دانشگاه علوم پزشکی و خدمات
بهداشتی درمانی استان زنجان

Zanjan University of Medical Sciences

Department of Physical Education

1

Health -related physical fitness

Definitions of terms

What are the goals of physical education?

The goal of physical education is to develop physically literate individuals who have the knowledge, skills and confidence to enjoy a lifetime of healthful physical activity

What is defined as a sport?

Defines sport as "an athletic activity requiring skill or physical prowess". ... Oxford Dictionary defines sport as "an activity involving physical exertion and skill in which an individual or a team competes against another or others for entertainment

What are the skill related fitness?

The skill-related components of physical fitness include: power, speed, agility, coordination, balance, and reaction time

What is the health related fitness?

Health-related fitness (HRF) is theoretically defined as a multidimensional construct containing the components cardiorespiratory endurance, muscular strength, muscular endurance, flexibility and body composition

There are five areas of health related fitness. They are heart and lung endurance or cardiovascular endurance, muscular strength, muscular endurance, flexibility, and body composition.

Heart and lung endurance or cardiovascular endurance is the ability to exercise the entire body for long periods of time. It requires a strong heart, healthy lungs, and clear blood vessels to supply the body with oxygen.

Activities to improve fitness in this area include running, swimming and aerobic dance. A person must do the activity continuously for a minimum of ٢٠ minutes within their target heart rate zone. Endurance/cardiovascular activity should be done a minimum of ٣ days per week. Every other day is preferable. The mile or the pacer will measure fitness testing in this area.

Muscular Strength is the amount of force you can put forth with your muscles. It is often measured by how much weight you can lift. People with strength have fewer problems with backaches and can carry out their daily tasks efficiently. Examples of muscular strength include push-ups, weight lifting heavy weight with few repetitions, and pull-ups. Fitness testing will be measured by doing push-ups.

Muscular Endurance is the ability to use the muscles, which are attached to the bones, many times without getting tired. People with good muscular endurance are likely to have better posture, have fewer back problems, and be better able to resist fatigue than people who lack muscular endurance.

You can improve muscular endurance by lifting weights with many repetitions or doing sit-ups. Measuring the number of sit-ups you can do correctly is used for fitness testing.

Flexibility is the ability to use your joints fully. You are flexible when the muscles are long enough and the joints are free enough to allow movement.

People with good flexibility have fewer sore and injured muscles. Stretching before and after activities will help to improve flexibility. The sit-and-reach and the trunk lift are two tests used to measure flexibility.

Body Composition is the percentage of body weight that is fat compared to other body tissue, such as bone and muscle. People who have a high percentage of fat are more likely to be ill and have a higher death rate than lean people. Exercise and eating the right foods in the proper amounts can improve body composition. Body composition can be measured using an instrument called calipers, a specialized scale, or it can be calculated by using the body mass index (BMI) which uses height and weight to determine your BMI.

What is cardiorespiratory endurance?

Cardiorespiratory endurance is the level at which your heart, lungs, and muscles work together when you're exercising for an extended period of time.

What is sport safety?

Definition: Sporting activities can improve both the physical and mental health of children, teaching them to work with other children and improving their coordination and confidence. Safety precautions and equipment can be instrumental in preventing or lessening injuries from sporting activities

What are the safety measures in sports?

Take these five steps to prevent injuries so you can stay in the game:

Wear protective gear, such as helmets, protective pads, and other gear.

Warm up and cool down.

Know the rules of the game.

Watch out for others.

Don't play when you're injured

The definition of organized sports includes traditional team sports commonly acknowledged as well as other types of sports. Participation in organized sports provides the benefits of (١) physical activity, by engaging in vigorous exercise, achieving fitness, and learning athletic skills; (٢) socialization, by experiencing camaraderie and learning teamwork and sportsmanship; and (٣) competition, by challenging oneself to perform against others, by striving to continually improve oneself toward achieving one’s full athletic potential, and by learning to win and lose with grace and dignity.١ Organized sports participation, however, can result in the acquisition of a variety of infectious diseases and conditions. Physical contact among athletes, sharing of equipment (such as worn personal protective equipment or braces plus towels,

drinking vessels, showers, and locker rooms), and contact with athletic surfaces (mats, artificial turf, dirt, grass, and gym or weight room equipment) can all be responsible for transmission of infection.[٢–٩] In addition, certain organized sports carry specific additional risks; for example, wrestlers practicing in close quarters are especially vulnerable to skin infections.[١٠,١١]

Athletes should be taught proper personal hygiene (eg, hand-washing, showering, and proper laundering of uniforms and practice clothing on a daily or regular basis).[١٢–١٥] Avoidance of sharing of drinking vessels (water bottles, ladles, or cups), mouth guards, towels, braces, batting helmets, personal protective equipment, bars of soap, bath sponges, razors or electric hair shavers, and callus trimmers is also important in reducing infectious risk.[٢–٩] In addition, athletic programs should ensure regular (daily, weekly, and monthly) cleaning of facilities and equipment (eg, weight room, railings, mats, blocking dummies, locker rooms, and showers).[١٦–١٩] Those who manage sports programs and facilities should develop a plan for proper cleaning and maintenance of a sanitary sporting environment by using guidelines such as those published by the American College of Sports Medicine.[٢٠]

Special attention should be paid to proper management of blood and other body fluids.[٢١] Just as hospitals in the United States have concentrated on preventing hospital-associated infections in recent years, the same level of focus on infection prevention and control needs to be present within the organized sports community, including among athletes, parents, coaches, athletic directors, equipment managers, certified athletic trainers, administrators, janitorial staff, team physicians, facility managers, and league officials.

Although the primary care pediatrician may appear to be peripheral in this athletic milieu of organized sports, leadership from physicians has always been welcome and expected regarding issues of public health and safety. Furthermore, because pediatricians need to provide medical clearance to athletes to participate in organized sports, the preparticipation physical examination is an opportunity to verify that the athlete does not have a skin condition or infection that could be transmitted to others. This visit between the physician and the student athlete allows the primary care pediatrician to deliver anticipatory guidance. Ensuring that immunizations are current per recommendations of the Centers for Disease Control and Prevention, the Advisory Committee on Immunization Practices, and the American Academy of Pediatrics is important, and pediatric providers should identify and document cases in which vaccines are refused or incomplete because of medical exemptions (eg, serious allergy to a vaccine component). Coaches and trainers are primarily responsible for reviewing and stressing to the athlete the key hygiene behaviors needed to minimize the risk of obtaining or spreading infection in organized sports. However, primary care pediatricians can help reinforce such educational messages.

Before you jump on the elliptical machine or hit the running trails, consider doing a brief warmup first. And think about following your workout with a quick cool-down session. Sure, a warmup and cool-down may add a few minutes to your exercise routine, but they might also reduce stress on your heart and other muscles.

Why warm up and cool down

Warm ups and cool-downs generally involve doing your activity at a slower pace and reduced intensity.

Warming up helps prepare your body for aerobic activity. A warmup gradually revs up your cardiovascular system by raising your body temperature and increasing blood flow to your muscles. Warming up may also help reduce muscle soreness and lessen your risk of injury.

Cooling down after your workout allows for a gradual recovery of preexercise heart rate and blood pressure. Cooling down may be most important for competitive endurance athletes, such as marathoners, because it helps regulate blood flow. Cooling down doesn't appear to help reduce muscle stiffness and soreness after exercise, but more research is needed.

Although there's controversy about whether warming up and cooling down can prevent injuries, proper warmups and cool-downs pose little risk. Plus, they seem to give your heart and blood vessels a chance to ease into — and out of — an exercise session. So if you have the time, consider including a warmup and cool-down in your workout routine.

How to warm up

Warm up right before you plan to start your workout. In general, warm up by focusing first on large muscle groups, such as your hamstrings. Then you can do exercises more specific to your sport or activity, if necessary.

Begin by doing the activity and movement patterns of your chosen exercise, but at a low, slow pace that gradually increases in speed and intensity. This is called a dynamic warmup. A warmup may produce mild sweating, but generally won't leave you fatigued.

Here are some examples of warm-up activities:

- To warm up for a brisk walk, walk slowly for five to ١٠ minutes.
- To warm up for a run, walk briskly for five to ١٠ minutes.
- To warm up for swimming, swim slowly at first and then pick up the tempo as you're able.

How to cool down

Cooling down is similar to warming up. You generally continue your workout session for five minutes or so, but at a slower pace and reduced intensity.

Here are some examples of cool-down activities:

- To cool down after a brisk walk, walk slowly for five to ١٠ minutes.
- To cool down after a run, walk briskly for five to ١٠ minutes.
- To cool down after swimming, swim laps leisurely for five to ١٠ minutes.

If stretching exercises are part of your workout routine, it's best to do them after the warm-up or cool-down phase, when your muscles are already warm.

Stretching can improve flexibility and range of motion about a joint. Stretching may also help improve your performance in some activities by allowing your joints to move through their full range of motion. However, studies haven't consistently shown that stretching helps prevent muscle soreness or injury.

Be kind to your body

Finding time for regular aerobic workouts — plus warming up and cooling down — can be challenging. But with a little creativity, you can probably fit it in. For example, walking to and from the gym can be your warm up and cool-down.

Exercise Prescription

Exercise prescription commonly refers to the specific plan of fitness-related activities that are designed for a specified purpose, which is often developed by a fitness or rehabilitation specialist for the client or patient. Due to the specific and unique needs and interests of the client/patient, the goal of exercise prescription should be successful integration of exercise principles and behavioral techniques that motivates the participant to be compliant, thus achieving their goals. [١, ٢, ٣, ٤, ٥, ٦, ٧, ٨, ٩]

Components of exercise prescription

An exercise prescription generally includes the following specific recommendations:

- Type of exercise or activity (eg, walking, swimming, cycling)
- Specific workloads (eg, watts, walking speed)
- Duration and frequency of the activity or exercise session
- Intensity guidelines – Target heart rate (THR) range and estimated rate of perceived exertion (RPE)
- Precautions regarding certain medical (or other) concerns or related comments

Overview

Substantial data are available regarding the benefits of physical activity. [١, ٢, ٣, ٤, ٥, ٦, ٧] For primary preventative benefits, physical activity patterns should begin in the early school years and continue throughout an individual's life. Schools must specifically designate physical education programs with aerobic activities for children at early ages. Programs should include recreational sports (eg, running, dancing, swimming). Support at home for an active lifestyle for children helps to promote healthy physical activity patterns.

In the clinical setting, discuss physical activity and provide exercise prescriptions for patients and their families. In some instances, suggestions could be made about implementing physical activity recommendations at the work site.

Consider intensity, duration, frequency, mode, and progression in all types of physical activity programs. As children and adolescents become adults and discontinue the athletic endeavors of

school and college, primary prevention must include a plan for a lifetime of appropriate physical activity. Ideally, this activity should be performed for at least ٣٠-٦٠ minutes, ٤-٦ times weekly or ٣٠ minutes on most days of the week. The frequency, duration, and intensity of activity should be individualized (exercise prescription) to personal satisfaction, mode, and progression.

Subjects may use individual end points of exercise, such as breathlessness and/or a fatigue level ranging from somewhat hard to hard on the Borg perceived exertion scale (see Glossary of Terms, Borg rating of perceived exertion [RPE]). Standardized charts that designate heart rates may help by providing heart rate end points that can be measured immediately after exercise, but these are not necessary. Exercise should include aerobic activities, such as bicycling (stationary or routine), walk-jog protocols, swimming, and other active recreational or leisure sports. Shoes and clothing should be appropriate for extremes of heat, cold, and humidity.

Resistive exercises using free weights or standard equipment should be performed ٢-٣ times per week. These exercises should include ٨-١٠ exercise sets that consist of ١٠-١٥ repetitions per set (including arms, shoulders, chest, trunk, back, hips, and legs) and are performed at a moderate intensity. If free weights are used, ١٥-٣٠ lb is generally adequate or resistance that requires a perceived effort that is relatively hard (ie, an RPE ١٥-١٦). Resistive exercises tend to complement aerobic exercise in that some training effect is realized.[١٠] However, as adults age, development of muscle tone and strengthening of body musculature is more important.

The long-term effect of any physical activity program is affected by compliance. In today's mobile society, an exercise plan must include activities for business trips and vacations. Exercise facilities may not be convenient in such settings, which may mean improvising. For example, a walk-jogger should bring walking or running shoes and find a safe place to walk or run at a pace that approximates the usual activity level. Many hotels or motels have exercise facilities with a track or treadmill, exercise cycle, and weights, enabling travelers or others away from their usual routine to maintain an exercise program.

Physical activity measured in total time or kilocalories (kcal) or kilojoules (kJ) per week is appropriate and may be achieved with various combinations of scheduling, such as ١٠-١٥ minutes in the morning, at noon, and/or an afternoon/evening session. Many persons may schedule longer, less frequent periods of exercise. As intensity decreases, frequency and duration should increase and vice versa. The dosage or total energy (calorie) expenditure per week must be individualized (exercise prescription).

Persons with influenza syndromes or respiratory illnesses should decrease or stop exercise until they have recovered. If the recovery time is greater than ٢-٣ weeks, activity should be resumed at a lower level to compensate for the slight loss in training level. Maintenance of the cardiovascular training effects of exercise has been shown to be more related to the exercise intensity than to exercise frequency or duration. In other words, if the intensity is maintained, even though the exercise sessions are less frequent or shorter in duration, transient reductions in conditioning from the decreased exercise appears to be minimized.

Various exercise testing measures of functional capacity should be used in special populations but are not necessary for primary prevention. Traditionally, many athletically inclined persons

like to have periodic oxygen-uptake (VO_2) measurements to assess their level of training. Physical activity levels are associated with long-term peak oxygen uptake (VO_{2peak}). Highly active individuals have higher VO_{2peak} compared with individuals who are inactive, and modification of activity levels from low to high can lead to substantially higher VO^2_{peak} compared with continuing to have low activity levels. [11]

Additionally, one study developed a nonexercise model of cardiorespiratory fitness by assessing age, waist circumference, leisure time physical activity, and resting heart rate. This model proved to be fairly accurate in predicting VO^2_{peak} in a healthy population of both men and women, and it may be a valid means of assessing cardiorespiratory fitness in an outpatient setting. [12]

However, recent technologic advances have not only made cardiopulmonary (CPX) or metabolic (CMET) testing more commonplace among medical practices, but they have also become increasingly popular as a part of a routine physical and stress test evaluation, especially for individuals who are considered at high risk for cardiovascular disease (eg, those with hypertension, shortness of breath, chest discomfort, or abnormal blood lipid levels).

A lifestyle of physical activity from childhood throughout the adult years fosters health and longevity. Even brisk walking as a physical activity/exercise habit promotes health benefits. This is the simplest program for most individuals and has clear benefits. This improved state of health is enhanced by weight control, restricted intake of saturated fat and cholesterol, abstinence from cigarette smoking, and control of high blood pressure and glucose intolerance.

For patient education resources, visit the Public Health Center, as well as Walking for Fitness and Strength Training.

Benefits of Exercise

Routine exercise improves tissue VO_2 affects the following:

- Improves insulin sensitivity
- Improves glycemic control in persons with type 2 diabetes (and, hence, decreases overall mortality) [13]
- Decreases blood pressure
- Decreases low-density lipoprotein and triglyceride levels
- Increases high-density lipoprotein levels

Considerable data also support evidence that exercise may decrease the prevalence of colon cancer and endometrial cancer. Exercise also helps with osteoarthritis and obesity, as well as reportedly benefits persons with migraine headaches and fibromyalgia.

Middle-aged men and women who work in physically demanding jobs or perform moderate to strenuous recreational activities have fewer manifestations of coronary artery disease than their less active peers. Meta-analysis studies of clinical trials reveal that medically prescribed and supervised exercise can reduce mortality rates for persons with coronary artery disease. [1, 7, 14, 15, 16, 17, 18]

The results from one study noted that moderate-to-vigorous physical activity at least ٣ times per week was associated with lower risk of secondary cardiovascular disease (CVD) events in patients previously diagnosed with CVD. Researchers suggest improvement of metabolic and inflammatory risk markers as biological mechanisms. [١٩]

In a meta-analysis of ٣٣ studies that included almost ٢٠٠,٠٠٠ participants and cases, Kodama et al quantified the relationship between better cardiorespiratory fitness and lower rates of coronary heart disease (CHD) and CVD events, as well as deaths from all causes. [٢٠] When cardiorespiratory fitness was estimated as maximal aerobic capacity (MAC) expressed in metabolic equivalent (MET) units, a MAC of ≥٧.٩ METs was associated with substantially lower rates of CHD/CVD events and all-cause mortality. [٢٠]

Furthermore, categorization of cardiorespiratory fitness as low (< ٧.٩ METs), intermediate (٧.٩-١٠.٨ METs), or high (≥١٠.٩ METs) yielded risk ratios (RRs) for CHD/CVD in low-fitness participants of ١.٤٧ compared with intermediate-fitness participants and ١.٥٦ compared with high-fitness participants. The corresponding RRs for all-cause mortality in low-fitness versus intermediate-fitness participants was١.٤٠ and that of low-fitness versus high-fitness participants was ١.٧٠ (*P*< ٠.٠٠١). [٢٠]

Several studies suggest that relatively small amounts of physical activity show considerable reductions in mortality and improved health outcomes among participants when compared with sedentary control subjects. These findings imply that a minimal activity (ie, exercising once per week) may have positive health benefits even though fitness may not be measurably improved. Some authors have suggested that a threshold of physical activity may be necessary for maintaining optimal health and that future investigations should involve control subjects who participate in at least minimal activity levels rather than comparing exercise treatment groups to control subjects who are completely sedentary.

In addition to the physical benefits of exercise, both short- and long-term aerobic exercise training is associated with improvements in various indexes of psychologic functioning. Cross-sectional studies reveal that compared with sedentary individuals, active persons are more likely to be better adjusted, to perform better on tests of cognitive functioning, to exhibit reduced cardiovascular responses to stress, and to report fewer symptoms of anxiety and depression.

In one report, persons who increased their activity levels from ١٩٦٥-١٩٧٤ were at no greater risk for depression than those individuals who were active all along; however, persons who were active and became inactive were ١.٥ times as likely to become depressed by ١٩٨٣ compared with those who maintained an active lifestyle. Longitudinal studies have also documented significant improvement in psychologic functioning. Exercise training reduces depression in healthy older men and in persons with cardiac disease or major depression.

In a study of ١٥ patients with moderately advanced Parkinson disease who were put on a ١٦-week course of high-intensity exercise training, Kelly et all found that the patients experienced the following functional and clinical improvements: total body strength (+٣٠-٥٦٪); leg power (+٤٢٪); single leg balance (+٣٤٪); sit-to-stand motor unit activation requirement (-٣٠٪); ٦-min walk (+٤٣ m), Parkinson's Disease Quality of Life Scale (PDQ-٣٩, -٧.٨pts); Unified Parkinson's

Disease Rating Scale (UPDRS) total (-٥.٧ pts) and motor (-٢.٧ pts); and fatigue severity (-١٧٪). [٢١]

Exercise also improves self-confidence and self-esteem, attenuates cardiovascular and neurohumoral responses to mental stress, and reduces some type A behaviors. Although exercise training generally has not been found to improve cognitive performance, short bouts of exercise may have short-term facilitative effects.

Despite the positive physical and mental health benefits of exercise, long-term adherence to exercise programs remains problematic. Overall physical activity levels decrease with aging, in minority populations, in females, in disabled persons, and in those with chronic disease. Only an estimated ٥٠٪ of all persons who initiate an exercise program continue the habit for more than ٦ months. The issue of nonadherence is particularly important because exercise is only beneficial if it is maintained for extended periods. Thus, developing strategies to improve exercise initiation and adherence, especially for persons who are among the least active (eg, ٧٥٪ of black women; less educated, obese, elderly persons), is important. [٢٢, ٢٣, ٢٤, ٢٥, ٢٦, ٢٧]

Different Types of Exercise

Exercise has been defined as an activity for the express purpose of improving fitness or health. Physical activity includes all forms of activity (eg, occupational, recreational, sports-related) that are performed without the specific purpose of fitness or health. Different types of exercise are as follows:

- Aerobic (eg, walking, swimming)
- Anaerobic (eg, sprinting)
- Isotonic (eg, lifting weights)
- Resistance training: This involves providing some form of resistance to the contracting muscles to stimulate the body to increase strength. Multiple types of equipment are used for resistance training, including hand weights; cam machines; pulleys; and hydraulic, elastic, rubber, fiberglass, and magnetic equipment.
    - Strength or resistance training is very important to improve functionality and reduce the risk of injury. As people age, the lean tissue (ie, muscle) declines more from lack of use than from aging itself. Regularly performing some type of resistance training is imperative.
    - Because the demand on the heart is generally less during strength training than while walking at a moderate pace, resistance training is regarded as safe for patients with many heart conditions. Patients should never strain or hold their breath while attempting to lift something; straining can adversely affect blood flow to the heart.

General Guidelines

Resistance and repetitions

- Resistance: The appropriate resistance may be provided by hand weights, elastic resistance, calisthenics, or machines and should be no more than what one can lift for approximately ١٥-٢٠ repetitions. Perceived effort should only be moderate or somewhat hard.
- Repetition: A set is a group of repetitions, such as ٢ or ٣ sets of ١٥ repetitions. The number of sets depends on several factors, including time constraints, motivation, and personal goals. One to ٣ sets are adequate for strength development. Add ١ set per week, increasing up to ٣ sets.
- Progress: Progression can be made as one finds that the weight being used can be lifted more than ٢٠-٢٥ times. One should then increase the resistance slightly (eg, add ١-٥ lb) and resume the training. As one reaches muscle fatigue, more stimulation of the muscle tissue results in protein being added to the muscle groups. Significant strength changes generally occur within ٦ weeks.
- Other: Stretching should also be part of the exercise plan.

Type of exercise (mode)

- Intensity: This should range from low to moderate for healthy individuals.
- Duration: Continuous aerobic activity for ٢٠-٦٠ minutes is recommended.
- Frequency
    - Individuals with a less than a ٣-MET capacity should engage in multiple short sessions each day.
    - Individuals with a ٣- to ٥-MET capacity should engage in ١-٢ sessions per day.
    - Individuals with a greater than ٥-MET capacity should engage in ٣-٥ sessions per week.

Energy (caloric) expenditure

- Per-minute calculation: To calculate kilocalories per minute (kcal/min), multiply the METs times ٣.٥ times body weight in kilograms (kg) and divide by ٢٠٠ (ie, kcal/min = [METs × ٣.٥ × kg body weight]/٢٠٠). For example, the energy (caloric) expenditure of a ٧٠-kg individual at a prescribed ٦-MET capacity with a weekly goal of ١٠٠٠ per week is calculated as (٦ × ٣.٥ × ٧٠ kg)/٢٠٠, which equals ٧.٣٥ kcal/min (٣٠.٨٧ kJ/min). To convert kilocalories to kilojoules, note that ١ kcal = ٤.٢ kJ.
- Per-week calculation: This determines the exercise duration per week. Using the numbers from the example above, divide ١٠٠٠ kcal (٤٢٠٠ kJ) by ٧.٣٥ kcal/min (٣٠.٨٧ kJ/min), which equals ١٣٦ min/wk or approximately ٢٠-٣٠ minutes, ٦ d/wk.

Lifetime activities

- Vary the type of activity. Pick an activity that is enjoyable. The activity can be any type that uses most muscles, elevates the heart rate, and may be sustained for ٢٠ minutes or longer. For example, one may find stationary cycling boring but enjoy playing tennis or racquetball.

- Vary the duration and intensity within the guidelines. Some days, decrease the intensity of the activity but increase the duration. On other days, warm up and then increase the intensity to the upper range of the guidelines but decrease the duration.
- Contract with a friend (buddy system) or participate in group classes.
- Use music for rhythm. If an activity is boring, either change it or find another one that is enjoyable. For example, if one is stationary cycling, videos that show outdoor scenery are available. Also, new saddles are available that make cycling much more comfortable.
- Make exercising enjoyable by selecting at least ٢ activities that are enjoyable.
- Conditioning may be realized from many activities if applied correctly.
- Walk daily, whether one has a dog or not.

Selecting the right physical activities

See the list below:

- Select physical activities that are enjoyable, use most of the muscles, are rhythmic, and may be sustained for several minutes to an hour.
- Plan to exercise every other day until more adequately adapted to the activity.
- Think of the frequency, intensity, time, and type (ie, FITT) plan.
    - Frequency: This is how often per week one will perform the exercise. Plan on most days of the week.
    - Intensity: This is how hard one exercises. Moderate effort is appropriate.
    - Time: This is the duration of each session. Start off with as little as needed (١٠ min if necessary).
    - Type: This is the choice of physical activity, which can include recreational activities and domestic or occupational activities. A short list of each follows:
        - Recreational activities
        - -

          Participating in aerobic activity classes; performing calisthenics, gymnastics, low-impact aerobics, martial arts

        - -

          Backpacking, climbing hills, stair climbing, walking, hiking, orienteering, running

        - -

          Playing badminton, baseball, basketball, catch (eg, flying discs), cricket, handball, racquetball, lacrosse, rugby, shuffleboard, table tennis, tennis, volleyball, water polo

        - -

Body building, bowling, boxing, cycling, dancing, fencing, gardening, golfing, horseback riding, hunting, in-line skating, skating, rope skipping, skiing, snow shoeing, weight lifting, windsurfing

- -

Canoeing, sailing, scuba diving, swimming, fishing, participating in water activities

- Domestic or occupational activities – Cleaning windows, doing housework, mowing, packing and unpacking, plowing, sanding, sawing, sweeping, stocking shelves, pushing a wheelbarrow, performing yard work, etc

- Set goals, which may include those regarding health, improving physical capacity or performance.
- Motivation may be helpful for compliance. See the following tips:
  - Join a class or facility, or contract with a friend (buddy system).
  - Listen to one's body (eg, slowing down or skipping if tired or ill). Start at the present level to prevent soreness.
  - Exercise at the same time each day.
  - Make sure to have good-quality nutrition.
  - Make exercising a priority; scheduling a time benefits the individual.
  - Get advice if help is needed.

Exercise Prescription for Special Populations

Advanced age

- Maximum ventilatory perfusion (VQ) drops ٥-١٥٪ per decade in individuals aged ٢٠-٨٠ years. A lifetime of dynamic exercise maintains the individual's VQ at a level higher than that expected for any given age. The rate of decline in VQ is directly related to maintenance of the physical activity level, which emphasizes the importance of physical activity.
- Developing and maintaining aerobic endurance, joint flexibility, and muscle strength is important in a comprehensive exercise program, especially as people age. Elderly women and men show comparable improvement in exercise training, and adherence to training in elderly individuals is high.
- Resistance training exercise alone has only a modest effect on risk factors compared with aerobic endurance training, but resistance training does aid carbohydrate metabolism through the development or maintenance of muscle mass and effects on basal metabolism. Furthermore, resistance training is recommended by most health promotion organizations for its effects on maintenance of strength, muscle mass, bone mineral density, functional capacity, and prevention and/or rehabilitation of musculoskeletal problems (eg, low back pain).
- In elderly individuals, resistance training is both safe and beneficial in improving flexibility and quality of life. Persons with cardiovascular disease are usually asked to

refrain from heavy lifting and forceful isometric exercises, but moderate-intensity dynamic strength training is safe and beneficial in persons at low risk.

.

Exercise intensity is generally expressed as a percentage of either HR or VO_2. By definition, VO_2 is the oxygen uptake by an individual at rest or during exertion, expressed commonly in milliliters of oxygen consumed per kilogram body weight per minute (mL/kg/min)

Heart rate reserve (HRR) is defined as the maximal heart rate (HR_{max}) observed during a symptom-limited exercise stress test minus the resting heart rate (HR rest). A percentage of the HRR range is added to the HR rest to determine a target heart rate (THR) range to be used during exercise. This approach accounts for individual variability in the HR rest and better reflects the peak exercise oxygen consumption (VO_{2max}). VO_{2max} reflects the highest rate of oxygen consumption that one can achieve.

Oxygen uptake reserve (VO_2 R) is the difference between resting and maximal VO_2. Previous guidelines suggest exercise prescriptions should be based on the oxygen uptake reserve (VO_2 R) rather than a direct percentage of the VO_{2max}.[٣٧] Exercise intensities based on VO_2 R are approximately equal to the same percentage values for HRR; therefore, the use of HRR in determining appropriate exercise intensities is suitable in most cases. However, certain exceptions to using this approach may include patients with poor chronotropic responses, dysautonomia, pacemakers, or heart transplantation.

Target heart rate (THR) for exercise is generally recommended from ٥٠٪ to ٨٥٪ HRR (or VO_2 R). For deconditioned individuals, ٤٠-٥٠٪ HRR may be more appropriate for beginning exercise, whereas physically active individuals may require higher intensities to achieve improvements in their conditioning. As an illustration in determining THR, the example below uses a resting HR (RHR) of ٧٠ and a HR_{max} of ١٨٠ bpm.

The HRR is ١٨٠ – ٧٠, or ١١٠ bpm. Using an average intensity of ٦٠-٨٠٪ HRR, the THR ranges are calculated (Karvonen approach) as follows:

THR = (HRR × ٦٠٪) + RHR;

THR = (١١٠ × ٠.٦٠) + ٧٠ = ١٣٦ bpm

to

(١١٠ × ٠.٨٠) + ٧٠ = ١٥٨ bpm

So, a THR range would be ١٣٦-١٥٨ bpm or a pulse count of ٢٢-٢٦ beats per ١٠ seconds.

Metabolic equivalents (METs) are useful units when recommending exercise. By definition, ١ MET is the amount of oxygen consumed at rest or about ٣.٥ mL/kg/min. However, recent studies indicate that the average resting MET level in subjects with coronary heart disease is ٢٣٪ to ٣٦٪

lower than the ٣.٥ mL/kg/min standard value. [٣٨] Nevertheless, most people walking ٢ mph require ٢ METs, and ٣ mph require ٣-٤ METs. Published MET tables describe many activities in terms of the estimated MET requirements. For example, if an individual has a $VO_{٢max}$ of ٣٤ mL/kg/min, the $VO_٢$ R is ٣٤ minus the resting $VO_٢$ of ٣.٥ mL/kg/min equals ٣٠.٥ mL/kg/min. Dividing this result by ٣.٥ yields ٨.٧ METs. Using ٦٠-٨٠٪ $VO_٢$ R, the recommended range of exercise METs may be determined by the following:

(٨.٧ × ٠.٦٠) + ١.٠ (resting) = ٦.٢ METs

to

(٨.٧ × ٠.٨٠) + ١.٠ (resting) = ٨ METs

When one consults a common MET table, an exercise intensity of ٦.٢-٨.٠ METs is equivalent to a slow walk-jog combination exercise, hiking with a backpack, hill climbing, and numerous other moderately vigorous activities.

Exercise intensity may be customized to the individual (exercise prescription) based upon their metabolic response to progressive exercise if the $VO_{٢max}$ and the **anaerobic threshold (AT)** or **ventilatory threshold (VT)** is determined. By definition, the VT may be described as the level of oxygen consumption ($VO_٢$) at which a significant increase in anaerobiosis occurs, as evidenced by an increase in blood lactate levels and respiratory responses to the increasing exercise workload. MET is a unit of energy or level of oxygen used at rest (١ MET = $VO_٢$ of ٣.٥ mL/kg/min).

Exercise intensity refers to how much energy is expended when exercising. Perceived intensity varies with each person. It has been found that intensity has an effect on what fuel the body uses and what kind of adaptations the body makes after exercise. Intensity is the amount of physical power (expressed as a percentage of the maximal oxygen consumption) that the body uses when performing an activity. For example, exercise intensity defines how hard the body has to work to walk a mile in ٢٠ minutes.[١]

Measures of Intensity

Heart Rate is typically used as a measure of exercise intensity.[٢] Heart rate can be an indicator of the challenge to the cardiovascular system that the exercise represents.

The most precise measure of intensity is oxygen consumption ($VO_٢$). $VO_٢$ represents the overall metabolic challenge that an exercise imposes. There is a direct linear relationship between intensity of aerobic exercise and $VO_٢$. Our maximum intensity is a reflection of our maximal oxygen consumption ($VO_٢$ max). Such a measurement represents a cardiovascular fitness level.[٣]

$VO_٢$ is measured in METs (mL/kg/min). One MET, which is equal to ٣.٥ ml/kg per minute, is considered to be the average resting energy expenditure of a typical human being. Intensity of

exercise can be expressed as multiples of resting energy expenditure. An intensity of exercise equivalent to ٦ METs means that the energy expenditure of the exercise is six times the resting energy expenditure.[٤]

Intensity of exercise can be expressed in absolute or relative terms. For example, two individuals with different measures of VO_2 max, running at ٧ mph are running at the same absolute intensity (miles/hour) but a different relative intensity (% of VO_2 max expended). The individual with the higher VO_2 max is running at a lower intensity at this pace than the individual with the lower VO_2 max is.[٥]

Some studies measure exercise intensity by having subjects perform exercise trials to determine peak power output,[٦] which may be measured in watts, heart rate, or (on a cycle) average cadence (cycling). This approach attempts to gauge overall workload.

Intensity Levels

Exercise is categorized into three different intensity levels. These levels include low, moderate, and vigorous and are measured by the metabolic equivalent of task (aka metabolic equivalent or METs). The effects of exercise are different at each intensity level (i.e. training effect). Recommendations to lead a healthy lifestyle vary for individuals based on age, weight, and existing activity levels. "Published guidelines for healthy adults state that ٢٠-٦٠ minutes of medium intensity continuous or intermittent aerobic activity ٣-٥ times per week is needed for developing and maintaining cardiorespiratory fitness, body composition, and muscular strength."[٧]

Physical Activity	MET
Light Intensity Activities	**< ٣**
sleeping	٠.٩
watching television	١.٠
writing, desk work, typing	١.٨
walking, ١.٧ mph (٢.٧ km/h), level ground, strolling, very slow	٢.٣
walking, ٢.٥ mph (٤ km/h)	٢.٩
Moderate Intensity Activities	**٣ to ٦**
bicycling, stationary, ٥٠ watts, very light effort	٣.٠
walking ٣.٠ mph (٤.٨ km/h)	٣.٣
calisthenics, home exercise, light or moderate effort, general	٣.٥
walking ٣.٤ mph (٥.٥ km/h)	٣.٦
bicycling, <١٠ mph (١٦ km/h), leisure, to work or for pleasure	٤.٠
bicycling, stationary, ١٠٠ watts, light effort	٥.٥
Vigorous Intensity Activities	**> ٦**
jogging, general	٧.٠

calisthenics (e.g. pushups, situps, pullups, jumping jacks), heavy, vigorous effort	٨.٠
running jogging, in place	٨.٠
rope jumping	١٠.٠

Fuel Used

The body uses different amounts of energy substrates (carbohydrates or fats) depending on the intensity of the exercise and the heart rate of the exerciser. Protein is a third energy substrate, but it contributes minimally and is therefore discounted in the percent contribution graphs reflecting different intensities of exercise. The fuel provided by the body dictates an individual's capacity to increase the intensity level of a given activity. In other words, the intensity level of an activity determines the order of fuel recruitment. Specifically, exercise physiology dictates that low intensity, long duration exercise provides a larger percentage of fat contribution in the calories burned because the body does not need to quickly and efficiently produce energy (i.e., adenosine triphosphate) to maintain the activity. On the other hand, high intensity activity utilizes a larger percentage of carbohydrates in the calories expended because its quick production of energy makes it the preferred energy substrate for high intensity exercise. High intensity activity also yields a higher total caloric expenditure.[^]

This table outlines the estimated distribution of energy consumption at different intensity levels for a healthy ٢٠-year-old with a Max Heart Rate (MHR) of ٢٠٠.

Intensity (%MHR)	Heart Rate (bpm)	% Carbohydrate	% Fat
٦٥-٧٠	١٣٠-١٤٠	١٥	٨٥
٧٠-٧٥	١٤٠-١٥٠	٣٥	٦٥
٧٥-٨٠	١٥٠-١٦٠	٦٥	٣٥
٨٠-٨٥	١٦٠-١٧٠	٨٠	٢٠
٨٥-٩٠	١٧٠-١٨٠	٩٠	١٠
٩٠-٩٥	١٨٠-١٩٠	٩٥	٥
١٠٠	١٩٠-٢٠٠	١٠٠	-

These estimates are valid only when glycogen reserves are able to cover the energy needs. If a person depletes glycogen reserves after a long workout (a phenomenon known as "hitting the wall") or during a low carbohydrate diet, the body will shift into ketosis and use mostly fat and muscle for energy. Intermittent fasting can be used to train the body to shift easily into ketosis.

The ١٢-minute run fitness test was developed by Kenneth Cooper, M.D., in ١٩٦٨١ as an easy way to measure aerobic fitness and provide an estimate of VO٢ max for military personnel. The Cooper test, as it's also known, is still used today as a field test for determining aerobic fitness.

Dr. Cooper found that there is a very high correlation between the distance someone can run (or walk) in ١٢ minutes and their VO٢ max value, which measures the efficiency with which someone can use oxygen while exercising. This test is still one of the basic fitness tests used by the military.

It is also used by many coaches and trainers to determine cardiovascular fitness and track fitness over time. This simple test also allows you to compare your cardiovascular endurance with others of your age and gender.

What Is Cardiovascular Endurance?

In sports, cardiovascular endurance refers to an athlete's ability to sustain prolonged exercise for minutes, hours, or even days. Endurance testing is a way to measure the efficiency of an athlete's circulatory system and respiratory system in supplying oxygen to the working muscles and support sustained physical activity.

Endurance generally refers to aerobic endurance. Aerobic exercise requires oxygen to help supply the energy needed for exercise. The objective of endurance training, then, is to develop and improve the body systems that produce and deliver the energy needed to meet the demands of prolonged activity.٢

How to Perform the ١٢-Minute Run Test

The Cooper ١٢-minute run test requires the person being tested to run or walk as far as possible in a ١٢ minute period. The objective of the test is to measure the maximum distance covered by the individual during the ١٢-minute period١ and is usually carried out on a running track by placing cones at various distances to enable measuring of the distance.

A stopwatch is required for ensuring that the individual runs for the correct amount of time. Here are some factors to keep in mind when performing the Cooper ١٢-minute run test:

- **Distance**: Record the total number of miles or kilometers you traveled in ١٢ minutes.
- **Equipment**: You'll need a timer to know when ١٢ minutes are up. Note that some running watches and fitness monitors have a ١٢-minute fitness test mode.
- **Location**: This test is designed to be conducted on a track with clearly marked distance. You can perform the test on a treadmill, but be sure to raise the incline to one degree to simulate outdoor running.
- **Safety**: This is a strenuous fitness test and it's recommended that you have your physician's clearance before performing this test on your own.
- **Speed**: When you are warmed up, get going. Run or walk as far as you can in ١٢ minutes.

- **Warm-Up**: Perform a short warm-up of ١٠ to ١٥ minutes of low to moderately strenuous activity before performing any fitness testing.

Calculate Your ١٢-Minute Run Test Results

To calculate your estimated VO٢ Max results (in ml/kg/min) use either of these formulas:

- **Kilometers**: VO٢max = (٢٢.٣٥١ x kilometers) - ١١.٢٨٨
- **Miles**: VO٢max = (٣٥.٩٧ x miles) - ١١.٢٩١

The easiest way to get your test results (your VO٢ max score) and compare yourself with others of your age and sex is with an online ١٢-minute test results calculator.

After you complete the test, you can compare your results to the norms and recommendations for your age and sex.

١٢-Minute Run Fitness Test Results

Instead of using the calculation and getting your VO٢ max, you can use the distance you achieved to find how you rate.

Age	Excellent	Above Average	Average	Below Average	Poor
Male ٢٠-٢٩	over ٢٨٠٠ meters	٢٤٠٠-٢٨٠٠ meters	٢٢٠٠-٢٣٩٩ meters	١٦٠٠-٢١٩٩ meters	under ١٦٠٠ meters
Females ٢٠-٢٩	over ٢٧٠٠ meters	٢٢٠٠-٢٧٠٠ meters	١٨٠٠-٢١٩٩ meters	١٥٠٠-١٧٩٩ meters	under ١٥٠٠ meters
Males ٣٠-٣٩	over ٢٧٠٠ meters	٢٣٠٠-٢٧٠٠ meters	١٩٠٠-٢٢٩٩ meters	١٥٠٠-١٩٩٩ meters	under ١٥٠٠ meters
Females ٣٠-٣٩	over ٢٥٠٠ meters	٢٠٠٠-٢٥٠٠ meters	١٧٠٠-١٩٩٩ meters	١٤٠٠-١٦٩٩ meters	under ١٤٠٠ meters
Males ٤٠-٤٩	over ٢٥٠٠ meters	٢١٠٠-٢٥٠٠ meters	١٧٠٠-٢٠٩٩ meters	١٤٠٠-١٦٩٩ meters	under ١٤٠٠ meters
Females ٤٠-٤٩	over ٢٣٠٠ meters	١٩٠٠-٢٣٠٠ meters	١٥٠٠-١٨٩٩ meters	١٢٠٠-١٤٩٩ meters	under ١٢٠٠ meters
Males ٥٠	over ٢٤٠٠ meters	٢٠٠٠-٢٤٠٠ meters	١٦٠٠-١٩٩٩ meters	١٣٠٠-١٥٩٩ meters	under ١٣٠٠ meters
Females ٥٠	over ٢٢٠٠ meters	١٧٠٠-٢٢٠٠ meters	١٤٠٠-١٦٩٩ meters	١١٠٠-١٣٩٩ meters	under ١١٠٠ meters

Resources for further reading

Balady GJ, Williams MA, Ades PA, et al. Core components of cardiac rehabilitation/secondary prevention programs: ٢٠٠٧ update: a scientific statement from the American Heart Association Exercise, Cardiac Rehabilitation, and Prevention Committee, the Council on Clinical Cardiology; the Councils on Cardiovascular Nursing, Epidemiology and Prevention, and Nutrition, Physical Activity, and Metabolism; and the American Association of Cardiovascular and Pulmonary Rehabilitation. Circulation. ٢٠٠٧ May ٢٢. ١١٥(٢٠):٢٦٧٥-٨٢. [Medline]. [Full Text].

Talbot LA, Morrell CH, Fleg JL, Metter EJ. Changes in leisure time physical activity and risk of all-cause mortality in men and women: The Baltimore Longitudinal Study of Aging. Prev Med. ٢٠٠٧ Aug-Sep. ٤٥(٢-٣):١٦٩-٧٦. [Medline].

Taylor NF, Dodd KJ, Shields N, Bruder A. Therapeutic exercise in physiotherapy practice is beneficial: a summary of systematic reviews ٢٠٠٢-٢٠٠٥. Aust J Physiother. ٢٠٠٧. ٥٣(١):٧-١٦. [Medline]. [Full Text].

The President's Council on Physical Fitness and Sports. Physical activity and health. A report of the Surgeon General, US Department of Health and Human Services, Center for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion. Centers for Disease Control and Prevention. Available at http://www.cdc.gov/nccdphp/sgr/sgr.htm. Accessed: September ١٢, ٢٠٠٧.

American College of Sports Medicine. ACSM's Guidelines for Exercise Testing and Prescription. ٧th ed. Philadelphia, Pa: Lippincott Williams & Wilkins; ٢٠٠٦.

American College of Sports Medicine. ACSM's Resource Manual for Guidelines for Exercise Testing and Prescription. ٥th ed. Philadelphia, Pa: Lippincott, Williams & Wilkins; ٢٠٠٦.

Fletcher GF, Balady G, Blair SN, et al. Statement on exercise: benefits and recommendations for physical activity programs for all Americans. A statement for health professionals by the Committee on Exercise and Cardiac Rehabilitation of the Council on Clinical Cardiology, American Heart Association. Circulation. ١٩٩٦ Aug ١٥. ٩٤(٤):٨٥٧-٦٢. [Medline]. [Full Text].

Hoffmann TC, Maher CG, Briffa T, Sherrington C, Bennell K, Alison J, et al. Prescribing exercise interventions for patients with chronic conditions. CMAJ. ٢٠١٦ Apr ١٩. ١٨٨ (٧):٥١٠-٨. [Medline].

Phillips D. Exercise Prescriptions for Chronic Conditions: A How-to Guide. Medscape Medical News. Available at http://www.medscape.com/viewarticle/٨٦٠٧٣٣. March ٢٢, ٢٠١٦; Accessed: June ١٦, ١٩٧٩.

Knuttgen HG. Strength training and aerobic exercise: comparison and contrast. J Strength Cond Res. ٢٠٠٧ Aug. ٢١(٣):٩٧٣-٨. [Medline].

Aspenes ST, Nauman J, Nilsen TI, Vatten L, Wisløff U. Physical Activity as a Long Term Predictor of Peak Oxygen Uptake: The HUNT-Study. Med Sci Sports Exerc. ٢٠١١ Feb ٢٨. [Medline].

Nes BM, Janszky I, Vatten LJ, Nilsen TI, Aspenes ST, Wisløff U. Estimating V?O٢peak from a Nonexercise Prediction Model: The HUNT Study, Norway. Med Sci Sports Exerc. ٢٠١١ Nov. ٤٣(١١):٢٠٢٤-٢٠٣٠. [Medline].

Jeon CY, Lokken RP, Hu FB, van Dam RM. Physical activity of moderate intensity and risk of type ٢ diabetes: a systematic review. Diabetes Care. ٢٠٠٧ Mar. ٣٠(٣):٧٤٤-٥٢. [Medline]. [Full Text].

Laukkanen JA, Rauramaa R, Salonen JT, Kurl S. The predictive value of cardiorespiratory fitness combined with coronary risk evaluation and the risk of cardiovascular and all-cause death. J Intern Med. ٢٠٠٧ Aug. ٢٦٢(٢):٢٦٣-٧٢. [Medline].

Smith SC Jr, Allen J, Blair SN. AHA/ACC guidelines for secondary prevention for patients with coronary and other atherosclerotic vascular disease: ٢٠٠٦ update endorsed by the National Heart, Lung, and Blood Institute. J Am Coll Cardiol. ٢٠٠٦ May ١٦. ٤٧(١٠):٢١٣٠-٩. [Medline]. [Full Text].

Wenger NK, Froelicher ES, Smith LK, et al. Cardiac rehabilitation as secondary prevention. Agency for Health Care Policy and Research and National Heart, Lung, and Blood Institute. Clin Pract Guidel Quick Ref Guide Clin. ١٩٩٥ Oct. ١٧:١-٢٣. [Medline]. [Full Text].

Smith SC Jr, Blair SN, Criqui MH, et al. Preventing heart attack and death in patients with coronary disease. Circulation. ١٩٩٥ Jul ١. ٩٢(١):٢-٤. [Medline].

Health and Public Policy Committee, American College of Physicians. Cardiac rehabilitation services. Ann Intern Med. ١٩٨٨ Oct ١٥. ١٠٩(٨):٦٧١-٣. [Medline].

Hamer M, Ingle L, Carroll S, Stamatakis E. Physical activity and cardiovascular mortality risk: possible protective mechanisms?. Med Sci Sports Exerc. ٢٠١٢ Jan. ٤٤(١):٨٤-٨. [Medline].

Kodama S, Saito K, Tanaka S, et al. Cardiorespiratory fitness as a quantitative predictor of all-cause mortality and cardiovascular events in healthy men and women: a meta-analysis. JAMA. ٢٠٠٩ May ٢٠. ٣٠١(١٩):٢٠٢٤-٣٥. [Medline].

Kelly NA, Ford MP, Standaert DG, Watts RL, Bickel CS, Moellering DR, et al. Novel, high-intensity exercise prescription improves muscle mass, mitochondrial function, and physical capacity in individuals with Parkinson's disease. J Appl Physiol (١٩٨٥). ٢٠١٤ Mar ١. ١١٦(٥):٥٨٢-٩٢. [Medline]. [Full Text].

Dugan SA. Exercise for health and wellness at midlife and beyond: balancing benefits and risks. Phys Med Rehabil Clin N Am. ٢٠٠٧ Aug. ١٨(٣):٥٥٥-٧٥, xi. [Medline].

Myers J, Hadley D, Oswald U, et al. Effects of exercise training on heart rate recovery in patients with chronic heart failure. Am Heart J. ٢٠٠٧ Jun. ١٥٣(٦):١٠٥٦-٦٣. [Medline].

Deruelle F, Nourry C, Mucci P, et al. Optimal exercise intensity in trained elderly men and women. Int J Sports Med. ٢٠٠٧ Jul. ٢٨(٧):٦١٢-٦. [Medline].

Blair SN, Kohl HW ٣rd, Barlow CE, et al. Changes in physical fitness and all-cause mortality. A prospective study of healthy and unhealthy men. JAMA. ١٩٩٥ Apr ١٢. ٢٧٣(١٤):١٠٩٣-٨. [Medline].

Lee IM, Hsieh CC, Paffenbarger RS Jr. Exercise intensity and longevity in men. The Harvard Alumni Health Study. JAMA. ١٩٩٥ Apr ١٩. ٢٧٣(١٥):١١٧٩-٨٤. [Medline].

Coats AJ, Adamopoulos S, Radaelli A, et al. Controlled trial of physical training in chronic heart failure. Exercise performance, hemodynamics, ventilation, and autonomic function. Circulation. ١٩٩٢ Jun. ٨٥(٦):٢١١٩-٣١. [Medline]. [Full Text].

Zainuldin R, Mackey MG, Alison JA. Prescription of Walking Exercise Intensity From the ٦-Minute Walk Test in People With Chronic Obstructive Pulmonary Disease. J Cardiopulm Rehabil Prev. ٢٠١٤ Jun ٣٠. [Medline].

Mendes R, Sousa N, Almeida A, Subtil P, Guedes-Marques F, Reis VM, et al. Exercise prescription for patients with type ٢ diabetes-a synthesis of international recommendations: narrative review. Br J Sports Med. ٢٠١٥ Dec ٣٠. [Medline].

Duncombe D, Skouteris H, Wertheim EH, et al. Vigorous exercise and birth outcomes in a sample of recreational exercisers: a prospective study across pregnancy. Aust N Z J Obstet Gynaecol. ٢٠٠٦ Aug. ٤٦(٤):٢٨٨-٩٢. [Medline].

Kramer MS, McDonald SW. Aerobic exercise for women during pregnancy. Cochrane Database Syst Rev. ٢٠٠٦. ٣:CD٠٠٠١٨٠. [Medline].

Clapp JF ٣rd. Exercise during pregnancy. A clinical update. Clin Sports Med. ٢٠٠٠ Apr. ١٩(٢):٢٧٣-٨٦. [Medline].

Clapp JF ٣rd, Simonian S, Lopez B, Appleby-Wineberg S, Harcar-Sevcik R. The one-year morphometric and neurodevelopmental outcome of the offspring of women who continued to exercise regularly throughout pregnancy. Am J Obstet Gynecol. ١٩٩٨ Mar. ١٧٨(٣):٥٩٤-٩. [Medline].

Clapp JF ٣rd. A clinical approach to exercise during pregnancy. Clin Sports Med. ١٩٩٤ Apr. ١٣(٢):٤٤٣-٥٨. [Medline].

Fortner RT, Pekow PS, Whitcomb BW, Sievert LL, Markenson G, Chasan-Taber L. Physical activity and hypertensive disorders of pregnancy among Hispanic women. Med Sci Sports Exerc. ٢٠١١ Apr. ٤٣(٤):٦٣٩-٤٦. [Medline].

Chomistek AK, Chiuve SE, Jensen MK, Cook NR, Rimm EB. Vigorous physical activity, mediating biomarkers, and risk of myocardial infarction. Med Sci Sports Exerc. ٢٠١١ Oct. ٤٣(١٠):١٨٨٤-٩٠. [Medline].

Swain DP, Leutholtz BC. Heart rate reserve is equivalent to %VO٢ reserve, not to %VO٢max. Med Sci Sports Exerc. ١٩٩٧ Mar. ٢٩(٣):٤١٠-٤. [Medline].

Savage, PD; Toth, MJ and Ades, PA. A re-examination of the metabolic equivalent concept in individuals with coronary heart disease. Journal of Cardiopulmonary Rehabilitation and Prevention. May-Jun/ ٢٠٠٧. ٢٧:١٤٣-١٤٨. [Medline].

Brockie J. Exercise for women in the early postmenopausal years. J Br Menopause Soc. ٢٠٠٦ Sep. ١٢(٣):١٢٦-٧. [Medline].

Marles A, Legrand R, Blondel N, et al. Effect of high-intensity interval training and detraining on extra VO٢ and on the VO٢ slow component. Eur J Appl Physiol. ٢٠٠٧ Apr. ٩٩(٦):٦٣٣-٤٠. [Medline].

Suleman A, Sung BH, Ajmal M, et al. Caffeine and its effects on the heart: facts, myths, and controversies [no longer available online]. Life and Medical Sciences Online (Wiesbaden, Germany). ٢٠٠٠ Apr. ١:

Yoon BK, Kravitz L, Robergs R. VO٢max, protocol duration, and the VO٢ plateau. Med Sci Sports Exerc. ٢٠٠٧ Jul. ٣٩(٧):١١٨٦-٩٢. [Medline].