AMERICAN COLLEGE of SPORTS MEDICINE®

Progression Models in Resistance Training for Healthy Adults

POSITION STAND

This pronouncement was written for the American College of Sports Medicine by Nicholas A. Ratamess, Ph.D.; Brent A. Alvar, Ph.D.; Tammy K. Evetoch, Ph.D., FACSM; Terry J. Housh, Ph.D., FACSM (Chair); W. Ben Kibler, M.D., FACSM; William J. Kraemer, Ph.D., FACSM; and N. Travis Triplett, Ph.D.

SUMMARY

In order to stimulate further adaptation toward specific training goals, progressive resistance training (RT) protocols are necessary. The optimal characteristics of strength-specific programs include the use of concentric (CON), eccentric (ECC), and isometric muscle actions and the performance of bilateral and unilateral single- and multiple-joint exercises. In addition, it is recommended that strength programs sequence exercises to optimize the preservation of exercise intensity (large before small muscle group exercises, multiple-joint exercises before single-joint exercises, and higher-intensity before lower-intensity exercises). For novice (untrained individuals with no RT experience or who have not trained for several years) training, it is recommended that loads correspond to a repetition range of an 8–12 repetition maximum (RM). For intermediate (individuals with approximately 6 months of consistent RT experience) to advanced (individuals with years of RT experience) training, it is recommended that individuals use a wider loading range from 1 to 12 RM in a periodized fashion with eventual emphasis on heavy loading (1–6 RM) using 3- to 5-min rest periods between sets performed at a moderate contraction velocity (1–2 s CON; 1–2 s ECC). When training at a specific RM load, it is recommended that 2–10% increase in load be applied when the individual can perform the current workload for one to two repetitions over the desired number. The recommendation for training frequency is 2–3 d·wk^{-1} for novice training, 3–4 d·wk^{-1} for intermediate training, and 4–5 d·wk^{-1} for advanced training. Similar program designs are recommended for *hypertrophy* training with respect to exercise selection and frequency. For loading, it is recommended that loads corresponding to 1–12 RM be used in periodized fashion with emphasis on the 6–12 RM zone using 1- to 2-min rest periods between sets at a moderate velocity. Higher volume, multiple-set programs are recommended for maximizing hypertrophy. Progression in *power* training entails two general loading strategies: 1) strength training and 2) use of light loads (0–60% of 1 RM for lower body exercises; 30–60% of 1 RM for upper body exercises) performed at a fast contraction velocity with 3–5 min of rest between sets for multiple sets per exercise (three to five sets). It is also recommended that emphasis be placed on multiple-joint exercises especially those involving the total body. For *local muscular endurance* training, it is recommended that light to moderate loads (40–60% of 1 RM) be performed for high repetitions (>15) using short rest periods (<90 s). In the interpretation of this position stand as with prior ones, recommendations should be applied in context and should be contingent upon an individual's target goals, physical capacity, and training status. Key Words: strength, power, local muscular endurance, fitness, functional abilities, hypertrophy, health, performance

INTRODUCTION

The current document replaces the American College of Sports Medicine (ACSM) 2002 Position Stand entitled "Progression Models in Resistance Training for Healthy Adults" (8). The 2002 ACSM Position Stand extended the resistance training (RT) guidelines initially established by the ACSM in the position stand entitled "The Recommended Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory and Muscular Fitness, and Flexibility in Healthy Adults" (7), which suggested the minimal standard of one set of 8–12 repetitions for 8–10 exercises, including one exercise for all major muscle groups, and 10–15 repetitions for older and more frail persons. The 2002 Position Stand (8) provided a framework for superior training prescription guidelines relative to the need for progression in healthy (without disease or orthopedic limitations) novice, intermediate, and advanced trainees. Specifically, these guidelines effectively distinguished numerous modifications to the original guidelines to accommodate individuals seeking muscular development beyond that of minimal general health and fitness. Since 2002, numerous studies have been published examining one or more RT variable(s) to support the progressive adaptation in muscular strength and performance. These studies have identified other mechanisms of physiological adaptations and have served to bolster the scientific integrity of the RT knowledge base. As with all position stands, interpretation of these revised recommendations should be applied in context and should be contingent upon an individual's goals, physical capacity, and training status.

Progression in RT may be defined as "the act of moving forward or advancing toward a specific goal over time until the target goal has been achieved," whereas maintenance

0195-9131/09/4103-0687/0
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/MSS.0b013e3181915670

Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory, Musculoskeletal, and Neuromotor Fitness in Apparently Healthy Adults: Guidance for Prescribing Exercise

AMERICAN COLLEGE of SPORTS MEDICINE®

POSITION STAND

This pronouncement was written for the American College of Sports Medicine by Carol Ewing Garber, Ph.D., FACSM, (Chair); Bryan Blissmer, Ph.D.; Michael R. Deschenes, Ph.D., FACSM; Barry A. Franklin, Ph.D., FACSM; Michael J. Lamonte, Ph.D., FACSM; I-Min Lee, M.D., Sc.D., FACSM; David C. Nieman, Ph.D., FACSM; and David P. Swain, Ph.D., FACSM.

SUMMARY

The purpose of this Position Stand is to provide guidance to professionals who counsel and prescribe *individualized* exercise to apparently healthy adults of all ages. These recommendations also may apply to adults with certain chronic diseases or disabilities, when appropriately evaluated and advised by a health professional. This document supersedes the 1998 American College of Sports Medicine (ACSM) Position Stand, "The Recommended Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory and Muscular Fitness, and Flexibility in Healthy Adults." The scientific evidence demonstrating the beneficial effects of exercise is indisputable, and the benefits of exercise far outweigh the risks in most adults. A program of regular exercise that includes cardiorespiratory, resistance, flexibility, and neuromotor exercise training *beyond* activities of daily living to improve and maintain physical fitness and health is *essential* for most adults. The ACSM recommends that most adults engage in moderate-intensity cardiorespiratory exercise training for ≥30 min·d^{-1} on ≥5 d·wk^{-1} for a total of ≥150 min·wk^{-1}, vigorous-intensity cardiorespiratory exercise training for ≥20 min·d^{-1} on ≥3 d·wk^{-1} (≥75 min·wk^{-1}), or a combination of moderate- and vigorous-intensity exercise to achieve a total energy expenditure of ≥500–1000 MET·min·wk^{-1}. On 2–3 d·wk^{-1}, adults should also perform resistance exercises for each of the major muscle groups, and neuromotor exercise involving balance, agility, and coordination. Crucial to maintaining joint range of movement, completing a series of flexibility exercises for each the major muscle–tendon groups (a total of 60 s per exercise) on ≥2 d·wk^{-1} is recommended. The exercise program should be modified according to an individual's habitual physical activity, physical function, health status, exercise responses, and stated goals. Adults who are unable or unwilling to meet the exercise targets outlined here still can benefit from engaging in amounts of exercise *less than* recommended. In addition to exercising regularly, there are health benefits in concurrently reducing total time engaged in sedentary pursuits and also by interspersing frequent, short bouts of standing and physical activity between periods of sedentary activity, even in physically active adults. Behaviorally based exercise interventions, the use of behavior change strategies, supervision by an experienced fitness instructor, and exercise that is pleasant and enjoyable can improve adoption and adherence to prescribed exercise programs. Educating adults about and screening for signs and symptoms of CHD and gradual progression of exercise intensity and volume may reduce the risks of exercise. Consultations with a medical professional and diagnostic exercise testing for CHD are useful when clinically indicated but are not recommended for universal screening to enhance the safety of exercise.

Key Words: Practice Guidelines, Prescription, Physical Activity, Physical Fitness, Health, Aerobic Exercise, Resistance Exercise, Flexibility Exercise, Neuromotor Exercise, Functional Fitness

INTRODUCTION

Many recommendations for exercise and physical activity by professional organizations and government agencies have been published since the *sui generis* publications of the American College of Sports Medicine (ACSM) (10,11). The number of recommendations has escalated after the release of the 1995 Centers for Disease Control and Prevention (CDC)/ACSM public health recommendations (280) and the 1996 US Surgeon General's Report (371), and the ostensibly contradictory recommendations between these documents have led to confusion among health professionals, fitness professionals, and the public (32,155). The more recent recommendations of the American Heart Association (AHA)

0195-9131/11/4307-1334/0
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/MSS.0b013e318213fefb

AMERICAN COLLEGE of SPORTS MEDICINE®

POSITION STAND

Physical Activity and Bone Health

This pronouncement was written for the American College of Sports Medicine by Wendy M. Kohrt, Ph.D., FACSM (Chair); Susan A. Bloomfield, Ph.D., FACSM; Kathleen D. Little, Ph.D.; Miriam E. Nelson, Ph.D., FACSM; and Vanessa R. Yingling, Ph.D.

SUMMARY

Weight-bearing physical activity has beneficial effects on bone health across the age spectrum. Physical activities that generate relatively high-intensity loading forces, such as plyometrics, gymnastics, and high-intensity resistance training, augment bone mineral accrual in children and adolescents. Further, there is some evidence that exercise-induced gains in bone mass in children are maintained into adulthood, suggesting that physical activity habits during childhood may have long-lasting benefits on bone health. It is not yet possible to describe in detail an exercise program for children and adolescents that will optimize peak bone mass, because quantitative dose-response studies are lacking. However, evidence from multiple small randomized, controlled trials suggests that the following exercise prescription will augment bone mineral accrual in children and adolescents:

Mode:	impact activities, such as gymnastics, plyometrics, and jumping, and moderate intensity resistance training; participation in sports that involve running and jumping (soccer, basketball) is likely to be of benefit, but scientific evidence is lacking
Intensity:	high, in terms of bone-loading forces; for safety reasons, resistance training should be <60% of 1-repetition maximum (1RM)
Frequency:	at least 3 $d \cdot wk^{-1}$
Duration:	10–20 min (2 times per day or more may be more effective)

During adulthood, the primary goal of physical activity should be to maintain bone mass. Whether adults can increase bone mineral density (BMD) through exercise training remains equivocal. When increases have been reported, it has been in response to relatively high intensity weight-bearing endurance or resistance exercise; gains in BMD do not appear to be preserved when the exercise is discontinued. Observational studies suggest that the age-related decline in BMD is attenuated, and the relative risk for fracture is reduced, in people who are physically active, even when the activity is not particularly vigorous. However, there have been no large randomized, controlled trials to confirm these observations, nor have there been adequate dose-response studies to determine the volume of physical activity required for such benefits. It is important to note that, although physical activity may counteract to some extent the *aging-related* decline in bone mass, there is currently no strong evidence that even vigorous physical activity attenuates the *menopause-related* loss of bone mineral in women. Thus, pharmacologic therapy for the prevention of osteoporosis may be indicated even for those postmenopausal women who are habitually physically active. Given the current state of knowledge from multiple small randomized, controlled trials and large observational studies, the following exercise prescription is recommended to help preserve bone health during adulthood:

Mode:	weight-bearing endurance activities (tennis; stair climbing; jogging, at least intermittently during walking), activities that involve jumping (volleyball, basketball), and resistance exercise (weight lifting)
Intensity:	moderate to high, in terms of bone-loading forces
Frequency:	weight-bearing endurance activities 3–5 times per week; resistance exercise 2–3 times per week
Duration:	30–60 $min \cdot d^{-1}$ of a combination of weight-bearing endurance activities, activities that involve jumping, and resistance exercise that targets all major muscle groups

It is not currently possible to easily quantify exercise intensity in terms of bone-loading forces, particularly for weight-bearing endurance activities. However, in general, the magnitude of bone-loading forces increases in parallel with increasing exercise intensity quantified by conventional methods (e.g., percent of maximal heart rate or percent of 1RM).

The general recommendation that adults maintain a relatively high level of weight-bearing physical activity for bone health does not have an upper age limit, but as age increases so, too, does the need for ensuring that physical activities can be performed safely. In light of the rapid and profound effects of immobilization and bed rest on bone loss, and the poor prognosis for recovery of mineral after remobilization, even the frailest elderly should remain as physically active as their health permits to preserve skeletal integrity. Exercise programs for elderly women and men should include not only weight-bearing endurance and resistance activities aimed at preserving bone mass, but also activities designed to improve balance and prevent falls. Maintaining a vigorous level of physical activity across the lifespan should be viewed as an essential component of the prescription for achieving and maintaining good bone health.

INTRODUCTION

In Caucasian, postmenopausal women, osteoporosis is defined as a bone mineral density (BMD) value more than 2.5 standard deviations below the young adult mean value (52), with or without accompanying fractures. Whether the same criteria should apply to premenopausal women, women of other races, or men remains to be confirmed. In the U.S. and other developed countries the incidence of osteoporosis is increasing at rates faster than would be predicted by the increase in the proportion of aged individuals. Multiple

0195-9131/04/3611-1985
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/01.MSS.0000142662.21767.58

Appropriate Physical Activity Intervention Strategies for Weight Loss and Prevention of Weight Regain for Adults

AMERICAN COLLEGE of SPORTS MEDICINE®

POSITION STAND

This pronouncement was written for the American College of Sports Medicine by Joseph E. Donnelly, Ed.D. (Chair); Steven N. Blair, PED; John M. Jakicic, Ph.D.; Melinda M. Manore, Ph.D., R.D.; Janet W. Rankin, Ph.D.; and Bryan K. Smith, Ph.D.

ABSTRACT

Overweight and obesity affects more than 66% of the adult population and is associated with a variety of chronic diseases. Weight reduction reduces health risks associated with chronic diseases and is therefore encouraged by major health agencies. Guidelines of the National Heart, Lung, and Blood Institute (NHLBI) encourage a 10% reduction in weight, although considerable literature indicates reduction in health risk with 3% to 5% reduction in weight. Physical activity (PA) is recommended as a component of weight management for prevention of weight gain, for weight loss, and for prevention of weight regain after weight loss. In 2001, the American College of Sports Medicine (ACSM) published a Position Stand that recommended a minimum of 150 min·wk^{-1} of moderate-intensity PA for overweight and obese adults to improve health; however, 200–300 min·wk^{-1} was recommended for long-term weight loss. More recent evidence has supported this recommendation and has indicated more PA may be necessary to prevent weight regain after weight loss. To this end, we have reexamined the evidence from 1999 to determine whether there is a level at which PA is effective for prevention of weight gain, for weight loss, and prevention of weight regain. Evidence supports moderate-intensity PA between 150 and 250 min·wk^{-1} to be effective to prevent weight gain. Moderate-intensity PA between 150 and 250 min·wk^{-1} will provide only modest weight loss. Greater amounts of PA (>250 min·wk^{-1}) have been associated with clinically significant weight loss. Moderate-intensity PA between 150 and 250 min·wk^{-1} will improve weight loss in studies that use moderate diet restriction but not severe diet restriction. Cross-sectional and prospective studies indicate that after weight loss, weight maintenance is improved with PA >250 min·wk^{-1}. However, no evidence from well-designed randomized controlled trials exists to judge the effectiveness of PA for prevention of weight regain after weight loss. Resistance training does not enhance weight loss but may increase fat-free mass and increase loss of fat mass and is associated with reductions in health risk. Existing evidence indicates that endurance PA or resistance training without weight loss improves health risk. There is inadequate evidence to determine whether PA prevents or attenuates detrimental changes in chronic disease risk during weight gain.

0195-9131/09/4102-0459/0
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/MSS.0b013e3181949333

This document is an update of the 2001 American College of Sports Medicine (ACSM) Position Stand titled "Appropriate Intervention Strategies for Weight Loss and Prevention of Weight Regain for Adults" (68). This Position Stand provided a variety of recommendations such as the identification of adults for whom weight loss is recommended, the magnitude of weight loss recommended, dietary recommendations, the use of resistance exercise, the use of pharmacological agents, behavioral strategies, and other topics. The purpose of the current update was to focus on new information that has been published after 1999, which may indicate that increased levels of physical activity (PA) may be necessary for prevention of weight gain, for weight loss, and prevention of weight regain compared to those recommended in the 2001 Position Stand. In particular, this update is in response to published information regarding the amount of PA needed for weight management found in the National Weight Control Registry (155) and by the Institute of Medicine (67).

This update was undertaken for persons older than 18 yr who were enrolled in PA trials designed for prevention of weight gain (i.e., weight stability), for weight loss, or prevention of weight regain. Investigations that include older adults (i.e., older than 65 yr) are not abundant. Some concerns exist for the need for weight loss in older adults and for loss of fat-free mass and potential bone loss. This review considers the existing literature as it applies to the general population. However, it is likely that individuals vary in their response to PA for prevention of weight gain, for weight loss, and for weight maintenance. Successful results will also depend on energy intakes [Weight management. *J Am Diet Assoc.* 2009;109(2):330–46]. Trials with individuals with comorbid conditions that acutely affect weight and trials using pharmacotherapy were not included (i.e., acquired immunodeficiency syndrome, type 1 diabetes). Trials using

SPECIAL COMMUNICATIONS

AMERICAN COLLEGE of SPORTS MEDICINE®
AMERICAN DIABETES ASSOCIATION

JOINT POSITION STATEMENT

Exercise and Type 2 Diabetes

SUMMARY

Although physical activity (PA) is a key element in the prevention and management of type 2 diabetes mellitus (T2DM), many with this chronic disease do not become or remain regularly active. High-quality studies establishing the importance of exercise and fitness in diabetes were lacking until recently, but it is now well established that participation in regular PA improves blood glucose control and can prevent or delay T2DM, along with positively affecting lipids, blood pressure, cardiovascular events, mortality, and quality of life. Structured interventions combining PA and modest weight loss have been shown to lower T2DM risk by up to 58% in high-risk populations. Most benefits of PA on diabetes management are realized through acute and chronic improvements in insulin action, accomplished with both aerobic and resistance training. The benefits of physical training are discussed, along with recommendations for varying activities, PA-associated blood glucose management, diabetes prevention, gestational diabetes, and safe and effective practices for PA with diabetes-related complications.

INTRODUCTION

Diabetes has become a widespread epidemic, primarily because of the increasing prevalence and incidence of type 2 diabetes mellitus (T2DM). According to the Centers for Disease Control and Prevention, in 2007, almost 24 million Americans had diabetes, with one quarter of those, or 6 million, undiagnosed (261). Currently, it is estimated that almost 60 million US residents also have prediabetes, a condition in which blood glucose (BG) levels are above normal, thus greatly increasing their risk for T2DM (261). Lifetime risk estimates suggest that one in three Americans born in 2000 or later will develop diabetes, but in high-risk ethnic populations, closer to 50% may develop it (200). T2DM is a significant cause of premature mortality and morbidity related to cardiovascular disease (CVD), blindness, kidney and nerve disease, and amputation (261). Although regular physical activity (PA) may prevent or delay diabetes and its complications (10,46,89,112,176,208,259,294), most people with T2DM are not active (193).

In this article, the broader term "physical activity" (defined as "bodily movement produced by the contraction of skeletal muscle that substantially increases energy expenditure") is used interchangeably with "exercise," which is defined as "a subset of PA done with the intention of developing physical fitness (i.e., cardiovascular, strength, and flexibility training)." The intent is to recognize that many types of physical movement may have a positive effect on physical fitness, morbidity, and mortality in individuals with T2DM.

Diagnosis, classification, and etiology of diabetes. Currently, the American Diabetes Association (ADA) recommends the use of any of the following four criteria for diagnosing diabetes: 1) glycated hemoglobin (A_{1c}) value of 6.5% or higher, 2) fasting plasma glucose $\geq$ 126 mg·dL^{-1} (7.0 mmol·L^{-1}), 3) 2-h plasma glucose $\geq$ 200 mg·dL^{-1} (11.1 mmol·L^{-1}) during an oral glucose tolerance test using 75 g of glucose, and/or 4) classic symptoms of hyperglycemia (e.g., polyuria, polydipsia, and unexplained weight loss) or hyperglycemic crisis with a random plasma glucose of 200 mg·dL^{-1} (11.1 mmol·L^{-1}) or higher. In the absence of unequivocal hyperglycemia, the first three criteria should be confirmed by repeat testing (4). Prediabetes is diagnosed with an A_{1c} of 5.7%–6.4%, fasting plasma glucose of 100–125 mg·dL^{-1} (5.6–6.9 mmol·L^{-1}; i.e., impaired fasting glucose, or IFG), or 2-h postload glucose of 140–199 mg·dL^{-1} (7.8–11.0 mmol·L^{-1}; i.e., impaired glucose tolerance, or IGT) (4).

The major forms of diabetes can be categorized as type 1 or type 2 (4). In type 1, which accounts for 5%–10% of cases, the cause is an absolute deficiency of insulin secretion resulting from autoimmune destruction of the insulin-producing cells in the pancreas. T2DM (90%–95% of cases) results from a combination of the inability of muscle cells to respond to insulin properly (insulin resistance) and inadequate compensatory insulin secretion. Less common forms include gestational diabetes (GDM), which is associated with a 40%–60% chance of developing T2DM in the next 5–10 yr (261). Diabetes can also result from genetic defects in insulin action, pancreatic disease, surgery, infections, and drugs or chemicals (4,261).

Genetic and environmental factors are strongly implicated in the development of T2DM. The exact genetic defects are

This joint position statement is written by the American College of Sports Medicine and the American Diabetes Association; approved by Executive Committee of the American Diabetes Association in July 2010. This statement is published concurrently in *Medicine & Science in Sports & Exercise®* and *Diabetes Care*. Individual name recognition is stated in the acknowledgments at the end of the statement.

0195-9131/10/4212-2282/0
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/MSS.0b013e3181eeb61c

AMERICAN COLLEGE of SPORTS MEDICINE™
POSITION STAND

Exercise for Patients with Coronary Artery Disease

SUMMARY

American College of Sports Medicine Position Stand: "EXERCISE FOR PATIENTS WITH CORONARY ARTERY DISEASE." *Med. Sci. Sports Exerc.*, Vol. 26, No. 3, pp. i–v, 1994. Exercise training improves functional capacity and reduces clinical symptoms in patients with coronary artery disease. However, such patients are at increased risk for cardiovascular complications during exercise; therefore, appropriate safeguards should be employed to minimize these risks. Based on the documented benefits and risks of exercise for patients with coronary artery disease, it is the position of the American College of Sports Medicine that most patients with coronary artery disease should engage in individually designed exercise programs to achieve optimal physical and emotional health.

INTRODUCTION

This position stand will address exercise for patients with coronary artery disease. The following points are readily recognized. Patients with coronary artery disease are not a homogeneous group and must be considered individually. They vary greatly in their clinical status including: extent of coronary artery disease, left ventricular dysfunction, potential for myocardial ischemia, and presence of cardiac arrhythmias. Some patients with coronary artery disease have had prior cardiac events (e.g., myocardial infarction, cardiac arrest) or treatments (e.g., coronary artery bypass graft surgery, percutaneous transluminal coronary angioplasty, or other coronary artery interventions). Many patients have additional medical disorders including hypertension, peripheral vascular disease, valvular heart disease, chronic obstructive pulmonary disease, and diabetes mellitus.

Exercise in the outpatient setting will be addressed in this position stand, although in-hospital, early ambulation following cardiac events is also important.

EFFECTS OF EXERCISE TRAINING

Functional Capacity

Patients with coronary artery disease generally demonstrate reduced maximal oxygen uptake and exercise tolerance compared with their healthy contemporaries. The magnitude of the reduction varies in part with the severity of disease, and some coronary artery disease patients have normal exercise tolerance. Both a lower maximal stroke volume and heart rate may limit maximal cardiac output and oxygen uptake (7). The magnitude of the reduction in stroke volume depends on the amount of myocardium rendered ischemic by exercise and/or the size of prior myocardial infarction. The mechanism for the reduced exercise heart rate in unmedicated patients has not been defined. Maximal exercise performance in patients with angina pectoris is limited by discomfort. In patients with classic angina pectoris, such discomfort occurs at a highly reproducible (25) rate pressure product (heart rate times systolic blood pressure) if factors such as time of day, room temperature, and body position are constant (6). Many patients do not demonstrate this classic pattern, suggesting that coronary vasospastic changes contribute to the variation in their anginal threshold (42).

Both the patient's behavior and the physician's recommendations may also reduce the patient's exercise capacity. Detraining occurs both from self-induced and medically required restrictions in activity. Medications such as beta adrenergic blockers, although beneficial for symptomatic patients, may reduce exercise capacity in some patient groups, especially if these drugs are prescribed routinely or prophylactically in asymptomatic patients.

Exercise training increases functional capacity and maximal oxygen uptake ($\dot{V}O_{2max}$) in coronary artery disease patients by increasing the arteriovenous oxygen difference, and in some cases maximal stroke volume as well (7). The relative contribution of these two factors to the increase in $\dot{V}O_{2max}$ varies with the patient population and type of training program. The increase in $\dot{V}O_{2max}$ in coronary artery disease patients after three months of training ranges from approximately 10–60% in published reports and averages about 20% (16,39). Increases in maximal work capacity may underestimate the functional benefits of exercise training, because marked increases in submaximal endurance capacity can occur in healthy subjects despite modest increases in $\dot{V}O_{2max}$ (35).

Symptoms of Myocardial Ischemia

Some of the greatest increases in effort tolerance following exercise training occur in patients with angina pectoris (8). Exercise training reduces submaximal heart rate at any given workload or activity and delays the onset of symptoms during exercise. Some patients actually have a disappearance of anginal pain after training (8). The reduction in anginal symptoms produced by exercise training may facilitate a decrease in drug therapy, but this benefit of exercise training has not been well quantified.

AMERICAN COLLEGE of SPORTS MEDICINE®

POSITION STAND

Exercise and Hypertension

This pronouncement was written for the American College of Sports Medicine by Linda S. Pescatello, Ph.D., FACSM, (Co-Chair), Barry A. Franklin, Ph.D., FACSM, (Co-Chair), Robert Fagard, M.D., Ph.D., FACSM, William B. Farquhar, Ph.D., George A. Kelley, D.A., FACSM, and Chester A. Ray, Ph.D., FACSM

SUMMARY

Hypertension (HTN), one of the most common medical disorders, is associated with an increased incidence of all-cause and cardiovascular disease (CVD) mortality. Lifestyle modifications are advocated for the prevention, treatment, and control of HTN, with exercise being an integral component. Exercise programs that primarily involve endurance activity prevent the development of HTN and lower blood pressure (BP) in adults with normal BP and those with HTN. The BP lowering effects of exercise are most pronounced in people with HTN who engage in endurance exercise with BP decreasing approximately 5–7 mm Hg after an isolated exercise session (acute) or following exercise training (chronic). Moreover, BP is reduced for up to 22 h after an endurance exercise bout (e.g., postexercise hypotension), with the greatest decreases among those with the highest baseline BP.

The proposed mechanisms for the BP lowering effects of exercise include neurohumoral, vascular, and structural adaptations. Decreases in catecholamines and total peripheral resistance, improved insulin sensitivity, and alterations in vasodilators and vasoconstrictors are some of the postulated explanations for the antihypertensive effects of exercise. Emerging data suggest genetic links to the BP reductions associated with acute and chronic endurance exercise. Nonetheless, definitive conclusions regarding the mechanisms for the BP reductions following endurance exercise cannot be made at this time.

Individuals with controlled HTN and no CVD or renal complications may participate in an exercise program or competitive athletics, but should be evaluated, treated, and monitored closely. Preliminary peak or symptom-limited exercise testing may be warranted, especially for men over 45 and women over 55 yr planning a vigorous exercise program (i.e., ≥ 60% $\dot{V}O_2R$, oxygen uptake reserve). In the interim, while formal evaluation and management are taking place, it is reasonable for the majority of patients to begin moderate intensity exercise training (40–<60% $\dot{V}O_2R$) such as walking. When pharmacologic therapy is indicated in physically active people it should, ideally: a) lower BP at rest and during exertion; b) decrease total peripheral resistance; and, c) not adversely affect exercise capacity. For these reasons, angiotensin converting enzyme (ACE) inhibitors (or angiotensin II receptor blockers in case of ACE inhibitor intolerance) and calcium channel blockers are currently the drugs of choice for recreational exercisers and athletes who have HTN.

Exercise remains a cornerstone therapy for the primary prevention, treatment, and control of HTN. The optimal training frequency, intensity, time, and type (FITT) need to be better defined to optimize the BP lowering capacities of exercise, particularly in children, women, older adults, and certain ethnic groups. Based upon the current evidence, the following exercise prescription is recommended for those with high BP:

Frequency: on most, preferably all, days of the week
Intensity: moderate-intensity (40–<60% of $\dot{V}O_2R$)
Time: ≥ 30 min of continuous or accumulated physical activity per day
Type: primarily endurance physical activity supplemented by resistance exercise

INTRODUCTION

Since the 1970s, significant technological and pharmacotherapeutic advances have been made in the treatment and control of cardiovascular disease (CVD) and its associated risk factors. Yet, hypertension (HTN) remains a major public health problem in the United States, with 58.4 million (28.7%) Americans aged 18 yr or older having HTN (systolic blood pressure [SBP] ≥ 140 and/or diastolic blood pressure [DBP] ≥ 90 mm Hg) (11,39,107,137). HTN prevalence is increasing whereas awareness of the condition and control rates is suboptimal (39,107,137). The positive relationship between CVD risk and blood pressure (BP) occurs with a BP as low as 115/75 mm Hg and doubles for each 20/10-mm Hg increase. A person with normal BP at 55 yr of age has a 90% lifetime risk of developing HTN (264). The BP classification of "prehypertension" (SBP 120–139 or DBP 80–89 mm Hg) has been introduced to stress the public health importance of reducing BP and preventing HTN via healthy lifestyle interventions for all people (39).

There are minimal cost and side effects associated with lifestyle interventions, and they interact favorably with other CVD risk factors. For these reasons, the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (39,137), the World Health Organization (WHO) (283), the European Society of Hypertension (61), and the National High Blood Pressure Education Program (271) recommend approaches such as regular physical activity for the prevention and treatment of HTN. Table 1 lists the WHO blood pressure classification scheme and Table 2 the treatment guidelines for HTN (61,137,283).

The purpose of this Position Stand is to present an evidence-based review of the current state of knowledge on

0195-9131/04/3603-0533
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/01.MSS.0000115224.88514.3A

AMERICAN COLLEGE of SPORTS MEDICINE

POSITION STAND

Exercise and Physical Activity for Older Adults

This pronouncement was written for the American College of Sports Medicine by Wojtek J. Chodzko-Zajko, Ph.D., FACSM, (Co-Chair); David N. Proctor, Ph.D., FACSM, (Co-Chair); Maria A. Fiatarone Singh, M.D.; Christopher T. Minson, Ph.D., FACSM; Claudio R. Nigg, Ph.D.; George J. Salem, Ph.D., FACSM; and James S. Skinner, Ph.D., FACSM.

SUMMARY

The purpose of this Position Stand is to provide an overview of issues critical to understanding the importance of exercise and physical activity in older adult populations. The Position Stand is divided into three sections: Section 1 briefly reviews the structural and functional changes that characterize normal human aging, Section 2 considers the extent to which exercise and physical activity can influence the aging process, and Section 3 summarizes the benefits of both long-term exercise and physical activity and shorter-duration exercise programs on health and functional capacity. Although no amount of physical activity can stop the biological aging process, there is evidence that regular exercise can minimize the physiological effects of an otherwise sedentary lifestyle and increase active life expectancy by limiting the development and progression of chronic disease and disabling conditions. There is also emerging evidence for significant psychological and cognitive benefits accruing from regular exercise participation by older adults. Ideally, exercise prescription for older adults should include aerobic exercise, muscle strengthening exercises, and flexibility exercises. The evidence reviewed in this Position Stand is generally consistent with prior American College of Sports Medicine statements on the types and amounts of physical activity recommended for older adults as well as the recently published *2008 Physical Activity Guidelines for Americans*. All older adults should engage in regular physical activity and avoid an inactive lifestyle.

In the decade since the publication of the first edition of the American College of Sports Medicine (ACSM) Position Stand "Exercise and Physical Activity for Older Adults," a significant amount of new evidence has accumulated regarding the benefits of regular exercise and physical activity for older adults. In addition to new evidence regarding the importance of exercise and physical activity for healthy older adults, there is now a growing body of knowledge supporting the prescription of exercise and physical activity for older adults with chronic diseases and disabilities. In 2007, ACSM, in conjunction with the American Heart Association (AHA), published physical activity and public health recommendations for older adults (see Table 1 for a summary of these recommendations) (167). Furthermore, the College has now developed best practice guidelines with respect to exercise program structure, behavioral recommendations, and risk management strategies for exercise in older adult populations (46). Recently, the Department of Health and Human Services published for the first time national physical activity guidelines. The *2008 Physical Activity Guidelines for Americans* (50) affirms that regular physical activity reduces the risk of many adverse health outcomes. The guidelines state that all adults should avoid inactivity, that some physical activity is better than none, and that adults who participate in any amount of physical activity gain some health benefits. However, the guidelines emphasize that for most health outcomes, additional benefits occur as the amount of physical activity increases through higher intensity, greater frequency, and/or longer duration. The guidelines stress that if older adults cannot do 150 min of moderate-intensity aerobic activity per week because of chronic conditions, they should be as physically active as their abilities and conditions allow.

This revision of the ACSM Position Stand "Exercise and Physical Activity for Older Adults" updates and expands the earlier Position Stand and provides an overview of issues critical to exercise and physical activity in older adults. The Position Stand is divided into three sections: Section 1 briefly reviews some of the structural and functional changes that characterize normal human aging. Section 2 considers the extent to which exercise and/or physical activity can influence the aging process through its impact on physiological function and through its impact on the development and progression of chronic disease and disabling conditions. Section 3 summarizes the benefits of both long-term exercise and physical activity and shorter-duration exercise programs on health and functional capacity. The benefits are summarized primarily for the two exercise modalities for which the most data are available: 1) aerobic exercise and 2) resistance exercise. However, information about the known benefits of balance and flexibility exercise is included whenever sufficient data exist. This section concludes with a discussion of the benefits of exercise and physical activity for psychological health and well-being.

0195-9131/09/4107-1510/0
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/MSS.0b013e3181a0c95c

SPECIAL COMMUNICATIONS