Prescribing Physical Activity: Applying the ACSM Protocols for Exercise Type, Intensity, and Duration Across 3 Training Frequencies

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Abstract: When physicians advise patients to attain more physical activity, they usually recommend a walking program. However, in a similar way to no exercise, those embarking on a walking program will typically lose 4 to 6 lb of lean weight and reduce their resting metabolic rate 2% to 3% every decade. These effects may be mitigated by the inclusion of resistance exercise. The American College of Sports Medicine (ACSM) minimum exercise guidelines recommend 20 minutes of aerobic activity 3 days per week, and 1 set (8–12 repetitions) of 8 to 10 resistance exercises to train the major muscle groups 2 days per week. However, large-scale testing of these recommendations in a field setting has been minimal. Men and women between 21 and 80 years (N = 1619) participated in a 10-week combined strength and aerobic activity program based on the ACSM protocols for exercise intensity and duration across 3 training frequencies (1, 2, or 3 sessions/week). Across all training frequencies, mean changes included a reduction in body fat of 1.97%, a decrease in fat weight of 1.7 kg, an increase in lean weight of 1.35 kg, a reduction in systolic blood pressure of 3.83 mm Hg, and a reduction in diastolic blood pressure of 1.73 mm Hg. More frequent weekly training sessions were associated with greater improvements in body fat percent, fat weight, and lean weight. Participants responded favorably to the ACSM exercise program with a 91% completion rate and a 95% satisfaction rating. This article presents recommendations for prescribing safe, effective, and time-efficient exercise programs.

Keywords: strength training; resistance exercise; physical activity; training frequency; body composition; adult fitness

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Applying the ACSM Protocols Across Three Training Frequencies

For many years, physicians have advised patients to initiate a walking program for the primary purposes of reducing body weight and improving physical fitness. Although this recommendation is widely followed, it is inadequate to address many of the degenerative problems associated with the aging process. More specifically, walking programs do not address the muscle loss and metabolic slowdown that lead to fat gain and increase the risk of obesity, diabetes, osteoporosis, and a variety of related infirmities.[1] Indeed even high-intensity running programs have a negligible effect on preventing muscle loss in middle-aged adults.[2]

To maintain and improve musculoskeletal fitness, performing regular resistance exercise (commonly known as strength training) is essential. Without regular resistance exercise, middle-aged and older men and women lose 4 to 6 lb of muscle tissue every decade of life.[3] This often insidious loss of muscle is largely responsible for a 2% to 3% reduction per decade in resting metabolic rate.[4] Resting metabolism is responsible for up to 70% of daily calorie use in sedentary adults. Thus a decrease in resting metabolic rate is typically accompanied by an increase in fat weight. Other things being equal, calories that were previously used to maintain the lost muscle tissue are stored as fat.

Numerous studies have demonstrated that relatively brief sessions of resistance exercise performed on a regular basis can significantly increase muscle mass in men and women of all ages.[5–11] Similar research has shown that strength training can significantly increase resting metabolic rate in adults and older adults.[6,9,12–15]

Muscles function as the engines of the body. Increasing muscle mass and metabolic rate can be effective means for enhancing personal health and physical fitness. Research has revealed that regular resistance exercise is effective for: decreasing fat weight and reducing the risk of obesity;[6,16] increasing bone mineral density with implications for osteoporosis;[8,17] increasing lumbar spine muscle strength with implications for low back pain;[18,19] increasing insulin sensitivity/blood glucose utilization with implications for type 2 diabetes;[20–23] reducing resting blood pressure with implications for cardiovascular disease;[24–27] improving blood lipid profiles with implications for cardiovascular disease;[28,29] enhancing vascular condition with implications for cardiovascular disease;[30] increasing gastrointestinal transit speed with implications for colon cancer;[31] improving physical self-concept[32] and decreasing depression;[33] improving function in patients with postcoronary issues,[34,35] chronic obstructive pulmonary disease,[36] and arthritis;[37] and reducing the risk for metabolic syndrome,[38,39] cardiovascular disease,[40] and premature all-cause mortality.[25,41]

Strength training protocols in which participants perform a set of 8 to 10 exercises for the major muscle groups are generally referred to as circuit strength training. Successive exercises work different muscle groups, thereby permitting participants to take relatively brief transition periods between exercises. Because of the relatively high percentage of activity time, circuit strength training has proved effective for increasing the contractile characteristics of skeletal muscle and for improving muscle metabolic qualities.[42] Indeed, recent research has demonstrated that circuit strength training can increase the mitochondrial content and oxidative capacity of trained muscle tissue.[43,44]

Several scientific publications have presented compelling evidence for the beneficial role of strength training in health and disease.[1,40–42] However, there is general agreement that a comprehensive fitness program should include both resistance exercise and aerobic activity, as set out in the recently updated American College of Sports Medicine (ACSM) and Americal Heart Association (AHA) recommendations for physical activity and public health.[45] For aerobic activity, the guidelines call for 30 minutes of moderate-intensity aerobic exercise (eg, walking) 5 days/week or 20 minutes of vigorous-intensity aerobic exercise (eg, jogging) 3 days/week, or some combination. For muscle-strengthening activity, the recommendations call for 8 to 10 exercises for the major muscle groups, performed on 2 or more nonconsecutive days/week, using a resistance such that 8 to 12 repetitions result in volitional fatigue. These ACSM and AHA recommendations are very similar to the 1995 ACSM guidelines on exercise testing and prescription,[46] which provided the basis for our study on training frequency.

The effects of different strength training frequencies have been studied with varying results. In most studies, the dependent variable was muscular strength, which has a large neurological (motor learning) component. One study showed no significant differences in strength gains among groups training 1, 2, or 3 days/week.[47] In another study,[48] the 1 day/week training group did not differ from the control group, whereas the 2 days/week and 3 days/week training groups experienced significant and similar increases in strength. A study that compared strength training frequencies of 1 and 3 days/week reported about 62% as much strength gain from 1 weekly workout as from 3 weekly training sessions.[49] Research conducted in our exercise facility found 2 days/week training to be more effective than 1 day/week training for increasing strength in preadolescent participants.[50] A study that examined the effects of 2 days/week and 3 days/week strength training found significant and similar increases in both muscle strength and lean tissue mass.[51] We are unaware of studies that have investigated the effects of different training frequencies for combined strength and endurance exercise on body composition and resting blood pressure.

The purpose of this study was to investigate the effects of the ACSM training protocols for combined aerobic activity and strength exercise on body fat percent, fat weight, lean weight, and resting blood pressure in previously inactive adults. Because the ACSM guidelines called for a minimum of 2 weekly workouts for strength exercise and 3 weekly workouts for endurance exercise, we implemented 2 days/week and 3 days/week training programs, and a 1 day/week training program for additional contrast.

We hypothesized that training 3 days/week would be more effective than training 2 days/week, and that each of these training frequencies would be more productive than training 1 day/week for decreasing body fat percent and fat weight, for increasing lean weight, and for reducing resting systolic and diastolic blood pressures.

Methods

Participants

There were 1619 adult participants in this study (77% women; 23% men) between the ages of 21 and 80 years (mean [M] = 53.79 ± 13.83) recruited from the greater Boston area between 1996 and 2004 through newspaper columns. Informed consent was attained for each participant, and the study was approved by the Medical/Fitness Review Board of the South Shore YMCA. Each participant also completed a medical history questionnaire, and anyone (10%–15% of each exercise group) with possible exercise contraindications (eg, cardiovascular disease, orthopedic problems, seizures) was required to present written physician permission before taking part in the program. Baseline data, by group, are presented in Table 1. The groups were similar in all areas with the exception of age. Participants of the 2 days/week training group were substantially older (M = 56.32 ± 13.69) than participants in the 1 day/week group (M = 52.26 ± 12.60) and the 3 days/week group (M = 51.03 ± 13.62).

Measures

Body fat percent and resting blood pressure were measured before and after the 10-week training program. Body fat percent was assessed by skinfold calipers (MicroFit) and computerized ultrasound technology (SomaTech), and blood pressure was measured automatically by a hospital Dinamap™ Critikon® Vital Signs Monitor 1846SX. Fat weight and lean weight were calculated from body weight and body fat percent measures. Baseline values of body fat percent, fat weight, lean weight, systolic blood pressure and diastolic blood pressure for participants in the 3 training groups are presented in Table 1.

Exercise Training

Protocols were administered by qualified fitness instructors in a designated exercise facility adjacent to but separate from the main fitness center at the South Shore YMCA. The exercise facility was equipped with 10 standard weightstack machines that cumulatively addressed the major muscle groups (leg extension, leg curl, double chest, back pullover, lateral raise, biceps curl, triceps extension, abdominal curl, low back extension, neck flexion/extension), and had common cardiovascular exercise devices (2 treadmills, 1 recumbent cycle). All training was conducted in small exercise classes supervised by the first author, consisting of no more than 6 participants with 2 instructors. One-hour classes were administered on a Monday-Wednesday-Friday sequence (3 days/week training), on a Tuesday-Thursday sequence (2 days/week training), and on Saturdays (1 day/week training). Class schedules (1, 2, or 3 days/week) were self-selected to facilitate participant independence and satisfaction, which we postulated would lead to a higher program completion rate and similar attendance rates among the 3 training frequency groups. All exercise activity was completed within the 1-hour class period and included approximately 20 minutes of resistance training and 20 minutes of aerobic conditioning. During the initial training sessions, most participants required more time to complete the circuit of resistance exercises because of teaching/learning factors, and many participants performed shorter durations of aerobic activity because of low beginning fitness levels. Components of the protocol were counterbalanced so that 3 participants always did resistance exercise followed by aerobic activity, and 3 participants always did aerobic training followed by resistance exercise.

The strength training protocol required 1 set of each resistance exercise in order from larger to smaller muscle groups, using a weightload that could be lifted correctly between 8 and 12 repetitions to volitional fatigue. When a participant completed 12 repetitions, the resistance was raised by approximately 5%. Each repetition was performed in approximately 6 seconds, with about 2 seconds for the lifting phase (concentric muscle action) and about 4 seconds for the lowering phase (eccentric muscle action).

The aerobic training protocol began with a 3-minute warm-up period and ended with a 3-minute cool-down period, during which participants performed the exercise activity at a lower training intensity (slower treadmill speed or reduced

Table 1. Baseline Means (± SD) for Participants by Training Frequency

	1/Week Group (n = 81)	**2/Week Group (n = 845)**	**3/Week Group (n = 693)**
Body fat (%)	27.87 (± 5.29)	27.62 (± 5.20)	28.61 (± 5.40)
Fat weight (kg)	21.96 (± 8.29)	21.81 (± 8.12)	24.74 (± 9.60)
Lean weight (kg)	55.28 (± 9.88)	55.95 (± 10.27)	60.21 (± 10.70)
Systolic blood pressure (mm Hg)	127.83 (± 18.35)	128.72 (± 18.24)	127.92 (± 18.62)
Diastolic blood pressure (mm Hg)	75.96 (± 10.26)	76.13 (± 12.00)	77.99 (± 10.63)

Abbreviations: SD, standard deviation.

cycle resistance). The steady-state cardiovascular conditioning period was performed at an exercise intensity sufficient to attain 70% to 80% of each participant's age-predicted maximum heart rate. However, participants were not permitted to train above level 15 (hard exertion) on the Borg (6 to 20) scale for rating perceived physical exertion,[52] even if their heart rate did not exceed the recommended range.

Adherence and Satisfaction

Program adherence was determined by the percentage of training sessions completed out of the total number of class sessions offered. Participant satisfaction in all program areas was assessed anonymously by written questionnaires using rating scales of 1 (low satisfaction) to 5 (high satisfaction).

Data Analyses

Data were collected over 8 years on 1619 men and women who completed essentially identical 10-week exercise programs with different training frequencies (1, 2, or 3 sessions/week). Data were analyzed using multivariate analysis of variance (MANOVA) with post hoc multiple comparisons using a Bonferroni correction and multivariate analysis of covariance (MANCOVA). All of the underlying assumptions for a MANOVA were tested without finding any violations. For follow-up contrast, effect sizes were calculated. A minimum value of $P < 0.05$ was used to establish statistical significance.

Results

The overall participant drop-out rate was 9%, with a program completion rate of 91%. The mean rates of exercise adherence (percentage of scheduled classes attended) were 84%, 83%, and 80% for participants who trained 1, 2, and 3 days/week, respectively. Exercise adherence did not significantly differ by training groups ($\chi^2 = 0.024$).

Overall changes (M and SD) across all training frequencies demonstrated a 1.97% (± 1.51) reduction in body fat percent, a 1.70 kg (± 2.30) decrease in fat weight, a 1.35 kg (± 2.97) increase in lean weight, a 3.83 mm HG (± 13.92) reduction in resting systolic blood pressure, and a 1.73 mmg HG (± 9.39) reduction in resting diastolic blood pressure.

Changes from baseline to treatment end by frequency of training across measures are shown in Table 2. Multivariate analysis of variance indicated that training frequency influenced change in the measured outcomes.

Changes in body fat percent varied by frequency of training (F [2, 1609] = 14.67; $P < 0.001$). Participants who trained 1 day/week experienced significantly less reduction in body fat percent (M = 1.43 ± 1.35) than participants who trained 2 days/week (M = 1.85 ± 1.49; $P < 0.01$; effect size [ES] = 0.27) and participants who trained 3 days/week (M = 2.19 ± 1.52; $P < 0.01$; ES = 0.51). Participants who trained 3 days/week also reduced their body fat percent significantly more than participants who trained 2 days/week ($P < 0.01$; ES = 0.29).

Participants in the 3 training groups differed in fat weight change (F [2, 1609] = 11.7, $P < 0.001$). The 3 days/week training group lost significantly more fat weight (M = 2.01 ± 2.61 kg) than the 2 days/week training group (M = 1.47 ± 2.04 kg, $P < 0.05$; ES = 0.24), and the 1 day/week training group (M = 1.34 ± 1.72 kg; $P < 0.01$, ES = 0.27). There were no significant differences in fat weight change between the groups training once or twice per week.

Differences in training frequency effects were observed for changes in lean weight, (F [2, 1609] = 4.94; $P < 0.01$). Participants who trained 2 days/week or 3 days/week gained

Table 2. Baseline to Post-Test Changes (M ± SD) by Training Frequency

	1/ Week Group (n = 81)	2/Week Group (n = 845)	3/Week Group (n = 693)
Body fat (%)	–1.43 (± 1.35)	–1.85[a] (± 1.49)	–2.19[b,c] (± 1.52)
Fat weight (kg)	–1.34 (± 1.72)	–1.47 (± 2.04)	–2.01[b,c] (± 2.61)
Lean weight (kg)	0.33 (± 3.57)	1.40[a] (± 3.21)	1.40[b] (± 2.53)
Systolic blood pressure (mm Hg)	–4.19 (± 12.13)	–3.14 (± 13.53)	–4.63 (± 14.63)
Diastolic blood pressure (mm Hg)	–1.97 (± 8.33)	–1.36 (± 9.89)	–2.15 (± 8.89)

[a]2/wk > 1/wk, $P < 0.01$.
[b]3/wk > 1/wk, $P < 0.01$.
[c]3/wk > 2/wk, $P < 0.05$.
Abbreviations: M, mean; SD, standard deviation.

similar amounts of lean weight (M = 1.40 ± 3.21 kg; M = 1.40 ± 2.53 kg), and significantly more lean weight than participants who trained 1 day/week (M = 0.33 ± 3.57 kg; $P < 0.01$; ES = 0.27 and 0.33, respectively). Fat weight and lean weight changes for the 3 training frequencies are presented in Figure 1.

Changes in lean weight did not differ significantly by age. Lean weight gains for participants aged 20 to 44 years, 45 to 54 years, 55 to 64 years, and 65 to 80 years were 1.12 kg (± 1.19), 1.39 kg (± 3.98), 1.24 kg (± 2.13), and 1.42 kg (± 2.16), respectively.

Multivariate analysis of variance indicated no significant effect of training frequency on change in resting blood pressure. Training 1, 2, or 3 days/week was associated with similar reductions in resting systolic and diastolic blood pressure readings (see Table 2). Changes in resting systolic and diastolic blood pressures were significant ($P < 0.05$) for all training frequencies.

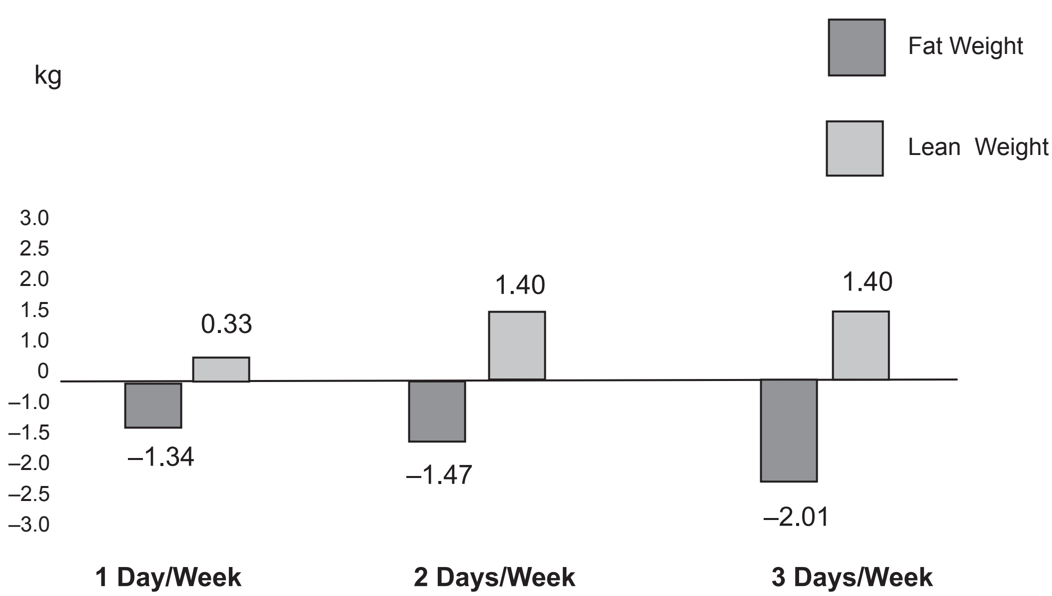
Postprogram anonymous questionnaires revealed that 95% of the participants reported high levels of satisfaction with the exercise program (4 or 5 rating on the 5-point scale), and were committed to continue training on their own.

Discussion

When examined by change in body fat percent, the 3 days/week training frequency was associated with significantly greater decreases than the 1 day/week or 2 days/week training frequencies. However, further analysis of the fat weight and lean weight components revealed some interesting findings. Not surprisingly, participants who trained 3 days/week lost significantly more fat weight than participants who trained 1 or 2 days/week. By performing both resistance and endurance exercise, the participants met the US Department of Health and Human Services guidelines for physical activity energy expenditure on their training days.[53] Logically, more frequent training sessions corresponded to more calories burned through exercise on a weekly basis. Each exercise session was estimated to use approximately 300 calories.

On the other hand, participants who trained 2 days/week or 3 days/week experienced similar increases in lean weight, for significantly more muscle gain than participants who trained 1 day/week. Thus, a once weekly strength training session appears to be insufficient to maximize muscle development in adult exercisers, which is consistent with our research on youth exercisers[50] and the adult study by DeMichele et al.[48] It would also appear that 2 weekly strength workouts provide as much stimulus for muscle building as 3 weekly strength workouts in beginning participants. This result is consistent with that of Candow and Burke,[51] who trained previously inactive men and women (ages 27–58 years) 2 or 3 days/week for 6 weeks. These findings should be encouraging to men and women who desire the beneficial effects of resistance exercise but who are unwilling or unable to schedule

Figure 1. 10-week changes in fat weight and lean weight by training frequency group (N = 1612).



3 strength training sessions each week. Furthermore, these findings support the ACSM (2006)[54] recommendation to perform strength training on 2 or 3 nonconsecutive days a week, as both training frequencies produced similar lean weight gains in these studies.

Because approximately 70% of the US adult population is overweight,[55] the basic ACSM exercise program may be more effective than dieting alone for attaining and maintaining desirable body composition.[56] Diet programs typically reduce muscle mass and decrease resting metabolic rate, essentially promoting weight regain.[57] Conversely, strength training builds muscle tissue and increases resting metabolic rate, resulting in additional energy use during the exercise session and throughout the day.[6,9,12–15] Dieting alone characteristically reduces energy, strength, and physical function, but strength training uses energy to increase strength and physical function. The 3 days/week trainees added 1.4 kg of lean weight and lost 2 kg of fat weight over the 10-week training period. Although this result represents only a 0.6 kg reduction in body weight, the participants experienced a 3.4 kg (2.2%) improvement in body composition.

All 3 training frequencies were effective for significantly reducing resting systolic and diastolic blood pressures, with no significant differences observed among the exercise groups. Although training 3 days/week was marginally associated with greater systolic and diastolic blood pressure changes, it would appear that 1 strength/endurance exercise session a week may be sufficient for lowering resting blood pressure in previously inactive adults.

Findings on adherence, attendance, and personal satisfaction showed that men and women between 21 and 80 years responded positively to 10 weeks of standard resistance exercise and aerobic activity performed in accordance with the minimum ACSM training guidelines in a supervised YMCA setting. Indeed, 91% of the study participants completed the training program, class attendance averaging between 80% and 84% for the 3 training group frequencies of 1, 2, or 3 days/week, and 95% of the study participants reported high levels of satisfaction with the exercise protocols.

The study demonstrated that a basic and brief fitness program incorporating the minimum ACSM training guidelines for strength and endurance exercise is an appropriate activity prescription for previously sedentary but otherwise healthy adults. The possible advantages of complex and long-duration training sessions over basic and short-duration training sessions for beginning exercisers have been questioned.[58] Many previously inactive adults are unlikely to be able to perform high-volume exercise protocols. However, most people should be capable of performing 20 minutes of resistance training and 20 minutes of aerobic exercise 1, 2, or 3 days/week. Over a 10-week period, 1 weekly training session appears to be as effective as 2 or 3 weekly workouts for reducing resting blood pressure, but less effective for improving body composition. Two weekly training sessions appear to be as effective as 3 weekly workouts for increasing lean weight, but less effective for reducing fat weight. Three weekly training sessions appear to produce the greatest reduction in body fat percent, and the greatest overall improvement in body composition (fat weight loss and lean weight gain).

We therefore suggest advising healthy patients to perform a basic exercise program in accordance with the minimum ACSM training guidelines on 3 nonconsecutive days/week. If this recommendation is not practical, 2 weekly exercise sessions should produce similar improvements in lean weight and resting blood pressure. Although not as effective as more frequent training sessions for changing body composition, 1 weekly workout appears to elicit similar reductions in resting systolic and diastolic blood pressures. Because exercise adherence has been a problem, we recommend that physicians refer their patients to evidence-based training programs with a strong behavior change focus.[59]

We hope that patients will find the ACSM minimum protocols for exercise type, intensity, and duration both effective and time efficient, and that they will apply the appropriate training frequency for desired improvements in body composition, resting blood pressure, and enhanced physical fitness.

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Conflict of Interest Statement

Wayne L. Westcott, PhD discloses conflicts of interest with Nautilus, Inc. Janet R. Wojcik, PhD discloses conflicts of interest with Fitness Resource Associates, Inc. Richard A. Winett, PhD, James J. Annesi, PhD, and Eileen S. Anderson, EdD, and Patrick J. Madden, MD disclose no conflicts of interest.

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