ACSM STRENGTH TRAINING GUIDELINES

Role in Body Composition and Health Enhancement

by Wayne Westcott, Ph.D., CSCS

LEARNING OBJECTIVES

- To provide information on the role of strength training in reversing the degenerative processes of muscle loss, metabolic slowdown, and fat gain. To examine the effects of resistance exercise on obesity and related chronic health problems. To present physiological and psychological benefits attained through application of the ACSM strength training guidelines.

Key words:
Muscular Conditioning, Physical Activity, Resistance Exercise, Risk Factor Reduction, Weight Loss

OBESITY AND CHRONIC DISEASE

Body mass index (BMI), which is based on height and weight relationships, is the most frequently used predictor for classifications of overweight (BMI = 25.0 to 29.9) and obesity (BMI = 30 or higher). Using BMI, a recent report by the National Health and Nutrition Examination Survey (NHANES IV) indicated that about 66% of the population is overweight, with more than 32% being obese (36). Because BMI does not account for the loss of lean weight associated with aging (12,13), it may underestimate the percentage of middle-aged and older adults who have excess body fat (<22% for males, <32% for females) (2).

Consider a 40-year-old woman who weighs 150 lbs and is 30% fat (45 lbs fat weight, 105 lbs lean weight). If she weighs the same at age 60 years, her BMI has not changed. However, if she has not engaged in resistance exercise, she most likely has lost 10 lbs of lean weight and added 10 lbs of fat weight making her 37% fat (55 lbs fat weight, 95 lbs lean weight) (11).

When lean weight loss is taken into account, it is likely that even more American adults than the 66% identified by BMI calculations as overweight actually have too much body fat. Because excess fat is associated with a number of chronic diseases, such as Type 2 diabetes, hypertension, and coronary heart disease (2), as well as reduced life expectancy (37), it is essential to implement successful intervention strategies.

DIETARY INTERVENTION

Without question, reduced calorie diet plans are the most popular approach to weight loss. Although low-calorie diet programs are effective for short-term weight reduction (39), there is little evidence that diets lead to lasting weight loss or health benefits (28). In fact, an extensive review of diet studies with long-term follow-up by researchers at the University of California, Los Angeles, CA, led the authors to conclude that dieters who maintain their weight loss are the rare exception (28). For example, in one of the reviewed studies, the diet group was 0.9 kg heavier than their baseline body weight 1 year after completing the temporarily successful weight loss program (45).

ACTIVITY INTERVENTION

If diets do not work for permanent weight loss, what does? According to a report from the Surgeon General, physical activity has proved effective for fat loss and also has been associated with health benefits such as reduced risk of type 2 diabetes and heart disease (48). However, unlike the mass participation in diet plans, relatively few adults and seniors perform regular physical activity. A 2008 report of physical

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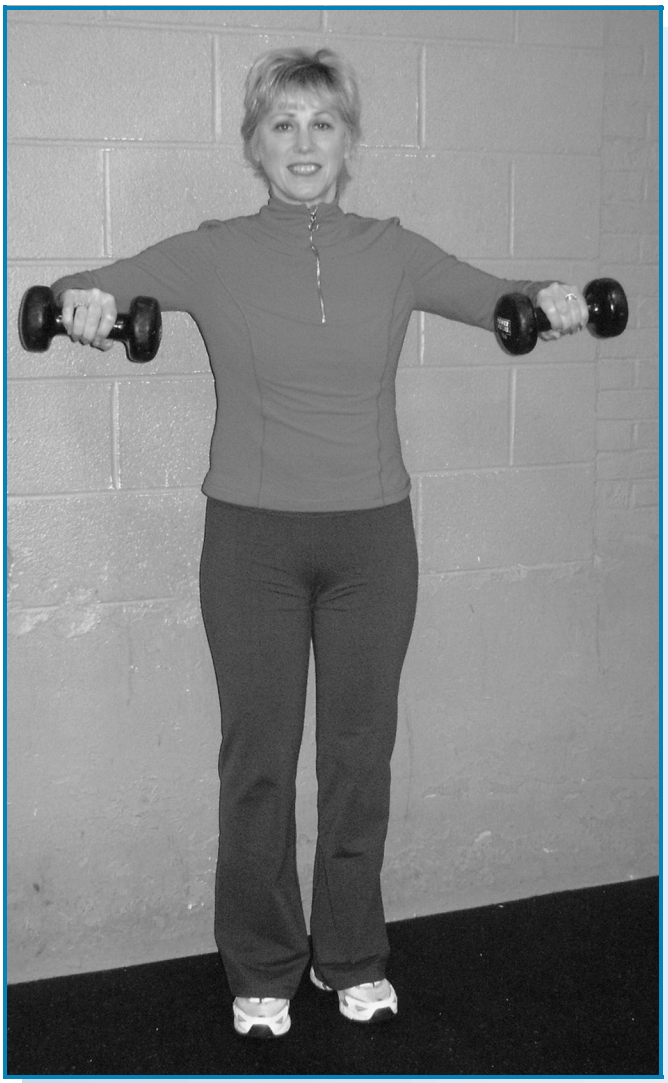

activity in the United States, as measured by accelerometer, revealed that only 3.5% of adults attain 30 or more minutes of moderate-intensity activity (*e.g.,* walking) five or more days a week (47). Ironically, many people are pursuing diet plans that do not provide permanent weight loss or health benefits, but relatively few adults are performing physical activity that can positively impact fat loss, fitness, and health.

Why is such a small percentage of our adult population doing regular exercise? Based on the results of a recent study conducted for the U.S. Air Force (50), it may be that the standard activity recommendation of 30 to 60 minutes of aerobic activity, five or more days a week is unrealistic for most overweight and underfit individuals. Air Force personnel must pass a fitness assessment that includes a 1.5-mile run, abdominal circumference, push-ups, and trunk curls. Because running performance (50%) and waist girth (30%) account for 80% of the test score, people with higher percentages of body fat typically fail the fitness assessment. These individuals are advised to participate in a 3-month conditioning program consisting of mostly aerobic activity (specifically running) for 60 minutes a day, 4 to 5 days a week. Although these are excellent exercise guidelines for physically fit individuals, they are much too challenging for overfat men and women who cannot successfully complete a 1.5-mile run. Because many of those who fail the fitness test do not follow the training recommendations, they score no better on their second assessment. However, an alternative conditioning program consisting of a 25-minute strength training circuit 3 days a week produced significant improvements in all of the assessment categories (50).

The circuit strength training program consisted of 10 weight stack resistance machines (squat press, leg curl, leg extension, chest press, seated row, shoulder press, pulldown, triceps press, biceps curl, and abdominal crunch) interspersed with 10 stationary cycles. Each resistance exercise was performed for 60 seconds (1 set of 15 to 20 repetitions using 40% to 60% of maximum weight load). Between successive strength exercises,

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participants performed 60 seconds of stationary cycling, taking approximately 5 seconds' transition time from station to station. After 12 weeks of supervised training, the 57 participants decreased their mean 1.5-mile run time by 35.3 seconds, decreased their mean abdominal girth by 3.5 cm, increased their mean 1-minute push-ups by 7.1 repetitions, and increased their mean 1-minute abdominal crunches by 5.8 repetitions.

One advantage of the circuit strength training program was the shorter workout duration (25 minutes/session), with 1-minute exercise segments. Another advantage was the less frequent training schedule that matched the updated recommendations from the American College of Sports Medicine (ACSM) and the American Heart Association for vigorous-intensity aerobic activity performed a minimum of 20 minutes on 3 days each week (20). In addition, the circuit strength training exercises involved easily adjusted external resistance rather than fixed body weight resistance. However, the most notable difference between the traditional and the alternative training program was the latter's emphasis on resistance exercise. It would seem that a relatively brief strength training circuit is an effective means of improving body composition and enhancing key components of physical fitness in poorly conditioned Air Force personnel (50). Other circuit strength training programs have produced significant improvements in body composition, muscular strength, and cardiovascular endurance in healthy adults (15,16), college students (33), hypertensive adults (19), and cardiac patients (25).

FACTORS IN FAT GAIN

On average, adults who do not strength train lose approximately 4 to 6 lbs of muscle tissue per decade throughout the aging process (11,12,13). This often unnoticed loss of muscle may be the single largest contributor to the decline in resting metabolic rate (40) that averages 2% to 3% per decade in adults (26). The breakdown and synthesis of muscle protein are largely responsible for the energy expenditure associated with resting muscle tissue, which approximates 5 calories per day for each pound of muscle (53). Because resting metabolism accounts for about 70% of daily calorie use among sedentary adults, reduction of muscle mass and resting metabolic rate may be accompanied by an increase in fat weight (53). Assuming a consistent dietary pattern, the calories that were previously used to maintain the lost muscle tissue are stored as fat.

For example, a 2% per decade drop in resting metabolic rate actually averages a 1% reduction in resting calorie use over that 10-year period. Assuming a resting metabolism of 1,500 calories per day, this would average 15 fewer calories burned at rest

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on a daily basis. Although seemingly insignificant, if other things remain the same, a 15-calorie per day resting metabolic rate deficit may lead to a 15-lb per decade fat gain (15 calories × 365 days × 10 years = 54,750 calories ÷ 3,500 calories/lb fat = 15.6 lbs fat). Although eating more food or doing less physical activity can clearly contribute to fat accumulation, in a society characterized by volitional dietary restriction and chronic physical inactivity, it is likely that muscle loss and metabolic slowdown are factors in progressive fat gain.

FACTORS IN FAT LOSS

If the above assumptions are correct, a logical approach to fat loss would be to reverse the factors that lead to fat gain. There is evidence that the insidious process of muscle atrophy, resting metabolic rate reduction, and fat accumulation may be reversed through regular resistance exercise. For example, our study with 1,644 previously inactive adults and older adults showed an average lean (muscle) weight gain of 3.1 lbs (assessed by skinfold calipers and ultrasound technology) after 10 weeks of circuit strength training (49). Although we did not measure resting metabolism, other strength training studies have reported similar lean weight gains accompanied by 7% to 8% increases in resting metabolic rate (9,22,41). A recent study by Hackney *et al.* reported an average 8% increase in resting energy expenditure for 3 days after a high-effort strength training session (18). Other researchers, however, have failed to find an association between strength training and resting metabolic rate elevation (8,14,46).

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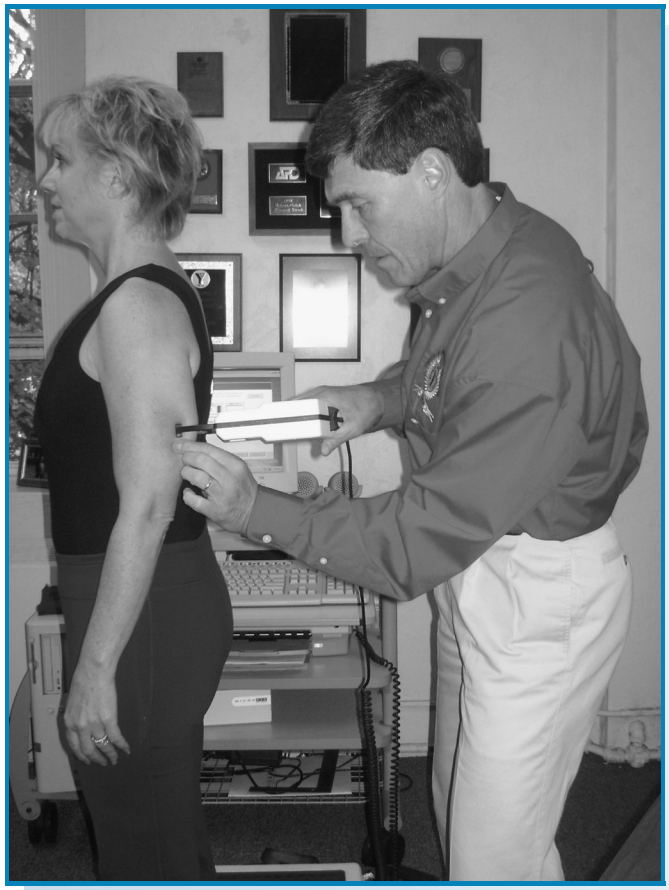

A possible explanation for these different research results may be the intensity of the strength training workouts. For example, the Hackney *et al.* study used a very intense training protocol (eight exercises for eight sets of six repetitions with an eccentric emphasis) that produced high levels of delayed-onset muscle soreness and would not be appropriate for beginning participants (18). On the other hand, low-volume training protocols performed to volitional fatigue have been associated with significant increases in resting metabolic rate (9,22,41). It should be noted that single-set strength training performed at high effort levels also can produce a degree of delayed-onset muscle soreness.

With respect to fat loss, the same studies that showed approximately 3 lbs of lean weight gain reported approximately 4 lbs of fat loss (9,22,41,49). These findings indicate that strength exercise may be effective for rebuilding muscle and reducing fat over training periods of 10 to 25 weeks.

HEALTH BENEFITS OF STRENGTH EXERCISE

In addition to decreasing body fat and reducing the risk of obesity (31), strength training stimulates a variety of positive adaptations that enhance both physical and mental health. Resistance exercise has produced beneficial outcomes for numerous physiological factors, including increased blood glucose utilization (34), reduced resting blood pressure (19), improved blood lipid profiles (6), enhanced vascular condition (38), increased gastrointestinal transit speed (27), increased bone mineral density (35), and improved body composition (10). It also has been shown to improve function in postcoronary patients (17) and chronic obstructive pulmonary disease (COPD) patients (21), as well as to reduce discomfort in people with low back pain (42) and arthritis (29). In addition, strength training has proved effective for decreasing depression (44) and for reducing the risk of metabolic syndrome (24,52), cardiovascular disease (7), and premature all-cause mortality (23).

The medical applications of strength training were further supported by a recent conditioning study with coronary disease patients (30). All of the subjects exercised 5 days per week for a period of 6 months. Those who alternated 3 days of endurance exercise with 2 days of strength training experienced approximately 50% more improvement in aerobic function ($\dot{V}O_2$ peak) than those who performed 5 days of endurance exercise only.

Why would 3 days of endurance exercise and 2 days of strength training produce more cardiovascular benefit than 5 days of endurance exercise alone. Consider that muscles function as the engines of the body, namely, the tissues where

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combustion takes place, energy is released, force is produced, and movement originates. As such, stronger muscles can have a positive impact on other body systems, including the skeletal system (32,35), cardiovascular system (7,30), gastrointestinal system (27), endocrine system (34), and neuromuscular system (42). A well-conditioned muscular system enables a physically active lifestyle and enhances numerous health factors that may reduce the risk of selected degenerative diseases and medical problems (53).

ACSM STRENGTH TRAINING GUIDELINES

In 1995, ACSM published research-based guidelines for a safe, effective, and time-efficient strength training protocol (1). These guidelines were essentially the same as the latest ACSM strength training recommendations (2006) that call for the following exercise procedures (2):

ACSM Strength Training Recommendations

- 8 to 10 exercises for the major muscles
- 1 set of each exercise
- 8 to 12 repetitions per set of exercise
- 2 or 3 nonconsecutive training days per week
- Full-range movements (pain free)
- Moderate speed movements (approximately 6 seconds per repetition)

Beginning in 1996, we studied a total of 1,644 men and women aged between 21 and 80 years who completed essentially identical 10-week training programs using the ACSM minimum protocols for strength and endurance exercise (1). On average, the participants added 3.1 lbs of lean weight and lost 3.7 lbs of fat weight (49). They also reduced their resting systolic blood pressure by 3.8 mm Hg and their resting diastolic blood pressure by 1.8 mm Hg. The Table presents the results of the relatively brief workouts for subjects who did two or three exercise sessions per week for 10 weeks.

As shown in the Table, two and three weekly strength training sessions proved equally effective for increasing lean (muscle) weight. Apparently, when following the ACSM strength and endurance training guidelines, two exercise sessions per week provide the essential stimulus for muscular development. The 3.1-lb increase in lean weight was similar to the lean weight gains experienced by subjects in other studies who performed strength training only (9,22,35,41). This outcome indicates that a combined program of strength and endurance exercise using the ACSM minimum training protocols may be as effective as strength training alone for increasing lean weight in previously inactive adults.

When examined by sex, the mean lean weight gain was significantly greater for men (4.6 lbs) than for women (2.6 lbs) (49). When examined by age, there were no significant differences in lean weight gain. Participants aged 21 to 44 years, 45 to 54 years, 55 to 64 years, and 65 to 80 years added 2.5 lbs, 3.1 lbs, 2.9 lbs, and 3.2 lbs of lean weight, respectively. Although the rate of lean weight gain is likely to decline in longer training programs, a later study using the same ACSM exercise protocols showed consistent increases in lean weight during both halves of a 6-month training period. The 46 participants (almost all of whom were middle-aged women) added 2.2 lbs of lean weight during the first 3 months of training and 2.5 lbs of lean weight during the second 3 months of training (51).

These findings suggest that the minimum ACSM training protocols may be productive for beginning participants for at least the first several months of a regular exercise program. However, in a 2-year study by Schmitz *et al*., the strength training group members increased their lean weight by 4.3% during the first year, but had no further lean weight gain during the second year (43).

Unlike diet programs, which are typically short-term, strength training should become a permanent lifestyle activity. Unfortunately, diet programs reduce muscle mass and decrease resting metabolism (5), essentially promoting fat regain (28). Conversely, strength training rebuilds muscle tissue and increases resting metabolic rate, which are positive factors in attaining and maintaining fat loss. Whereas dieting characteristically reduces energy for physical function, strength training uses energy to increase physical function. Considering these advantages over

TABLE: **Changes in Body Weight, Body Composition, and Resting Blood Pressure During a 10-Week Training Period by Exercise Frequency**

	Two/Week (n = 892)	Three/Week (n = 752)	All (N = 1,644)
Body weight, lbs	−0.1	−1.3	−0.6
Percent fat, %	−1.9*	−2.2*	−2.0*
Fat weight, lbs	−3.2*	−4.4*	−3.7*
Lean weight, lbs	+3.1*	+3.1*	+3.1*
Systolic blood pressure, mm Hg	−3.1*	−4.6*	−3.8*
Diastolic blood pressure, mm Hg	−1.4*	−2.2*	−1.8*

**Statistically significant change from beginning value ($P < 0.05$).*

dieting alone, it would seem reasonable to include strength exercise in weight loss programs. This information is consistent with the recently released ACSM Position Stand, "Appropriate Physical Activity Intervention Strategies for Weight Loss and Prevention of Weight Regain for Adults."

In addition to the favorable physiological adaptations associated with resistance exercise, the minimum ACSM strength and endurance training protocols may provide important psychological benefits. Separate studies using the same ACSM exercise program have revealed favorable changes in a variety of feelings and mood states. Using the Exercise-Induced Feeling Inventory to assess personal feelings before and after a single training session, we found significant improvements in the categories of positive engagement, revitalization, tranquility, and physical exhaustion (4). After exercise, the participants felt more purposefully engaged, more energetic, less troubled, and less fatigued.

Using the Tennessee Self-Concept Scale, Second Edition, and the Profile of Mood States to assess psychological changes during the 10-week training program, we found significant improvements in physical self-concept, total mood disturbance, depression, and fatigue (3). These positive changes contributed to the participants' improved attitude, self-confidence, and reinforcement with respect to physical activity.

Our 10-week studies using the ACSM strength and endurance training protocols have averaged a 91% completion rate, and our 6-month study had a 68% completion rate. In all of the studies, more than 95% of those who finished the exercise program rated the strength training component four or five on a 5-point scale (1 = lowest, 5 = highest) of personal satisfaction. During the 14 years (1995–2009) that we have used the ACSM training protocols for our exercise studies, only a few participants have reported exercise-related injuries (most were a recurrence of previous physical problems). It would therefore seem that the ACSM minimum training protocols for strength and endurance exercise provide a relatively safe and satisfying means for increasing lean weight and reducing fat weight in previously inactive adults.

SUMMARY

Several studies suggest that strength training may be an effective means of rebuilding muscle, recharging metabolism, and reducing fat in previously inactive adults and older adults. Training programs using the minimum ACSM protocols for strength and endurance exercise have shown significant

Health Benefits of Strength Training

Reduced risk of obesity

- Increased muscle mass
- Increased resting metabolism

Reduced risk of cardiovascular disease

- Decreased body fat
- Decreased resting blood pressure
- Enhanced vascular condition
- Improved blood lipid profiles

Reduced risk of colon cancer

- Increased gastrointestinal transit speed

Reduced risk of diabetes

- Decreased body fat
- Increased glucose uptake

Reduced risk of osteoporosis

- Increased bone mineral density

Reduced risk of low back pain

- Increased erector spinae muscle strength

Reduced risk of depression

- Increased muscle strength and functional abilities

Information obtained from references 6, 7, 10, 17, 19, 21, 23, 24, 27, 29, 31, 34, 35, 38, 42, 44, 49, 52, and 53.

Ten-Station Circuit of Dumbbell and Body Weight Exercises Using Mostly Multiple Joint Movements That Involve Two or More Major Muscle Groups

Exercise	Muscles	Repetitions	Sets
DB squat	Quadriceps, hamstrings, gluteus maximus	10–15	1–3
DB bench press	Pectoralis major, anterior deltoids, triceps	8–12	1–3
DB one arm bent row	Latissimus dorsi, posterior deltoids, biceps	8–12	1–3
DB step-up	Quadriceps, hamstrings, gluteus maximus	10–15	1–3
DB incline press	Pectoralis major, anterior deltoids, triceps	8–12	1–3
DB pullover	Latissimus dorsi, triceps	8–12	1–3
DB lunge (stationary)	Quadriceps, hamstrings, gluteus maximus	10–15	1–3
DB press	Deltoids, triceps, upper trapezius	8–12	1–3
DB curl	Biceps	8–12	1–3
BW trunk curl with bicycle action	Rectus abdominis, obliques, hip flexors	10–15	1–3

BW indicates body weight; DB, dumbbell.
Recommended repetition speed is about 6 seconds.
Recommended training progression is 5% more resistance upon completion of 15 repetitions of leg exercises or 12 repetitions of upper body exercises. Recommended training frequency is two or three nonconsecutive days per week.

improvements in body composition and resting blood pressure after 10 weeks of training. In fact, combined strength and endurance training seems to provide the same muscular benefits as strength training alone. Although there are numerous other strength training protocols, the ACSM guidelines seem well suited for the large percentage of our adult population who need to add muscle and lose fat. Research indicates that strength training may play an important role in fitness and health, specifically with respect to body composition, glucose utilization, resting blood pressure, blood lipid profiles, vascular condition, gastrointestinal transit, bone mineral density, postcoronary function, COPD function, low back pain, arthritis, depression, metabolic syndrome, cardiovascular disease, and all-cause mortality. It is, therefore, recommended that strength exercise be included in programs for fat loss and health enhancement.

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CONDENSED VERSION AND BOTTOM LINE

Sedentary living leads to muscle loss, metabolic slowdown, and fat gain. Presently, almost 70% of American adults are overfat and at increased risk for chronic diseases and other health problems. Dieting is a popular but ineffective approach for attaining permanent fat loss, and regular endurance exercise is performed by less than 5% of the adult population. Basic and brief strength training sessions have proved to be effective for rebuilding muscle, recharging metabolism, reducing fat, and enhancing a variety of health and fitness factors. The ACSM strength training guidelines provide a practical protocol for reversing degenerative processes and for eliciting physiological and psychological improvements that positively impact quality of life.