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Research Studies by Wayne Westcott

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Comparison of Strength Training and Stretching

Wayne L. Westcott, Ph.D., Rita La Rosa Loud, B.S.

In this study, 21 untrained subjects (x age = 53.6 years; 15 females, 6 males) performed 1 set of 12 Nautilus strength training exercises, 8 to 12 repetitions each, 2 or 3 days per week for 10 weeks. A similar group of 21 untrained subjects (x age = 52.7 years, 15 females, 6 males) performed the same strength training program, but followed each Nautilus exercise with a 20-second static stretch for the muscles just worked. Both groups also did approximately 20 minutes of moderate effort aerobic activity (treadmill walking or stationary cycling at about 70 percent of predicted maximum heart rate). The subjects who did *strength training only* increased hamstring flexibility by 1.5 inches (sit and reach test) and hamstring strength by 16.3 pounds (10 RM leg curl test). The subjects who performed *strength training plus stretching* increased hamstring flexibility by 2.4 inches and hamstring strength by 18.6 pounds.

A previous study using the same training protocols produced similar strength results. The *strength training only* group (n = 15, x age = 58.9 years) increased hamstring strength by 16.6 pounds (10 RM leg curl test), and the *strength training plus stretching* group (n = 19, x age = 45.1 years) increased hamstring strength by 20.5 pounds. The combined data revealed a 16.4 pound strength gain for the 36 subjects who did *strength training only*, and a 19.5 pound strength gain for the 40 subjects who performed *strength training plus stretching*. The 19 percent greater strength gain did not reach statistical significance, but indicated a trend favoring *strength training plus stretching* over *strength training only* for strength development.

Strength Training Elderly Nursing Home Patients

Wayne L. Westcott, Ph.D., Gary Reinl, Donna Califano, PTA

Nineteen elderly nursing home patients (14 women, 5 men; mean age 88.5 years) completed 14 weeks of physician prescribed and therapist supervised strength training. Participants averaged 2 workouts per week, and performed 1 set of 8 to 12 repetitions of the following Nautilus exercises: leg press, triceps press, compound row, low back, neck extension, and neck flexion. All subjects were assessed for body composition, muscle strength, joint flexibility, and functional capacity in activities of daily living before and after the strength training program. Mean changes were: 9.7% reduction in percent fat (22.7 to 20.5%), 9.8% decrease in fat weight (29.7 to 26.8 lbs.), 3.8% increase in lean weight (100.5 to 104.3 lbs.), 81.2% increase in 10 RM leg press (58.1 to 105.3 lbs.), 38.8% increase in 10 RM triceps press (37.9 to 52.6 lbs.), 9.4% increase in shoulder abduction range (100.0 to 109.4 deg.), 52.8% increase in seated hip flexion range (29.0 to 44.3 deg.), 14.2% improvement in functional independence measurement (FIM) score (77.5 to 88.5 pts.), 71.4% increase in mobility distance (122.2 to 209.4 ft.) and 36.4% reduction in falls (1.1 to 0.4 falls). All of the pre- to post-training changes were statistically significant ($p < .05$) except for the incidence of falls. There were no injuries associated with the exercise program. Based on these findings it is concluded that a six-exercise Nautilus strength training program is a safe, efficient, and effective means for improving body composition, muscle strength, joint flexibility, and functional capacity in activities of daily living in elderly nursing home patients.

Effects of Strength Training on Young Female Figure Skaters

Wayne L. Westcott, Ph.D., Erin Cleggett, B.A., Scott Glover, B.S., and Ryan Donnelly

Sixteen competitive figure skaters between 8 and 13 years of age ($x = 10.2$ years) completed a 10-week, in-season strength training program. The younger girls did 10 exercises on child-sized Schnell machines, and the older girls did 10 exercises on standard Nautilus machines. All participants performed 1 set of 13 to 15 repetitions, 1 or 2 days per week, under supervision of a personal trainer. The skaters increased lower body strength by 99 percent (47.4 to 94.5 lbs.), upper body strength by 36 percent (31.7 to 43.2 lbs.), hamstring flexibility by 5 percent (19.8 to 20.9 inches), and vertical jump height by 13 percent (10.2 to 11.5 inches). Figure skating coaches reported improved on-ice jumping ability, and all participants expressed personal satisfaction with the strength training program.

A follow-up study was conducted with 10 competitive figure skaters between 8 and 13 years of age ($x = 11.0$ years). The participants followed the same exercise procedures as the previous program except that they trained only one day per week. The skaters made significant improvements ($p < .05$) in body composition, muscle strength, joint flexibility and long jump distance. More specifically, they experienced a one point reduction in percent body fat (23.3 to 22.3 %), a 2.5-pound gain in lean weight (80.2 to 82.7 lbs.), a 45 percent increase in bench press strength (34.4 to 49.8 pounds), a 7 percent increase in hamstring flexibility (16.9 to 18.1 inches), and a 9 percent increase in standing long jump distance (4.5 to 4.9 feet). The findings from these studies indicate that a basic strength training program is effective for improving selected fitness parameters and performance factors in female figure skaters. It would also appear that a single weekly training session is sufficient for significant

strength development in young athletes who are concurrently training and competing.

Effects of Regular and Slow Speed Training on Muscle Strength

Wayne L. Westcott, Ph.D., Rita La Rosa Loud, B.S., Erin Cleggett, B.S., Scott Glover, B.S.

In this study, 73 untrained subjects (x age = 53.4 years', 50 females; 23 males) performed 1 set of 13 Nautilus exercises, 2 or 3 days a week for a period of 10 weeks. Forty-three subjects completed 8 to 12 repetitions per set at 7 seconds each (2 seconds lifting, 1 second pause, 4 seconds lowering,) and 30 subjects completed 4 to 6 repetitions per set at 14 seconds each (10 seconds lifting, 4 seconds lowering). All of the participants were tested for either the 10 repetition maximum weightload (regular-speed group) or the 5 repetition maximum weightload (slow-speed group) on the Nautilus chest press exercise during the 2nd and 10th week of the training program. Both groups began at about the same average strength level (57.7 vs. 54.9 lbs.). The regular-speed trainees finished at 74.0 lbs, for a 16.3-pound strength increase, and the slow-speed trainees finished at 78.9 lbs. for a 24.0-pound strength improvement. Analyses of variance revealed a statistically significant difference ($p < .02$) between the two training groups, favoring the slow exercise speed.

A previous study using the same training protocols produced similar strength results. All 74 subjects performed 1 set of 13 Nautilus exercises, 3 days a week for a period of 8 weeks, Thirty- nine subjects completed 8 to 12 repetitions per set, at 7 seconds each, and 35 subjects completed 4 to 6 repetitions per set at 14 seconds each. All of the participants were assessed for either the 10 repetition maximum weight load (regular-speed group) or the 5 repetition maximum weight load (slow-speed group) on all 13 Nautilus exercises during 'the 2nd and 8th week of the training program. Both groups began at about the same average strength level (45.2 vs 44.7 lbs.). The regular-speed group finished at 62.7 lbs. for a 17.5-pound strength increase, and the slow-speed group finished at 71.2 lbs. for a 26.5-pound strength improvement.

In both studies the beginning exercisers who performed slow-speed repetitions experienced 50 percent greater strength gains than the beginning exercisers who performed regular-speed repetitions. These results suggest that slow-speed training is highly-effective for increasing muscle strength in previously sedentary men and women.

Effects of Strength Training on Golfers **Abstract**

Wayne L. Westcott, Ph.D.

Seventy-seven golfers (63 males, 14 females, mean age 57 years) completed eight weeks of supervised strength training. All participants performed one set of 8 to 12 repetitions of 13 basic resistance exercises (Nautilus machines), three days a week throughout the study. The subjects made significant improvements in body composition (-2.0 percent fat), with a 4.1-pound decrease in fat weight and a 3.9-pound increase in lean (muscle) weight. On average, their muscle strength increased 56 percent, and their mean resting blood pressure decreased 4.5 mm Hg.

The 52 golfers who did strength training only (25 minutes per session) increased their club head speed (driving power) by 2.6 mph. The 25 golfers who performed both strength training

(25 minutes per session) and stretching exercises (10 minutes per session) increased their club head speed by 5.2 mph. It was concluded that a basic program of strength training is effective for improving golfers' body composition, muscle strength, resting blood pressure, and club head speed. Additionally, a combination of strength and stretching exercise may further increase club head speed, and is recommended for greater performance enhancement.

Comparison of Consolidated or Distributed Stretching in Conjunction with Strength Exercise

Wayne L. Westcott, Ph.D., Rita La Rosa Loud, B.S., Scott Glover

In this study, 79 untrained subjects (x age = 49.4; 61 females, 18 males) performed 1 set of 12 Nautilus strength training exercises, 8 to 12 repetitions each, 2 or 3 days per week for 10 weeks. Group A (n = 47) completed a consolidated sequence of six 20-second static stretches on a StretchMate apparatus during each training session. Group B (n = 32) distributed the stretching exercises throughout the workout, performing a 20-second static stretch on each Nautilus machine for the muscles just worked. The subjects who did consolidated stretching increased hamstring flexibility by 2.1 inches (sit and reach test) and hamstring strength by 19.8 pounds (10 RM leg curl test). The subjects who performed distributed stretching increased hamstring flexibility by 3.0 inches and hamstring strength by 19.6 pounds. There were no statistically significant differences between the two training groups, indicating that consolidated and distributed stretching are equally effective for enhancing joint flexibility and muscle strength in conjunction with a standard program of strength exercise.

Effect of Activity Order on Strength Development

Wayne L. Westcott, Ph.D.

Four separate studies were conducted to determine whether the order of performing strength and endurance exercise influenced strength development. During each one-hour training session, participants performed a standard strength workout (12 Nautilus machines; one set each of 8 to 12 repetitions) and a basic endurance workout (20 minutes of treadmill walking or stationary cycling; approximately 75 percent of maximum heart rate). The 205 subjects (men and women between 24 and 81 years of age) were randomly assigned to perform strength training followed by endurance training or endurance training followed by strength training. They were tested for strength gains (10 repetition maximum weightload) in the leg extension, chest press, super pullover, or lateral raise exercise over a 10-week training period. Results showed a mean strength increase of 16 pounds for the subjects who performed strength exercise first, and a mean strength increase of 15 pounds for the subjects who did endurance exercise first.

Because there were no significant differences in strength development between the two training protocols, it would appear that activity order may be a matter of personal preference.

Strength Training Frequency

Wayne L. Westcott, Ph.D., Rita La Rosa Loud, B.S., Scott Glover, B.S.

The subjects in this study were 71 previously sedentary adults and seniors who enrolled in a 10-week beginning exercise program (average age 51 years). During each training session, the participants performed about 25 minutes of strength training (12 resistance machines) and about 25 minutes of endurance exercise (treadmill walking or stationary cycling). Thirty-two subjects trained on Mondays, Wednesdays and Fridays, 33 subjects trained on Tuesdays and Thursdays, and six subjects trained only on Saturdays. With respect to strength development, the three-day-per-week exercisers increased 20.2 pounds, the two-day-per-week trainees increased 16.6 pounds, and the one-day per week participants increased 16.7 pounds. All three training frequencies produced significant strength gains, with one and two workouts per week providing 82 percent as much improvement as three workouts per week. While three strength training sessions a week may be most productive for beginning participants, the findings from this study suggest that one or two relatively brief bouts of strength exercise may be sufficient for stimulating significant strength gains in previously sedentary adults and seniors.

Changes in Exercise Weight loads and Perceived Exertion Ratings During A 10-Week Beginning Strength Training Program

Wayne L. Westcott, Ph.D., Rita La Rosa Loud, B.S., Scott Glover, B.S., Erin Cleggett, B.A.

This study involved 83 beginning exercisers (67 females, 16 males; mean age 49 years) who were assessed for exercise weight loads and perceived exertion ratings during the third, sixth and ninth week of their strength training program. As shown in Table 1, average exercise weight loads (10 repetition maximum) increased from 43.4 lbs. (Week 3) to 51.6 lbs. (Week 6) to 55.6 lbs. (Week 9), and average perceived exertion ratings (Borg Scale) increased from 11.5 (Week 3) to 13.5 (Week 6) to 13.8 (Week 9). Because the trainees added 3.0 lbs. of muscle, part of the strength gain may be attributed to muscle development. However, some of the strength improvement may have been due to higher exercise effort as the participants progressed through the training program. That is, both physiological and psychological factors appear to influence strength development in beginning adult exercisers.

Participants rated their effort level on all 12 Nautilus exercises during each three-week assessment. As presented in Table 2, their perceived exertion was consistently higher on the leg extension, double chest, biceps, and triceps machines. Conversely, their perceived exertion was consistently lower on the leg curl, low back, abdominal, and neck machines. These findings suggest that beginners may experience more training motivation using the following exercise progression, based on their perceptions of required exercise effort.

Week 1: Leg Curl, Low Back, Abdominal Curl, Neck Flexion, Neck Extension

Week 2: Add Lateral Raise, Super Pullover, Chest Cross

Week 3: Add Leg Extension, Decline Press, Biceps Curl, Triceps Extension

Table 1. Average exercise weightloads (10 repetition maximum) and perceived exertion ratings (Borg Scale) during the third, sixth, and ninth week of strength training (N = 56).

Week	Weightload	Exertion Rating
3	43.4 lbs.	11.5 Fairly Light
6	51.6 lbs.	13.5 Somewhat Hard
9	55.6 lbs.	13.8 Somewhat Hard/Hard

Table 2. Perceived exertion ratings on Borg Scale for 12 Nautilus exercises during the third, sixth, and ninth weeks of training (N = 56).

Week	Leg Ext.	Leg Curl	Chest Cross	Decline Press	Super Pullover	Lateral Raise	Biceps Curl	Triceps Ext.	Low Abd	Neck Back	Neck Curl	Flexion Ext.
3	13.3	12.1	12.9	13.7	12.3	12.5	13.0	13.0	11.3	12.4	11.3	11.3
6	14.1	12.9	14.3	14.1	13.5	13.4	14.1	14.1	12.3	13.6	12.8	12.4
9	14.5	13.3	14.3	14.5	14.1	13.8	14.7	14.4	12.6	13.4	13.2	12.8