diets can also lead to stroke by increasing blood coagulation plasma levels of coagulation factor VII, a substance released from the cell that causes the adherence of blood clots in blood vessels.[23] To combat these dangers, conventional programs recommend low fat diets, and exercise.[24] However, this is not to say that the Atkins diet is totally wrong and diets should be high in glucose and high protein. This can also have severe consequences. As discussed above, one of the consequences is that high carbohydrate diets play a role in weight gain, and an increase hunger.[9,25] But not all carbohydrates are bad, complex carbohydrates do not cause diabetes. Therefore in a weight loss regime, simple carbohydrates are to be kept low (low glycemic index), which will result in an increase in satiety.[26] The increased satiety after foods with a low glycemic index can last for as much as 4 hours after a meal.[27] While the glycemic index may not apply to older individuals, in terms of increas-

Figure 1. A subject is performing Gliding exercises involving hip adduction.

ing satiety, it does seem to increase satiety in younger individuals, including preadolescent children.[9,28] With a long bout of exercise, perceived exertion was also less when individuals are on a diet with a low glycemic index.[29] The rapid change in hormones and metabolism after ingestion of high glycemic foods due to rapid gastrointestinal absorption seems to be the villain in reducing satiety.[30]

In conclusion, a proper diet should have a reduced, but not absent, glycemic index. The diet should be balanced with a mixture of carbohydrates, lipids, and proteins. In the studies cited above, it is apparent that changes in glycemic index from day-to-day can have an adverse effect on cellular metabolism and satiety. Since fats produce water when burned and carbohydrates use water, modifying the glycemic index from day-to-day would also have effects on water retention. Thus an effective diet would maintain a constant, but low glycemic index with suitable exchanges to allow individuals to adjust their diet to avoid boredom.

But, as cited above, the exercise program is also essential in reducing girth, toning muscle, and aiding in the weight reduction process. The exercise program should involve a good range of motion, combine both weight and endurance training, and increase metabolism to a high enough level to increase thermogenesis during the diet and enhance weight loss.

In the present investigation, we used an exercise program that combined weight and endurance training together on an exercise video coupled with a ten-day diet. The diet itself is described under methods and involved a constant but low glycemic index and reduced calories with exchanges in the diet to allow individuals enough flexibility to avert becoming bored with the diet. In addition, low impact aerobics were used involving dynamic exercise while placing the feet in plastic discs referred to as Gliding to allow people to exercise rapidly and easily on a carpet or wooden floor and keep impact to a minimum.

The hypothesis to be tested then is will a constant and low glycemic index diet with an hour a day of dynamic exercise result in good compliance, loss in girth, toning of muscle and weight loss.

SUBJECTS

There were 2 groups of subjects in this study. One group of subjects acted as controls (n = 25), while the second group formed the active (experimental) group (n = 33). Muscle strength and muscle girth, before and after 10 days, was measured twice in the control group. The active group, on the other hand, participated in the diet and exercise program for a period of 10 days. The average age, height, and weight of both groups of subjects is given in Table 1. Twenty-two control subjects finished the study, as did thirty of the subjects on the diet. The subjects that dropped from the diet, dropped due to scheduling and medical issues unrelated to the study. All experimental procedures were approved by the Human Review Committee at Azusa Pacific University and all subjects signed a statement of informed consent.

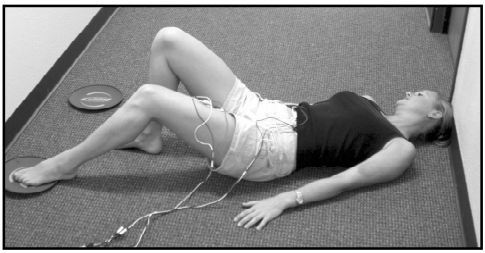

Figure 2. A subject is performing Gliding exercise for knee flexion and extension with the back supine on the floor.

METHODS

Measurement of Strength

Isometric strength of the gluteus maximus muscle was measured in the supine position. The exact position is that which optimized isolation of each muscle as shown by Kendall.[31] A cotton strap was placed around the leg and looped around an isometric strain gage transducer. The strain gage was linear in the range of 0 to 200 kg of force. The output of the transducer was amplified by a strain gage conditioner amplifier with a gain of 1000. The display, a Westin 1971 panel meter, was calibrated in force in kilograms. A sample and hold circuit was used in the strain gage amplifier such that subjects could observe their maximum effort and the display held the maximum reading for each force measurement.

Girth Measurements

Girth was measured with a model 67020 measuring tape produced by Vital Signs (Country Technology, Gays Mills, Wis). The tape applied 4 g of tension such that a uniform pressure was applied around the body for measurements. Girth was measured at the wrist, at the forearm, 3 inches below the olecranon process, around the chest at the level of the third thoracic vertebrae, at the umbilicus, at one and two inches above the umbilicus, at one and two inches below the umbilicus, at the mid-thigh, at the ankle, at the ischial crest, at the hip joints, and at two, four, and six inches below the iliac crest.

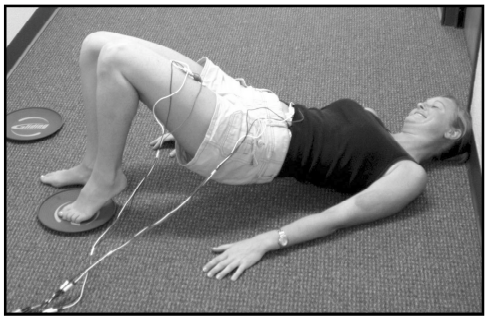

Figure 3. A subject is performing Gliding exercise for knee flexion and extension with the back lifted during the exercise to increase the work rate.

Finally, at the hip joints a tape was placed around the gluteus muscles parallel to the floor and the difference in the girth was recorded when 1.3 kg was applied to the tape. In this manner firmness of the gluteus muscles could be assessed.

Blood Pressure

Blood pressure was measured by auscultation of the left arm. The systolic blood pressure was determined as the first sound as the pressure cuff was released from 200 mmHg at 3 mmHg per second as per American Heart Association standards. The diastolic pressure was the change in sound form sharp to muffle.

Heart Rate

Heart rate was determined by counting the radial pulse over a 15-second period and multiplying by 4.

Video Exercise

Three videotapes were used in the exercise program. Savvier LP provided all 3 tapes. The first, called the Fat Burning Cardio video, involved low impact exercise and Gliding disks. The aerobic portion of the workout without the Gliding disks was low-impact aerobics to music with a moderator, who directed the exercise. In this manner, exercise was done in a regimented manner so that it simulated working out in a gym and

Table 1. General Characteristics of Subjects*

	Age (years)	Height (cm)	Weight 1	Weight 2	Change wt
Active Group	39.5	164.7	81.6	79.2	-2.4
SD	10.3	9.4	16.7	16.2	1.4
Control Group	25.6	164.6	66.7	66.7	0.0
SD	2.1	9.3	10.3	10.7	0.6

*Weight is measured in kg.

Table 2. General Composition of Diet

Protein Composition	Carbohydrate Composition	Lipid Composition
31%	44%	25%

variability in exercise intensity and workout from day to day was eliminated. The Gliding portion of the video involved placing the feet on plastic disks to aid in reducing the friction during the sliding movement of the legs in the abduction, adduction, and flexion extension directions. The tape lasted approximately 30 minutes. In addition to this video, 2 other videos were used, the Total Body Sculpturing video, and the Ultimate Buns and Legs video. The Total Body Sculpting video was 55 minutes in length and involved a pure, heavy dynamic workout. The other two videos, the Fat Burning Cardio and Ultimate Buns and Legs videos, are 30 minutes each. During the study, at days 2, 4, and 9 the Total Body Sculpture video was used and on days 1, 3, 5, and 8, subjects used both the Fat Burning Cardio and Ultimate Buns and Legs videos. Day 7 was a rest day and no exercise was performed; on day 6 only the Fat Burning Cardio video was used.

Assessment of Compliance

Compliance with the program was assessed in 2 ways. A six-point scale was used to assess exercise compliance. The scale used is as follows: 0, did not exercise at all; 1 = exercised 1 day of the 6 required; 2 = exercised 2 days of the 6 required; 3 = exercised 3 days of the 6 required; 4 = exercised 4 days of the 6 required; 5 = exercised 5 days of the 6 required; and 6 = exercised all 6 days.

There was also a diet compliance scale as follows: 0 = deviated from the diet completely all days; 1 = deviated from the diet 9 days; 2 = deviated from the diet 8 days; 3 = deviated from the diet 7 days; 4 = deviated from the diet 6 days; 5 = deviated from the diet 5 days; 6 = deviated from the diet 4 days; 7 = deviated from the diet 3 days; 8 = deviated from the diet 2 days; 9 = deviated from the diet 1 day; and 10 = did not deviate. For the diet compliance scale, subjects were asked to complete the log sheets on a daily basis for compliance and log any foods they ate that were not on the diet and the date.

Diet

The diet used in this study had a mixed composition of carbohydrates, protein, and fats. The caloric composition of the diet and the number of calories for the 10 days is shown in Table 2. The goal of the diet was to restrict energy by 500 to 1000 kcals per day for most people and to produce a steady, maintainable weight loss. Glycemic index was kept low to increase satiety after the meal and

Table 3. Vegetable Exchanges on Diet*

Artichoke (1/2 medium)	Lettuce (dark preferred)
Asparagus	Mushrooms
Beans (green, wax, Italian)	Okra
Bean sprouts	Onions & green onions
Beets	Pea pods (snow peas)
Broccoli	Peppers (green, red and yellow)
Brussels sprouts	Radishes
Cabbage & Chinese cabbage	Rutabaga
Carrots	Salad greens
Cauliflower	Sauerkraut (low sodium)
Celery	Spinach
Cucumber	Summer squash (yellow or zucchini)
Eggplant	Tomato (one medium or 5 cherry)
Endive	Tomato/vegetable (low sodium)
Escarole	Turnips
Greens (collard, mustard, turnip)	Water chestnuts
Hot peppers (Jalapenos)	
Kale	
Kohlrabi	
Leeks	

*1/2 cup of cooked or 1 cup of raw vegetables can be substituted from the list.

thereby reduce cravings. There is a high fiber provision in the diet averaging 28 grams per day to reduce the risk of cardiovascular disease and cancer. Sodium however, was left low to avoid water gain and was kept at less than 2400 mL per day. The diet consisted of 3 meals and 2 snacks per day to, again, avoid hunger between meals. The diet itself included a variety of fruits, vegetables, and whole grains, unsaturated fats, and lean protein to maintain good health and optimum energy. Participants were encouraged to drink 8 to 10 glasses of water per day at a minimum. This diet then complies with guidelines for proper nutrition during dieting as referred to in an article by the American Diabetes Association.[32] Fruit and vegetable exchanges are shown on Table 3, and the fruit exchanges allotted on the diet and their amounts are shown on Table 4. The daily diet plan is shown in Table 5.

Procedures

Subjects were medically screened for cardiovascular and neurological disorders. Girth was measured at the umbilicus, above and below the umbilicus, at the ischial tuberosity, at the top, middle and bottom of the thigh, and on the arm and the wrist. Blood pressure and heart rate were measured on all subjects as well. Muscle strength was measured in the quadriceps, hamstring, and gluteus maximus muscles. All the above measurements were repeated before and on the tenth day after initiation of the exercise and diet program. For control subjects, data was repeated before and after the 10-day period absent a diet and exercise program.

RESULTS

The results of the experiments are shown in Tables 6 to 11. As seen in Table 6, compliance was calculated, as

described under methods, for both the exercise and the diet. For the exercise, the average compliance is as shown in Table 6 was 84%. For the 30 subjects in the study, the average diet compliance was 83%. Thus by averaging the two together the total compliance was 83%.

The change in strength of the quadriceps, hamstrings, and gluteus maximus muscles is shown in Table 7 as the mean of all the subjects' ± the standard deviation. Significance is also shown at the bottom of the table as derived from a related *t* test. The strength of the quadriceps, hamstrings, and gluteus maximus muscles was 48 ± 19.6 kg, 31.6 ± 10.4 kg, and 37.7 ± 10.7 kg, respectively. As shown in this table, the average change in strength of the subjects for the quadriceps, hamstrings, and gluteus maximus for of the 10-day period was 16 ± 19.6 kg, 14.1 ± 12.63 kg, and 16.73 ± 21.7 kg for the 3 muscles respectively. All differences were significant. The control subjects showed no significant difference in strength over the test period ($P > 0.05$).

Girth measurements showed significant losses in key areas of the body. As shown in Table 8, measurements of wrist circumference, forearm circumference, and upper arm circumference, only showed significant changes for the upper arm and forearm. The wrist, as might be expected, showed no significant difference in these studies. For the control group, there was no significant difference in the pre- and post-test data ($P > 0.05$).

The most significant changes in girth were seen in the lower part of the body. In Table 9, the changes in girth are seen for the umbilicus, above and below the umbilicus, the gluteal area, and leg area.

The greatest changes in girth were seen at 1/2 inch above the umbilicus. For the group, for example, the initial girth was 95.9 ± 15.9 cm. After the diet and exercise program, the average subject

Table 4. Fruit Exchanges on Diet*

Fresh, Frozen, and Unsweetened Canned Fruit	
Apples (raw, 2 in. across)	1
Applesauce (unsweetened)	1/2 cup
Apricots (canned) (4 halves)	1/2 cup
Banana (9 in. long)	1/2
Blackberries (raw)	3/4 cup
Blueberries (raw)	3/4 cup
Cantaloupe (5 in. across)	1/3
Cantaloupe (cubes)	1 cup
Cherries (large, raw)	12 whole
Cherries (canned)	1/2 cup
Figs (raw, 2 in. across)	2
Fruit cocktail (canned)	1/2 cup
Grapefruit (medium)	1/2
Grapefruit (segments)	3/4 cup
Grapes (small)	15
Honeydew melon (medium)	1/8
Honeydew melon (cubes)	1 cup
Kiwi (large)	1
Mandarin oranges	3/4 cup
Mango (small)	1/2
Nectarines (2 1/2 in. across)	1
Orange (2 1/2 in. across)	1
Papaya	1 cup
Peach (2 3/4 in. across)	1
Peaches (canned) (2 halves)	1 cup
Pear (1/2 large)	1 small
Pears (canned) (2 halves)	1/2 cup
Persimmon (medium, native)	2
Pineapple (raw)	3/4 cup
Pineapple (canned)	3/4 cup
Plum (raw, 2 in. across)	2
Pomegranate	1/2
Raspberries (raw)	1 cup
Strawberries (raw, whole)	1 1/4 cups
Tangerine (2 1/2 in. across)	2
Watermelon (cubes)	1 1/4 cups
Dried Fruit	
Apples	4 rings
Apricots	7 halves
Dates (medium)	2 1/2
Figs	1 1/2
Prunes (medium)	3
Raisins	2 tbs
Fruit Juice	
Apple juice/cider	1/2 cup
Cranberry juice cocktail	1/3 cup
Grapefruit juice	1/2 cup
Grape juice	1/3 cup
Orange juice	1/2 cup
Pineapple juice	1/2 cup
Prune juice	1/3 cup

*** Servings of fruit may be substituted for another. Note: All canned fruit must be canned in juice and not sugar syrup.**

Table 5. Diet Plan for Typical 3-Day Period

DAY 1

Breakfast

Egg Scramble

Spray non-stick pan lightly with non-stick spray and cook onions, bell pepper, and mushrooms for 2 minutes. Add egg whites, scramble together, and cook until done. Serve with 2 slices of reduced sodium turkey bacon, 1/2 whole wheat English muffin, and 1 peach.

Snack

1 oz low-fat cheese

1 apple

Lunch

Tuna & Spinach Salad

Clean 2 cups raw spinach and place in bowl. Add 1/2 can water-packed tuna. Chop and mix in, 1 stalk celery, 5 mushrooms, 1/2 cucumber, 1/2 medium tomato, and 1 tbs vinaigrette dressing. Serve with a 1/2 whole wheat pita.

Snack

10 almonds

1/2 cup raisins

Dinner

Chinese Chicken

Cube 4 oz boneless chicken breast. Mix chicken, 1 cup broccoli, and 1 tbs low-sodium soy sauce in non-stick pan and sauté until done. Serve with 2 cups lettuce salad with 1 tbs vinaigrette dressing.

DAY 2

Breakfast

Oatmeal, Egg Whites, and Fruit

Make 1/2 cup cooked oatmeal and place in bowl. Sprinkle with 1/2 fresh cup berries and pour on 1/2 cup skim or soymilk. Serve with 2 slices of reduced sodium turkey bacon, 2 scrambled or hard-boiled egg whites.

Snack

6 oz plain yogurt

1/4 cup fat free granola

1/2 banana

Lunch

Healthy Pizza

Spread 5 tbs tomato sauce on 1/2 (separate two sides) whole wheat pita. Sprinkle with 1 oz shredded low-fat cheese and season to taste (ie, oregano, garlic, pepper flakes). Serve with 2 cups lettuce salad with 1 tbs vinaigrette dressing and 1 cup cubed melon.

DAY 2 (continued)

Snack

1 fat free turkey or veggie hot dog

1 tbs mustard

Dinner

Bar-B-Q Chicken

Mix 1 tsp honey, 1 tbs Mustard, and 3 tbs tomato sauce together. Spread evenly over 4 oz boneless chicken breast and oven broil or grill. Serve with 1 cup steamed summer squash and 1 cup steamed green beans.

DAY 3

Breakfast

Breakfast Burrito

Scramble 3 egg whites and wrap in 1/2 of a 12" whole wheat tortilla with 1/2 cup canned black beans and 1/2 cup fresh salsa. Serve with 1/2 banana.

Snack

1 slice whole wheat bread.

1 tsp natural peanut butter.

Lunch

Chef Salad

Chop and mix together, 6 slices low-sodium, lean ham lunch meat, 1 slice (1 oz) low-fat cheese, 1 hard-boiled egg, 2 cups lettuce, and 1 tbs vinaigrette.

Snack

1/2 cup low-fat, low-sodium cottage cheese

1 apple

Dinner

Veggie Burgers

Burgers: Cook 2 veggie burgers in pan or microwave until completely done.

Serve with 1 cup steamed zucchini slices, 1 cup steamed baby carrots, and 1 low-sodium dill pickle.

Table 6. Diet Compliance*

	Exercise	Diet	Total	%
Mean	7.50	8.32	15.82	83.27
SD	1.53	1.87	2.61	

*Raw scores given for exercise compliance (out of 8 total points), diet compliance (out of 9 total points) and total of exercise and diet (out of 17 total points) as well as % total compliance for both diet and exercise.

Table 7. Strength Changes in the Quadriceps, Gluteus Maximus and Hamstring Muscles*

	Quads	Hamstring	Gluts
Active Group			
Mean	16.00	14.14	16.73
SD	19.67	12.63	21.27
Signif.	0.01	0.01	0.01
Control Group			
Mean	0.18	2.35	3.53
SD	9.12	7.74	12.34
Signif.	> .05	> .05	> .05

*All measurements are in kg. Quads indicate quadriceps; and gluts, gluteus maximus muscles.

Table 8. Girth Change in Upper Body Muscles Before and After the Program*

	Wrist	Forearm	Upperarm
Active Group			
Mean	-0.23	-0.92	-2.24
SD	0.73	4.78	7.47
Signif	> 0.05	< 0.01	< 0.01
Control Group			
Mean	0.14	0.06	-0.38
SD	0.34	0.49	1.2
Signif	> 0.05	> 0.05	> 0.05

All measurements are in cm.

lost 7.4 ± 17.62 cm. In English units, this amounted to a loss of 2.9 inches at the waist. The large standard deviation was due to the variation between men and women in girth at the waste. But each individual in the study, lost girth and therefore, the loss was significant ($P < 0.01$).

The trochanter and the upper thigh showed much smaller changes. Data is shown as the mean and standard deviations for the entire group of subjects. For the thigh, for example, the loss was only 0.35 cm. But as shown in Table 7, there was an increase in hamstring strength from 31.6 to 45.3 kg, an increase of 44.6% in strength. This would have the effect of increasing thigh circumference in the face of a weight loss related reduction in thigh size. The overall effect would be a smaller loss in thigh circumference due to the hypertrophy of thigh muscle mass.

While the loss in girth at the gluteals and thigh was smaller than might be expected for such a loss in weight, it was still significant ($P < 0.01$). But, this is not surprising since the strength gains were also large in these muscles. Here, increased muscle mass would negate reductions in girth. For example, muscle strength for the gluteals, which started at 37.7 kg, increased by 57.3% after the diet. This would cause a large increase in the girth of the gluteals due to muscle hypertrophy.

As a measure of firmness of the gluteal muscles, as described under method, a 1.36 kg weight was applied against a tape to see the resistance to pressure of the gluteus maximus muscles measured around the trochanters. As

Table 9. Girth Change in Lower Body Muscles*

	umb	umb+1	umb+2	umb-1	umb-2	gluts	troch	thigh
Active Group								
Mean	-4.28	-7.40	-2.81	-5.42	-1.10	-0.35	-0.35	-0.35
SD	6.58	17.62	2.99	19.42	3.85	3.54	3.54	2.58
Sig	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Control Group								
Mean	0.52	-0.24	-0.09	0.38	0.11	0.02	0.03	-0.01
SD	2.09	3.04	2.86	1.79	2.69	1.10	1.40	3.46
Sig	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05

*The measurements are in cm. Umb indicates umbilicus; umb+1, 1 inch above the umbilicus; umb+2, 2 inches above the umbilicus; umb-1, 1 inch below the umbilicus; umb-2, 2 inches below the umbilicus; troch, at the trochanter; and thigh, at mid-thigh.

Table 10. Changes in Blood Pressure and Heart Rate

	Change Heart Rate BPM	Change Sys BP mm Hg	Change Dia BP mm Hg
Active Group			
Mean	-4.9	-8.3	-1.1
SD	6.4	7.4	5.7
Control Group			
Mean	0.2	0.1	-0.9
SD	5.9	8.2	6.9

shown in Table 10, there was also a significant increase ($P > 0.05$) in the firmness of the gluteus maximus muscles to pressure, showing increase toning of the muscles. Controls showed no significant difference.

Finally, as shown in Table 11, the heart rate and blood pressure were reduced in subjects on the diet. The heart rate showed only a small decrease amounting to 4.9 beats per minute, but the loss was significant ($P < 0.05$). Diastolic blood pressure was statistically the same comparing pre- and post diet values ($P > 0.05$). Systolic blood pressure was reduced by 8.3 mmHg. This loss was significant ($P < 0.01$). This was not seen in control subjects, where there were no significant differences over the 10-day period ($P > 0.05$).

DISCUSSION

With an ever-increasing incidence of obesity in the United States, it is no surprise that a variety of diets has been developed to reduce body weight.[32] These diets include the Atkins diet, South Beach diet, high protein diets, low protein diets, and every possible variation. But, losing weight involves not just reducing calories but increasing exercise. It has been well documented that during and after exercise, basil metabolism of the body increases for at least 30 minutes adding to the weight loss associated with a dietary program.[13] Also, individuals with high aerobic capacities have a larger thermogenic response than people with low aerobic capacities.[14] This increases thermogenesis, which can be maintained after aerobic exercise for 12 hours or more and adds to the weight loss process.[15]

In the present investigation, a mixed diet was used of approximately 1200 kcal per day was used. This diet resulted in a deficit of at least 500 to 1000 kcal per day and therefore, in itself should cause a weight loss. The fact that muscle strength increased while girth decreased,

points to the fact that the diet and exercise program were both effective. Subjects maintained high compliance, above 80% in all cases. Thus, for subjects on this diet it can only be presumed that compliance was high because the diet itself minimized hunger through its low lipid composition. Further, the increase in muscle strength over only a ten-day period showed the fitness potential of this particular videotape exercise regime in increasing muscle strength and endurance for the lower portion of the body. The best toning was observed in the gluteus maximus muscles, where the muscle became highly resistant to depression by force demonstrating increased toning in these and, likely, other muscles in the body.

The cardiovascular changes, principally the reduction in systolic blood pressure, show the cardiovascular benefits of the exercise. For such a short period of time, there was a significant loss in stress on the heart and arteries, due to an 8% loss in systolic blood pressure. Part of the loss can be attributed to weight loss, but the small magnitude of the weight loss makes this unlikely. In all probability, the dynamic exercise program was responsible for most of the cardiovascular effects. A good aerobic exercise program offers little strength training but a significant benefit on the cardiovascular system. And yet in the present investigation, strength did increase. The inescapable conclusion is that this program also accomplished strength training. When dynamic exercise is conducted slowly and against a moderate load, strength training is possible during dynamic exercise.[33,34] This is certainly the case here. High resistance dynamic exercise, as seen here, has a high static exercise component, which fatigues muscle strength and builds muscle mass.[35]

In summary, a proper diet and exercise program involving a mixed diet with a low glycemic index in the present investigation is shown to be ample and adequate means of increasing muscle strength, reducing weight and girth, and increasing tone in the lower part of the body. Certainly, the psychological aspects of weight loss here are significant. The fact that almost 2 clothing sizes can be lost in a 10-day period would lead to the high compliance we saw here for the program. With the ever increasing emphasis on high fat diets and Atkins approved food, it would appear that weight could be lost just as well and muscle increased just by moderating intake on a mixed diet with adequate exercise program.

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