Promoting and Prescribing Exercise for the Elderly

ROBERT J. NIED, M.D., Michigan State University, East Lansing, Michigan
BARRY FRANKLIN, PH.D., William Beaumont Hospital, Royal Oak, Michigan

Regular exercise provides a myriad of health benefits in older adults, including improvements in blood pressure, diabetes, lipid profile, osteoarthritis, osteoporosis, and neurocognitive function. Regular physical activity is also associated with decreased mortality and age-related morbidity in older adults. Despite this, up to 75 percent of older Americans are insufficiently active to achieve these health benefits. Few contraindications to exercise exist, and almost all older persons can benefit from additional physical activity. The exercise prescription consists of three components: aerobic exercise, strength training, and balance and flexibility. Physicians play a key role in motivating older patients and advising them regarding their physical limitations and/or comorbidities. Motivating patients to begin exercise is best achieved by focusing on individual patient goals, concerns, and barriers to exercise. Strategies include the "stages of change" model, individualized behavioral therapy, and an active lifestyle. To increase long-term compliance, the exercise prescription should be straightforward, fun, and geared toward a patient's individual health needs, beliefs, and goals. (Am Fam Physician 2002;65:419-26,427-8. Copyright© 2002 American Academy of Family Physicians.)

A patient information handout on exercise for the elderly, written by the authors of this article, is provided on page 427.

Members of various medical faculties develop articles for "Practical Therapeutics." This article is one in a series coordinated by the Department of Family Medicine at the University of Michigan Medical School, Ann Arbor. Guest editor of the series is Barbara S. Apgar, M.D., M.S., who is also an associate editor of AFP.

Regular exercise has been shown to decrease mortality and age-related morbidity in older adults.[1-3] Despite this, up to three fourths of the older adult population do not currently exercise at recommended levels. The relative risk (RR) for cardiovascular disease caused by sedentary living has been estimated to be 1.9, compared with other modifiable risk factors such as hypertension (RR = 2.1) and cigarette smoking (RR = 2.5), but it occurs at a much higher prevalence.[4] Fewer than 10 percent of women over age 75 smoke cigarettes while greater than 70 percent are insufficiently active.[5]

By the year 2030, 22 percent of the U.S. population will be older than 65 years, a total of 70 million people.[6] The fastest growing segment of the elderly population is the group older than 85 years, classified as "old old." Because activity levels generally decline with advancing age, the absolute number of inactive older Americans will most likely increase dramatically.

As the population of older adults increases, it will become vitally important for family physicians to counsel sedentary patients to become physically active.

Benefits of Exercise

As is the case in younger adults, regular exercise has been shown to provide a myriad of benefits in older adults *(Table 1)*.[1] Improvements in cardiovascular, metabolic, endocrine, and psychologic health are well documented.[1,7-9] Cardiovascular fitness, although not directly correlated with health benefits, is a determinant of functional independence.[10] Up to one third of the age-related decline in aerobic capacity ($\dot{V}O_2$ max) can be reversed with prolonged (six months or more) aerobic training.[1]

Regular exercise and/or increased aerobic fitness are associated with a decrease in all-cause mortality and morbidity in middle-aged and older adults.[2,3] Subgroup analysis of the Harvard Alumni study found that modest increases in life expectancy were possible even in those patients who did not begin regular exercise until age 75.[11] Mortality rates were also lower in those patients who did not begin regular exercise until late in life compared with patients who were active only in younger years and then subsequently stopped exercising.[11] Thus, it is never too late for patients to benefit from physical activity.

TABLE 1
Benefits of Exercise in Older Adults

Cardiovascular
Improves physiologic parameters ($\dot{V}O_2$ max, cardiac output, decreased submaximal rate-pressure product)
Improves blood pressure
Decreases risk of coronary artery disease
Improves congestive heart failure symptoms and decreases hospitalization rate
Improves lipid profile

Diabetes mellitus, type 2
Decreases incidence
Improves glycemic control
Decreases hemoglobin A_{1c} levels
Improves insulin sensitivity

Osteoporosis
Decreases bone density loss in postmenopausal women
Decreases hip and vertebral fractures
Decreases risk of falling

Osteoarthritis
Improves function
Decreases pain

Neuropsychologic health
Improves quality of sleep
Improves cognitive function
Decreases rates of depression, improves Beck depression scores.
Improves short-term memory

Cancer
Potential decrease in risk of colon, breast, prostate, rectum
Improves quality of life and decreases fatigue

Other
Decreases all-cause mortality
Decreases all-cause morbidity
Decreases risk of obesity
Improves symptoms in peripheral vascular occlusive disease

The health benefits of exercise follow a hyperbolic dose-response curve. Those patients who go from none to some exercise receive the greatest health benefits, while further increases in activity levels bring progressively smaller improvements.[12] Physicians can have the greatest overall impact by helping their sedentary patients to become active.

Illustrative Cases

CASE 1

A 71-year-old man who has moderately well-controlled hypertension, and osteoarthritis of the knees bilaterally and right hip. He is active in two bowling leagues and enjoys walking; however, both activities are becoming limited by pain in his knees.

He will benefit from increasing the level of activity and incorporating resistance training into his exercise routine. The patient began cross training with non–weight-bearing activities of swimming and biking three times per week. He was encouraged to wear good athletic shoes and may benefit from bracing, orthotics, nonsteroidal anti-inflammatory medication, or viscosupplementation. A twice-weekly, resistance training program was initiated focusing initially on lower extremity strength using light weights on a multipurpose machine.

CASE 2

An 85-year-old woman who lives alone has a previous history of a minor stroke and has hypertension controlled with a beta blocker. She does not have known osteoporosis or a history of fracture and is currently sedentary.

On examination, this patient had some difficulty with eyes-closed balance and was unable to stand from a chair without using both armrests, indicating fairly significant leg weakness. She began her exercise program by focusing on balance and strength with a simple home routine based on chair exercises, 12 oz soup cans, and balancing on one leg while holding the kitchen counter. Because she is asymptomatic for coronary artery disease, she can begin a low-intensity aerobic program without further testing. Because of the cold weather, the patient chose to begin walking the ground floor of her large apartment building, adding time and distance as she gains endurance.

The Authors

ROBERT J NIED, M.D., is currently in private practice with Mission Medical Associates, San Luis Obispo, Calif. Dr. Nied received his medical degree from the University of California, Los Angeles School of Medicine. He completed a residency in family medicine at the University of Michigan, Ann Arbor, and recently completed a fellowship in sports medicine at Michigan State University, East Lansing.

BARRY FRANKLIN, PH.D., is the director of the Cardiac Rehabilitation and Exercise Laboratories, William Beaumont Hospital, Royal Oak, Mich., and professor of physiology at Wayne State University School of Medicine, Detroit. He earned his doctorate in physiology from Penn State University, University Park, Pa. He is the immediate past president of the American College of Sports Medicine and serves on the editorial board of the *American Journal of Cardiology*, the *Journal of Cardiopulmonary Rehabilitation*, the *American Journal of Health Promotion*, and *Physician and Sportsmedicine*.

Address correspondence to Robert J. Nied, M.D., Mission Medical Associates, 1235 Osos St., San Luis Obispo, CA 93401. Reprints are not available from the authors.

Strength Training

Although the positive benefits of aerobic exercise are widely accepted, the importance of resistance training in the older population has also become increasingly apparent. Muscle strength declines by 15 percent per decade after age 50 and 30 percent per decade after age 70.[1] This is principally the result of sarcopenia (loss of muscle mass) and occurs to a greater degree in older women than men. Results from the Framingham disability study[13] demonstrate that 45 percent of women older than 65 years and 65 percent older than 75 years cannot lift 10 lb. Resistance training can result in 25 to 100 percent, or more, strength gains in older adults through muscle hypertrophy and, presumably, increased motor unit recruitment.[1,14]

Strength is intrinsic to daily function, especially in the very elderly. Most of the variance in walking speed in the elderly is related to leg strength, and increased strength has been shown to improve walking endurance and stair-climbing power. Strength training also improves nitrogen balance and can, combined with adequate nutrition, prevent muscle wasting in institutionalized elderly persons.[14,15]

The rise in heart rate and blood pressure with resistance work is largely proportional to the percent of maximal voluntary contraction (MVC). Consequently, minimal lifting (e.g., routine housework) can produce a dramatic rise in the rate-pressure product in weak, elderly patients. In addition to absolute strength gains, resistance training attenuates the cardiac demands of any given load because the load now represents a lower percentage of the MVC.[16]

Preparticipation Screening

HISTORY AND PHYSICAL

Before initiating an exercise program, most older adults should undergo a history and physical examination directed at identifying cardiac risk factors, exertional signs/symptoms, and physical limitations. There are few contraindications to aerobic exercise or resistance training *(Table 2)*.[1,16] Even patients with these conditions can safely exercise at low levels once appropriate evaluation and treatment have been initiated. For example, early exercise-based cardiac rehabilitation has become a mainstay of postmyocardial infarction care. The 26th Bethesda Conference guidelines[17] contain specific recommendations for patients with hypertension, valvular, and other cardiovascular disease.

Muscle strength declines by 15 percent per decade after age 50 and 30 percent per decade after age 70; however, resistance training can result in 25 to 100 percent, or more, strength gains in older adults.

Simple office tests for cardiovascular fitness and global strength have been described.[18,19] While these tests may be useful in following a patient's progress, they are generally not necessary for the initial exercise prescription. A resting office-based electro-

TABLE 2
Potential Contraindications to Aerobic Exercise and Resistance Training

Absolute	*Relative*
Recent ECG change or myocardial infarction	Cardiomyopathy
Unstable angina	Valvular heart disease
Third-degree heart block	Complex ventricular ectopy
Acute congestive heart failure	
Uncontrolled hypertension	
Uncontrolled metabolic disease	

ECG = electrocardiogram.

Adapted with permission from American College of Sports Medicine Position Stand. Exercise and physical activity for older adults. Med Sci Sports Exerc 1998;30:992-1008, and Pollock ML, Franklin BA, Balady GJ, Chaitman BL, Fleg JL, Fletcher B, et al. AHA Science Advisory. Resistance exercise in individuals with and without cardiovascular disease: benefits, rationale, safety, and prescription. Circulation 2000;101:828-33.

TABLE 3
Guidelines for Cardiac Stress Testing

Men ≥45 years and women ≥55 years who plan to exercise at ≥60 percent $\dot{V}O_2$ max
Known coronary artery disease or cardiac symptoms
Two or more coronary artery disease risk factors*
Diabetes
Known or major signs/symptoms of pulmonary or metabolic disease

**—Hypertension, smoking, hypercholesterolemia, obesity, sedentary lifestyle, family history of early coronary artery disease.*

Adapted with permission from Franklin BA, Whaley MH, Howley ET, eds. ACSM's guidelines for exercise testing and prescription. 6th ed. Baltimore: Lippincott Williams & Wilkins, 2000.

cardiogram (ECG) has limited use in preparticipation screening. Bradycardia, minor ST-wave changes, and atrial and ventricular complexes can be normal variants in older persons and are nonspecific for coronary artery disease.

TABLE 4
Recommended Levels of Physical Activity

Cardiovascular
Moderate aerobic activity for a combined total of at least 30 minutes, most days of the week.* Individual bouts of activity may be as brief as 10 minutes.
Strength training
A single set of 10 to 15 repetitions using eight to 10 different exercises, performed two to three times per week. Each repetition should be performed slowly through a full range of motion while avoiding holding one's breath (Valsalva maneuver). The training program should involve all major muscle groups.†
Balance and flexibility
Stretch major muscle groups once per day after exercise when muscles are more compliant.‡ Balance training and weight transfer program twice per week.§

**—For most older adults, moderate activity corresponds to 2.5 to 5.5 metabolic equivalents, equivalent to level walking at a 2.0 to 4.5 mph pace.*

†—Clinically relevant muscle groups include hip extensors, knee extensors, ankle plantar flexors and dorsiflexors, biceps, triceps, shoulders, back extensor, and abdominal muscles.

‡—Stretches should be performed in a "stretch and hold" fashion—avoid "ballistic" or "bouncing" stretches.

§—Supervised and progressively more difficult postural exercises that either reduce the base of support (e.g., one-leg stands), perturb the center of gravity (e.g., circle turns), stress postural muscles (e.g., heel stands), or reduce other sensory input (e.g., vision).

Adapted with permission from American College of Sports Medicine Position Stand. Exercise and physical activity for older adults. Med Sci Sports Exerc 1998;30:992-1008.

EXERCISE STRESS TESTING

The American College of Sports Medicine recommends exercise stress testing for all sedentary or minimally active older adults who plan to begin exercising at a vigorous intensity *(Table 3)*.[20] Most elderly patients, however, can safely begin a moderate aerobic and resistance training program without stress testing if they begin slowly and gradually increase their level of activity. A community-based walking program in Massachusetts involving almost 8,000 elderly patients reported no incidence of myocardial infarction or other adverse cardiac events during exercise over an eight-year period.[21] Patients should be counseled to discontinue exercise and seek medical advice if they experience major warning signs or symptoms (e.g., chest pain, palpitations, or lightheadedness).

Exercise stress testing can also be used to determine a patient's fitness level, generally expressed as metabolic equivalents (METs; one MET = 3.5 mL O_2 per kg per minute), and to define an appropriate range of exercise intensity.

The Exercise Prescription

The exercise prescription consists of three components: aerobic exercise, strength training, and balance and flexibility *(Table 4)*.[1]

Specific exercise recommendations for a given patient will depend on existing comorbidities and on the baseline level of physical activity. Initially, sedentary patients should begin at a very low level and gradually progress to a goal of moderate activity. Moderate activity can be defined using heart rate and $\dot{V}O_2$ max ranges, rating of perceived exertion, and MET charts for specific activities *(Table 5)*.[12] More simply, patients should exercise at the maximal intensity at which they are still able to comfortably carry on a conversation (the "talk test"). This may require some trial and error for patients. Warm-up and cool-down periods consisting of five to 10 minutes of less intense activity (e.g., slow walking, stretching) should be included to

TABLE 5
Activities Requiring Moderate Intensity Exercise*

Walking briskly (3 to 4 mph)
Cycling leisurely (≤10 mph)
Swimming with moderate effort
Doubles tennis
Golf—using a pull cart
Fishing—stand and cast
Canoeing leisurely (2 to 4 mph)
Mowing lawn with a power mower
Home repair, painting

mph = miles per hour

**—Moderate intensity defined as 3.0 to 6.0 metabolic equivalents or 4 to 7 kcal per minute and slightly lower (i.e., 2.5 to 5.5 metabolic equivalents) for older adults.*

Adapted with permission from Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA 1995;273:402-7.

decrease the risk of hypotension, and musculoskeletal and cardiovascular complications.

As in aerobic exercise, initially sedentary or irregularly active older adults beginning resistance training should start slowly and gradually advance the intensity of their training regimen. Patients should start with resistive bands/tubing, light weights (e.g., 2 lb hand weights or a can of food), or simple exercises such as repeatedly rising from a chair. Although health benefits are achievable with less intense training, significant strength gains require patients to train at an intensity in which they can complete 10 to 15 repetitions per set before reaching fatigue. Training needs to be progressively more intense with increasing weight to continue to derive additional strength gains and, possibly, to prevent the long-term loss of previous strength gains.[22]

The evidence for balance and flexibility training is inconclusive. Nevertheless, empiric evidence suggests that balance programs, such as repeatedly standing on one leg, can improve stability and decrease the risk of falls.[1] Deconditioned and sedentary elderly patients should be encouraged to improve their functional ability with strength and balance training before beginning aerobic exercise. A physical therapist can be helpful in identifying physical limitations and designing a specific exercise routine. Personal trainers or other athletic club personnel also may be helpful for relatively healthy patients who are already generally active. Trained geriatric exercise leaders are becoming increasingly common at health clubs and senior centers.

Exercise prescription for older adults consists of aerobic exercise, strength training, and balance and flexibility.

The complete exercise prescription, as demonstrated by the Activity Pyramid *(Figure 1)*, includes increased daily activities and regular aerobic, resistance, and balance exercises. Any exercise prescription, however, is a dynamic process that should be structured to fit an individual patient's current goals and comorbidities and be responsive to changes over time.

Promoting Physical Activity

In addition to helping patients to exercise safely, physicians also play an important role in promoting increased activity, especially in older patients.[23] The strength of physicians' advice is significantly correlated with the likelihood of adopting increased physical activity in older cardiac patients.[24]

There are many approaches to exercise promotion available for physicians. The "stages of change" model is often used to promote a range of positive behaviors.[25] Attempts to formalize this model for exercise promotion have met with moderate success.[26] Computer templates interacting directly with patients to create tailored messaging is a new focus, and several Web sites with specific exercise programs for adults are available. Many older patients, however, will require individualized counseling because of specific physical limitations, multiple comorbidities, or both.

The most successful compliance with long-term exercise is most likely achieved by

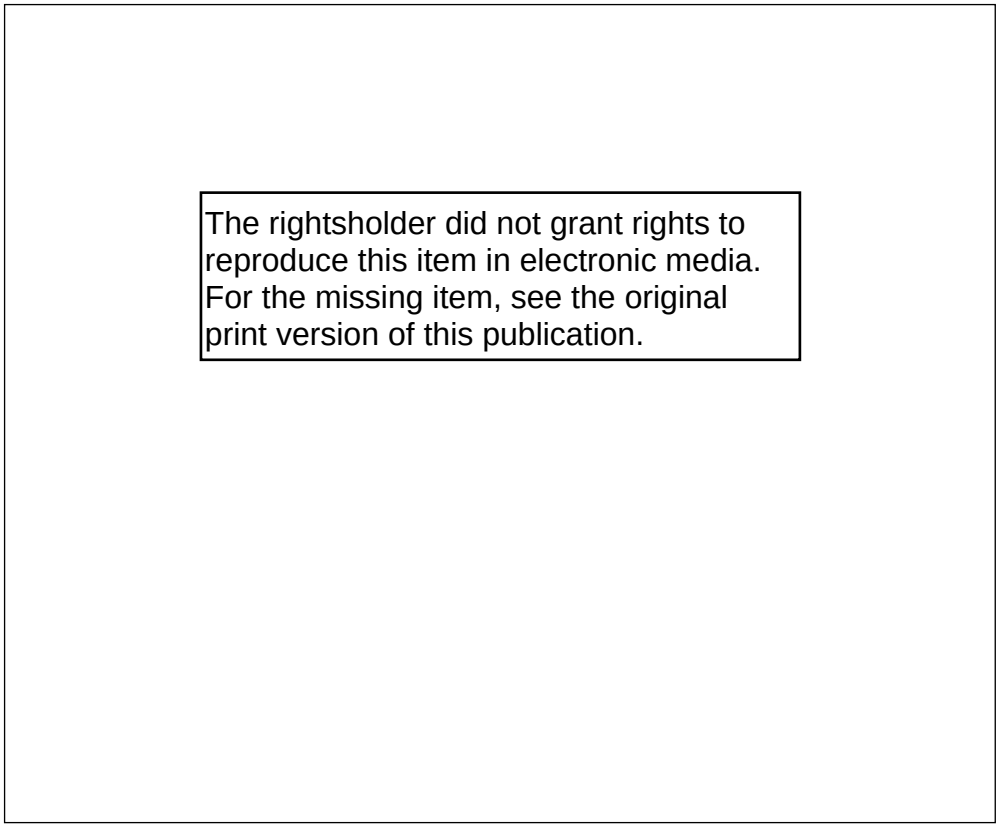

FIGURE 1. The Activity Pyramid.

identifying and overcoming barriers to activity, setting specific goals, recruiting spouse/family support, and providing positive reinforcement. Although this can be time consuming for family physicians, brief and repeated counseling has been shown to be highly effective.[27] Unfortunately, according to current Medicare guidelines, patient visits for exercise promotion are not reimbursable except as treatment for a specific disease or as part of a separate G-code visit. Some evidence exists, however, that exercise promotion is more effective when included as a part of counseling for a chronic disease.[8]

Overcoming Barriers to Exercise

Elderly patients face an array of personal, socioeconomic, and environmental barriers to exercise that are common to the general population, as well as barriers that are unique to the elderly *(Table 6)*.

One half of older adults cite musculoskeletal discomfort or disability as a reason for not exercising.[28] Decreasing exercise intensity and using a range of exercises can help avoid discomfort. It is often helpful to prescribe a range of exercise intensities that patients can match to their energy or functional level on any given day. Aquatic exercises limit the weight-bearing load while providing cutaneous assistance to proprioception. Cross-training, using a combination of activities, balances the risks and benefits of weight- and non–weight-bearing activities, uses a wider range of muscle groups, decreases the risk of overuse injury, and is less boring.

Habit is the single best predictor of inactivity across all age groups.[29] Older persons often must overcome a lifetime of ingrained behavior. Some older persons may be comfortable in a role of dependence and feel threatened by the charge of increased activity. Building on previous activities can help overcome the dominant influence of habit on activity levels. For example, patients may be encouraged to move the treadmill or stationary cycle in front of the television, or consider having a low step-aerobics box in the kitchen. An active lifestyle also has health benefits comparable with formal exercise regimens, but with improved rates of long-term compliance.[30]

Incorporating exercise into a prior routine

also makes it easier to remember, especially in very old and cognitively impaired persons. Exercises should be simple; any new skills will require specific instructions and repetition.

Self-efficacy—the confidence in one's ability to carry out a planned behavior—has been shown to be a predictor of stair-climbing ability, balance (i.e., risk of falling), and general functional decline in the elderly. In addition, it is also a strong predictor of exercise participation, especially in women.[31] Efficacy scores increase across the stages of change (i.e., patients become more confident of their abilities as their level of activity increases).[32] Patients with low self-efficacy should begin exercising with easily accomplished goals and receive frequent encouragement.

Despite the general lack of good exercise role models for older persons on television and through other media, societal norms are not predictive of intention to exercise. Exercise beliefs of family and close friends, however, are important influences. Education of significant others regarding the safety and benefit of exercise in older persons may be helpful.[29]

TABLE 6
Common Barriers to Exercise in Older Adults

Barrier	*Approach*
Self-efficacy	Begin slowly with exercises that are easily accomplished; advance gradually; provide frequent encouragement.
Attitude	Promote positive personal benefits of exercise; identify enjoyable activities.
Discomfort	Vary intensity and range of exercise; employ cross-training; start slowly; avoid overdoing.
Disability	Specialized exercises; consider personal trainer or physical therapist.
Poor balance/ataxia	Assistive devices can increase safety as well as increase exercise intensity.
Fear of injury	Balance and strength training initially; use of appropriate clothing, equipment, and supervision; start slowly.
Habit	Incorporate into daily routine; repeat encouragement; promote active lifestyle.*
Subjective norms	Identify and recruit influential others; education of patient and influential family/friends.
Fixed income	Walking and other simple exercises; use of household items; promote active lifestyle.
Environmental factors (e.g., inclement weather)	Walk in the mall; use senior centers; promote active lifestyle.
Cognitive decline	Incorporate into daily routine; keep exercises simple.
Illness/fatigue	Use a range of exercises/intensities that patients can match to their varying energy level.

**—Examples of an active lifestyle include using a golf pull cart while golfing, using a push mower, participating in activities such as stand and cast fishing or gardening, and taking the stairs.*

Additional Considerations

Physicians should match their advice to the patient's perception of how physical activity may be beneficial (e.g., weight loss, improved fitness, reduced coronary risk). Identify and focus on individual beliefs rather than on general health benefits. Help the patient set specific goals and avoid the discouragement of unrealistic expectations.

Understanding a patient's personality is also helpful. Whether patients are extroverted or introverted will greatly affect their compliance with a group exercise class versus a home program. As they become more functionally dependent, they often have less influence over when and how they exercise. This can be discouraging for those who have previously had a strong internal locus of control.[29]

For most patients, any additional activity beyond their current level will be beneficial. Patients should be encouraged to add to exercises that they are already performing such as climbing an additional flight of stairs or walking to a further light post or other distance marker each week. More frail elderly patients should increase intensity by adding hills, hand weights, or arm movements rather than increasing velocity.[1]

Finally, patients are more likely to do activities they consider enjoyable. They are also more likely to resume pleasurable activities following inevitable periods of relapse caused by illness, hospitalization, or travel. Social dancing, for example, is a great exercise and most nursing homes use games as a proxy for exercise. Patients can be helpful in designing their own exercise programs.

The authors thank Thomas L. Schwenk, M.D., professor and chair, Department of Family Medicine, University of Michigan, Ann Arbor, Mich., for his help in the preparation of the manuscript.

The authors indicate that they do not have any conflicts of interest. Sources of funding: none reported.

REFERENCES

1. American College of Sports Medicine Position Stand. Exercise and physical activity for older adults. Med Sci Sports Exerc 1998;30:992-1008.
2. Blair SN, Kohl HW 3rd, Paffenbarger RS Jr., Clark DG, Cooper KH, Gibbons LW. Physical fitness and all-cause mortality. A prospective study of healthy men and women. JAMA 1989;262:2395-401.
3. Vita AJ, Terry RB, Hubert HB, Fries JF. Aging, health risks, and cumulative disability. N Engl J Med 1998; 338:1035-41.
4. Dishman RK. Advances in exercise adherence. Champaign, Ill.: Human Kinetics, 1994:215.
5. Jones DA, Ainsworth BE, Croft JB, Macera CA, Lloyd EE, Yusuf HR. Moderate leisure-time physical activity: who is meeting the public health recommendations? A national cross-sectional study. Arch Fam Med 1998;7:285-9.
6. Laurie N. Healthy People 2010: setting the nation's public health agenda. Acad Med 2000;75:12-3.
7. Belardinelli R, Georgiou D, Cianci G, Purcaro A. Randomized, controlled trial of long-term moderate exercise training in chronic heart failure: effects on functional capacity, quality of life, and clinical outcome. Circulation 1999;99:1173-82.
8. Courneya KS, Mackey JR, Jones LW. Coping with cancer: can exercise help? Phys Sportsmed 2000;28(5):49-73.
9. King AC, Oman RF, Brassington GS, Bliwise DL, Haskell WL. Moderate-intensity exercise and self-rated quality of sleep in older adults. A randomized controlled trial. JAMA 1997;277:32-7.
10. Shephard RJ. Exercise and aging: extending independence in older adults. Geriatrics 1993;48(5):61-4.
11. Paffenbarger RS Jr., Hyde RT, Wing AL, Hsieh CC. Physical activity, all-cause mortality, and longevity of college alumni. N Engl J Med 1986;314:605-13.
12. Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA 1995;273:402-7.
13. Jette AM, Branch LG. The Framingham Disability Study: II. Physical disability among the aging. Am J Public Health 1981;71:1211-6.
14. Singh MA, Ding W, Manfredi TJ, Solares GS, O'Neill EF, Clements KM, et al. Insulin-like growth factor I in skeletal muscle after weight-lifting exercise in frail elders. Am J Physiol 1999;277(1 pt 1):E135-43.
15. Meredith CN, Frontera WR, O'Reilly KP, Evans WJ. Body composition in elderly men: effect of dietary modification during strength training. J Am Geriatr Soc 1992;40:155-62.
16. Pollock ML, Franklin BA, Balady GJ, Chaitman BL, Fleg JL, Fletcher B, et al. AHA Science Advisory. Resistance exercise in individuals with and without cardiovascular disease: benefits, rationale, safety, and prescription. Circulation 2000;101:828-33.
17. 26th Bethesda Conference: recommendations for determining eligibility for competition in athletes with cardiovascular abnormalities. January 6-7, 1994. Med Sci Sports Exerc 1994;26(10 suppl): S223-83.
18. Kasch FW, Phillips WH, Ross WD, Carter JE, Boyer JL. A comparison of maximal oxygen uptake by treadmill and step-test procedures. J Appl Physiol 1966;21:1387-8.
19. Rantanen T, Guralnik JM, Foley D, Masaki K, Leveille S, Curb JD, et al. Midlife hand grip strength as a predictor of old age disability. JAMA 1999;281:558-60.
20. Franklin BA, Whaley MH, Howley ET, eds. ACSM's guidelines for exercise testing and prescription. 6th ed. Baltimore: Lippincott Williams & Wilkins, 2000.
21. Evans WJ. Exercise training guidelines for the elderly. Med Sci Sports Exerc 1999;31:12-7.
22. Connelly DM, Vandervoort AA. Effects of detraining on knee extensor strength and functional mobility in a group of elderly women. J Orthop Sports Phys Ther 1997;26:340-6.
23. Stephens T. Fitness and lifestyle in Canada: a report. Ottawa: Fitness and Amateur Sport, 1983.
24. Ades PA, Waldmann M, McCann W, Weaver SO. Predictors of cardiac rehabilitation participation in older coronary patients. Arch Intern Med 1992; 152:1033-5.
25. Zimmerman GL, Olsen, CG, Bosworth MF. A 'stages of change' approach to helping patients change behavior. Am Fam Physician 2000;617: 1409-16.
26. Calfas KJ, Long BJ, Sallis JF, Wooten WJ, Pratt M, Patrick K. A controlled trial of physician counseling to promote the adoption of physical activity. Prev Med 1996;25:225-33.
27. Marcus BH, Goldstein MG, Jette A, Simkin-Silverman L, Pinto BM, Milan F, et al. Training physicians to conduct physical activity counseling. Prev Med 1997;26:382-8.
28. O'Neill K, Reid G. Perceived barriers to physical activity by older adults. Can J Public Health 1991; 82:392-6.
29. Shephard RJ. Determinants of exercise in people aged 65 years and older. In: Dishman RK, ed. Advances in exercise adherence. Champaign, Ill.: Human Kinetics, 1994:343-59.
30. Dunn AL, Marcus BH, Kampert JB, Garcia ME, Kohl HW 3rd, Blair SN. Comparison of lifestyle and structured interventions to increase physical activity and cardiorespiratory fitness: a randomized trial. JAMA 1999;281:327-34.
31. Biddle S, Goudas M, Page A. Social-psychological predictors of self-reported actual and intended physical activity in a university workforce sample. Br J Sports Med 1994;28:160-3.
32. Marcus BH, Simkin LR. The transtheoretical model: applications to exercise behavior. Med Sci Sports Exerc 1994;26:1400-4.