ESA

Exercise Prescription: An Overview

Table of Contents

Introduction

The ability to prescribe exercise encompasses the successful amalgamation of exercise science with behavioural approaches in a manner that results in long-term program compliance and attainment of the client's objectives.

In contrast to the areas of chemistry or physics, exercise physiology and behavioural sciences are sometimes less precise. We often cannot precisely compute physiological or psychological responses as various factors and confounders can affect the outcome.

These include age, physical and environmental settings, sex, previous experiences, genetics, and nutrition. When developing an exercise prescription, you should follow the fundamental recommendations provided by appropriate organisations. In doing so, you can aid in producing the required response both during a specific exercise training session and over the course of multiple repeated bouts of exercise training.

It is vital that you keep in mind, that not all individuals respond as envisaged, particularly those with a chronic illness. For instance, individuals with coronary artery disease may need adjustment of exercise intensity because they experience myocardial ischemia above a particular heart rate. Moreover, those presently undergoing cancer treatment often fatigue quickly and may better tolerate recurrent training sessions of reduced length. There are assorted reasons for modifying an exercise prescription in certain individuals including:

- Variance in physiological and perceptual responses to an exercise training session.
- Variance in the quantity and rate of exercise training responses.
- Differences in goals between clients.
- Variance in behavioural changes relative to the exercise prescription.

Each of the above reasons should be deliberated for both the initial development and subsequent review of the exercise prescription. A customised exercise prescription should not be considered sufficient unless it is appraised for effectiveness over time. As a rule, an individual's exercise prescription should be reassessed weekly until its boundaries appear to be safe as well as acceptable for improving health-related behaviours and elected physiological indexes.

The Purpose of the Exercise Prescription

As we are fully cognizant of all physical activity whether daily (e.g., occupational, household) or purposeful (i.e., exercise training performed to improve physical fitness)—has a positive effect on a range of health conditions. Routine exercise can diminish disease-related symptoms, develop functional capacity, and improve disease-related outcomes.

To that end, this module provides the minimal information an exercise specialist instructor (ESI) requires to develop and implement a safe and effective exercise prescription, using methods and exercise-comparable training principles, whether recommending exercise for a high-performance athlete or a client with a clinically manifest disease.

Firstly, it is essential to review modernised physical activity recommendations. A strong body of evidence shows that both single and repeated bouts of physical activity or exercise promote improvement in transitional risk factors (e.g., blood pressure, insulin sensitivity), mood, sleep, executive function, quality of life, and health (e.g., longevity, fall risk).

Although increasing an individual's weekly energy expenditure provides significant benefits, the target range is 150 to 300 minutes of moderate-intensity physical activity per week, a level nearly half the U.K. adult population does not currently achieve. Additionally, it has been stated that 30% of the population reports doing no moderate to vigorous activity.

Despite the usage of the term prescription, the development of an exercise prescription does not essentially need authorisation by a medical professional. In certain circumstances, however, it may be when the prescription is developed for a client with a clinically apparent disorder. For instance, a doctor's approval and a signature may be necessary to secure reimbursement from medical care for a client partaking in an ESI who feels approval is justified to limit individual liability. An ESI who is responsible for developing an exercise prescription regularly find that doing so is an art and a science; first, they must possess the essential knowledge and skills required to put into action a prescription that is safe, effective, and practical.

The main purpose of the exercise prescription is to deliver a valid and specific guide to help individuals attain health and physical fitness outcomes. The exercise prescription should be specific to the type of clinical population. Various authoritative organisations have distributed recommendations on prescribing exercise in certain populations, including healthy people and those with coronary artery disease, osteoporosis, hypertension, and diabetes, as well as senior individuals. The exercise prescription can also address the five health-related components of physical fitness:

- **Cardiorespiratory (aerobic) endurance:** the ability of the cardiorespiratory system to distribute oxygen to functional skeletal muscles during prolonged submaximal exercise and the capability of the skeletal muscles to use oxygen through aerobic metabolic pathways.
- **Muscular skeletal strength:** peak ability to generate force. Force may be advanced by isometric, dynamic, or isokinetic contractions.
- **Muscular skeletal endurance:** the ability to generate a submaximal force for a prolonged period.
- **Flexibility:** the ability of a joint or series of joints to move through their full range of motion.
- **Body composition:** the comparative percentage of fat and non-fat masses that compose total body weight.

Each of these components of physical fitness is associated with at least one facet of health, and each component is positively influenced by exercise training, for example reducing the risk of suffering a primary or secondary chronic disease. The typical benefits of consistent exercise training have been listed below:

- Improved cardiorespiratory and musculoskeletal fitness.
- Improved metabolic, endocrine, and immune function.
- Reduced all-cause mortality.

- Reduced risk of cardiovascular disease.
- Reduced risk of certain cancers (colon, breast).
- Reduced risk of osteoporosis and osteoarthritis.
- Reduced risk of non-insulin-dependent diabetes mellitus.
- Improved glucose metabolism.
- Reduced risk of obesity
- Overall improved health-related quality of life.
- Reduced risk of falling.
- Improved sleep patterns.

Three key tenets must be contemplated in the development of an exercise prescription:

- Specificity of training
- Progressive overload
- Reversibility

The ESI must also consider various qualities of an individual's psychosocial condition, including elements that may be pertinent to the beginning and adhering to an exercise training program.

Exercise Training Sequence

An inclusive exercise training program should comprise flexibility, resistance, and cardiorespiratory (aerobic) exercises. The order of the exercise training bout can be critical for well-being, safety, and effectiveness; equally, scientific evidence on this subject is still deficient. Before engaging in aerobic or resistance exercise training, clients should perform a minimum of 4-to-5 minutes of gradual full-body activity such as walking, cycling, or swimming. This will increase metabolic and bioenergetic activity within, and distribution to the active skeletal muscles, and increase the body temperature overall and within the muscle and muscle-tendon unit.

After the elevation in the body's metabolic responses (i.e., 1st phase warm-up), aerobic or resistance training, and flexibility exercises can be implemented to improve the client's range of motion. In a clinical population setting, if aerobic training and resistance training take place on the same day, the best method is to initially perform the activity that is the focus of that day's training.

Goal Setting

The inclusive exercise prescription should consider the goals that are exclusive for each client. Typical client-centred goals include the following:

- Improving appearance.
- Improving the quality of life.
- Managing body weight.
- Preparing for a sports competition.
- Improving the client's general health specifically to reduce the risk for primary or manifestation of disease.
- Reducing the burden of a chronic disease or condition (early fatigue, rehospitalization, depression, loss of personal control, economic hardship).

Individuals with certain syndromes repeatedly have objectives that relate directly to regressing or reducing the development of their illness and its side effects or the side effects of the treatments used to manage the disorder. An ESI must have a full understanding of how to modify the typical exercise prescription to provide the client with the greatest possible success in attaining their desired outcome. Equally, the ESI should help evaluate whether the identified goals are realistic and discuss them with clients when they are not.

Principles of Exercise Prescription

To increase the potential benefits of exercise training, irrespective of the area of importance (i.e., cardiorespiratory, strength, muscular endurance, body composition, range of motion, etc), respective principles should be considered; these are reviewed next.

Specificity of Training

Long-standing adaptations in physiological functioning transpire in direct response to a chronic or recurring series of stress stimuli. The principle of specificity of exercise training states that these physiologic alterations and adaptations are specific to the cardiorespiratory, neurological, and muscular responses that are called upon to accomplish the exercise activity. Specifically, the distinctive neuromuscular firing sequences and the cardiorespiratory responses that are engaged to perform an activity are the ones that experience the greatest degree of adaptation. For example, if a 1500 metre runner wants to do all he can to improve his performance, he should spend much of his training time running middle and longer distances; this type of training stress and combines (i) the cardiorespiratory processes concerned in the passage and use of oxygen with (ii) the firing of the neurons used during running at a higher velocity. In contrast, an Olympic weightlifter should not spend any of his practice time engaged in distance running and instead engage in explosive movement-specific activities and techniques.

Questions to Ask a Client When Developing an Exercise Program

Training Specificity

- *What are your specific goals when performing exercise (health, fitness, performance)?*
- *Do you want to exercise more?*
- *Do you want to be able to do more activities of daily living?*
- *Do you want to perform something that you currently cannot? If yes, describe.*

Mode

- *What types of exercise or activity do you like the best?*
- *Do you already have any exercise equipment in your home?*

- *What types of exercise do you like the least?*

Frequency

- *Do you know how many days per week of exercise or physical activity are needed for you to reach your goals?*
- *How many days during a week do you have 30 to 60 min for exercise?*

Intensity

- *Do your goals include optimal improvement of your fitness level or are your goals primarily related to your health?*
- *Do you have any musculoskeletal conditions that would limit how hard or often you can exercise?*

Time

- *What is the best time of the day for you to exercise?*
- *Can you arouse earlier on some days or take 30 to 40 minutes at mealtime for exercise?*

A typical example of specificity of training would be if we assessed an individual's peak oxygen uptake (O_2) on the treadmill one day and then repeated it on a stationary cycle the next day. We know that for this individual, O_{2peak} will be 5% to 15% higher on a treadmill vs. a cycle ergometer. Most of this variance is related to the weight independence linked with sitting on a cycle and the smaller total muscle mass used during cycling vs. running on the treadmill. Conversely, if this trial was repeated with well-trained competitive cyclists, there may be a comparable peak O_2 uptake regardless of whether assessed on the cycle or the treadmill.

This observation among well-trained cyclists is attributable to them spending nearly all their training time cycling and therefore, their physiologic adaptations are specific in response to such training specificity. Some crossover adaptations are likely to transpire from one training mode to another, partly due to the result of a combination of enhancements in both central cardiac function (e.g., increased stroke volume and cardiac output) and engaging the skeletal muscles used in the alternate exercise mode (e.g., training the leg muscles by cycling and then using many of those same leg muscles when running), which is the general foundation for the notion of cross-training.

Progressive Overload

The principle of progressive overload refers to the association between the magnitude of the exercise dose or stimulus and the benefits gained. Generally, an increase in the volume of exercise (to a degree) relates to greater improvements in health and fitness; however, there seems to be a level of exercise past which benefits plateau or feasibly diminish. For example, in the Harvard Alumni Health Study, an evident dose-response relationship was detected between all-cause death and the number of kilocalories expended each week. The findings suggested that for between 500 and 3,500 Kcal expended each week, the risk for mortality reduced as the kilocalories expended increased (**Figure 1**).

Please observe the rather sharp reduction in deaths between the energy expenditures of 500 and 1,500 kcal/week, suggesting that even trivial to modest increases in weekly energy expenditure provide important health outcomes.

Overload refers to an increase in total work above what is typically completed on a day-to-day basis. For instance, when an individual performs walking as part of an exercise training program to improve their fitness, the pace and duration for one or both parameters should be above what they normally experienced daily. Progressive overload is the gradual increase in the volume or intensity of work performed in response to the continual adaptation of the body to the work.

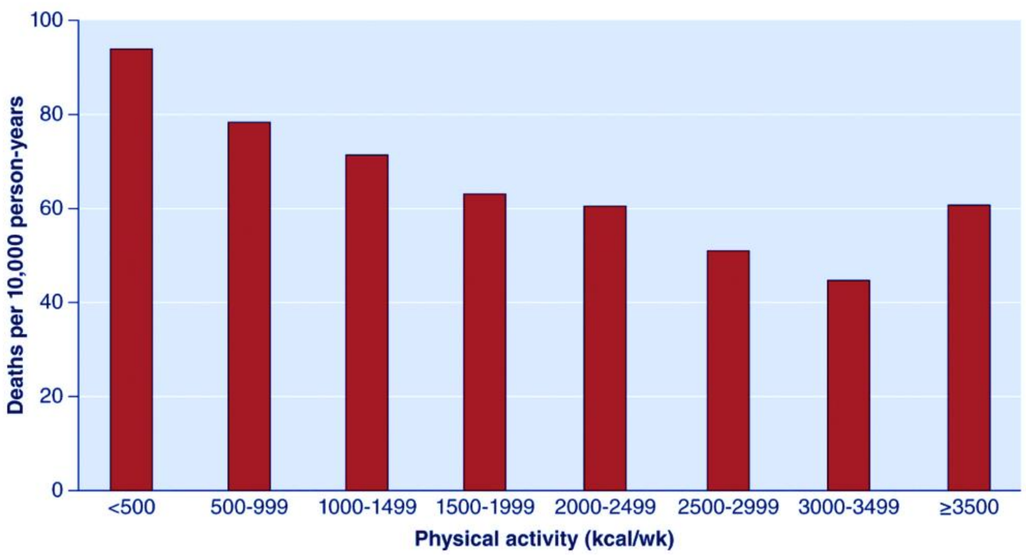

Figure 1: Paffenbarger et al., dose–response relationship between all-cause death and weekly energy expenditure (kcal/week) among Harvard alumni.

Applying the progressive overload principle to a client's walking program would require increasingly walking more often, farther, or at a faster pace. Overload is frequently expressed using the **FITT principle**, in which the **FITT-VP** acronym stands for **Frequency, Intensity, Time** (i.e., duration), **Type, Volume, and Progression of exercise**.

We must understand how these training parameters can be pooled together to quantify the total volume (the **V** in the **FITT-VP** acronym) of exercise a client engages in. While kilocalories per week can be used, as shown in **Figure 1**, other standard units for conveying total exercise volume are MET-min/week and MET-hour/week, where MET is defined as metabolic equivalents of task and 1 MET approximates a resting O_2 of 3.5 $mL{\cdot}kg^{-1}{\cdot}min^{-1}$. For instance, a 50-year-old client who square-dances at a moderate pace (~4 METs) for 40 minutes three times a week engages in 480 MET-min/week (4 × 40 × 3 = 480) or 8 MET-h/week (480 MET-min/week divided by 60 min/hour = 8 MET-h/week). Although it is often difficult to use MET-min or MET-h/week to prescribe exercise to clients, this unit of measurement is useful when comparing approximations of exercise volume across academic studies or recommendations for public health. Contemporary public health recommendations are that all adults engage in at least 8 MET-h/week of exercise.

Regarding exercise progression (the **P** in the **FITT-VP** acronym), mainly for the client who has not consistently exercised before, frequency and duration of activity are usually increased first to anticipated levels. Then, as tolerated by the client, intensity is increased. Concerning cardiorespiratory fitness, Gormley and colleagues reported that when the volume of exercise is controlled, exercise training at greater exercise intensities is related to greater gains in fitness.

Frequency

Frequency is the number of times an exercise bout or physical activity is performed (per day or per week).

Intensity

The intensity of exercise or physical activity refers to either the quantitatively measured work or the subjectively determined level of effort performed by the client. Typical objective measures of work that are essential to the ESI include heart rate, oxygen uptake (O_2 or METs), caloric expenditure (kilocalories [kcal] or joules [J]), mass or weight lifted (kilograms, pounds), and power output (kilograms per minute [$kg \cdot min^{-1}$] or watts [W]). The anaerobic, lactate or ventilatory thresholds may also be used to establish exercise intensity, but they are often impractical during exercise training in the medical setting.

The subjective level of effort can be assessed through (i) a verbal announcement from the client when performing the exercise activity (e.g., “I’m tired” or “This is easy”), (ii) the talk test (i.e., fastest pace achievable while still able to conduct a verbal exchange), or (iii) a standardised scale (e.g., Borg rating of perceived exertion). Regarding the Borg scale, the client must be trained in the correct use of this assessment tool to attain accurate indications of perceived effort.

Duration

Duration (the first **T** in the **FITT** acronym) refers to the quantity of time that is spent engaging in exercise or physical activity. For example, during aerobic-styled exercise training, the duration (e.g., 30 minutes or more) is accrued without interruption (often termed continuously) or with reduced rest periods. However, the Surgeon General’s report (1996) on physical activity and health included a key recommendation for exercise and better health. It stated that all children and adults should accrue a minimum of 30 minutes of moderate physical activity on most and preferably all days of the week. That suggests that 30 minutes of exercise can be achieved in a single continuous session (e.g., one 30-minute session of walking) or accumulated during the day (e.g., three 10 minutes bouts of walking, or one 15 min bout of stationary cycling plus one 15 min bout of stationary rowing).

Compared with the continuous approach, the discontinuous (i.e., accumulative) model seems to also improve cardiorespiratory fitness, improve blood pressure values, decrease frailty risk, and lower risk for all-cause mortality, with its effect on body composition, obesity, blood lipids, and blood glucose. The discontinuous model may be more attractive for currently inactive individuals endeavouring to become more physically active or for clients with low fitness levels.

Reversibility

Usually, with an 8 to 12-week period of physical training, most untrained individuals can anticipate a 10% to 30% improvement in O_{2peak} and work capacity, and a 25% to 30% increase in muscular strength; inactive individuals usually achieve gains at a quicker rate and to a greater relative degree than more active people. Changes in additional physiological variables, such as body weight and blood pressure, may take an additional amount of time. Sustaining these improvements involves a minimal volume of exercise training, and the reversibility principle defines the loss of these attained gains due to inactivity.

The reversal of physical fitness due to inactivity or an increased sedentary lifestyle is frequently termed deconditioning (or detraining) and is in addition to any loss of fitness with ageing. Regarding cardiorespiratory fitness and detraining, Saltin and associates reported on the effects of bed rest over 3 weeks in five subjects. The mean O_{2peak} decreased by 28% at week 3, and all subjects had reductions in peak cardiac output caused by reduced stroke volumes. This adverse trend was reversed when exercise training was again applied (so-called retraining). A further study supported the findings of Saltin et al. Coyle et al., (1984) observed the effects of seven subjects who exercised for 10 to 12 months and then engaged in 3 months of detraining. The authors observed a decrease in O_{2peak} by 7% between days 0 and 12 of detraining and by another 7% between days 21 and 56. The initial 7% reduction in O_{2peak} was the outcome of a near-equal 9% reduction in stroke volume, with the following reduction mainly due to a decline in arteriovenous oxygen difference.

The complete loss of exercise-related muscle strength and endurance adaptations transpires after only a few weeks to months of physical inactivity. A reduction in resistance training volume without a complete termination of physical training does, however, aid with the maintenance of much of the gained resistance training effects.

Regarding the degree of loss of flexibility or range of motion (ROM) with detraining or inactivity, various factors are involved including injury, specific individual physiology, amount of overall inactivity, and posture. The restoration of a flexibility training program (i.e., retraining) normally results in a fast regain of ROM.

Cardiorespiratory (Aerobic) Endurance

Exercise training to develop cardiorespiratory, or aerobic, endurance requires that the client perform physical activities that use large muscle groups and are continuous, repetitive, or rhythmic. Acceptable modes of exercise that involve large muscle groups include walking, running, cycling, stair climbing, skipping, and group aerobics (e.g., dance, step, cycling, and aquatics).

Exercises using predominantly the arms are more constrained but include upper body cycle ergometry, dual-action stationary cycling using only the arms, and wheelchair ambulation. Various modes of exercise using both the arms and legs include rowing, swimming, and exercise on some form of stationary apparatus (e.g., dual-action [arm and leg] cycles, stationary rowers, cross-country skiing, elliptical trainers, seated dual-action steppers).

Specificity of Training

The common benefits achieved from performing aerobic exercise seem to be independent of any individual type or means of training. For example, the Harvard Alumni Health Study suggested that males who were physically active and had a high weekly caloric expenditure, irrespective of mode, had a lower occurrence of all-cause mortality than those who were less active (**Figure 1**). A proceeding study of the Harvard alumni archive indicated that amongst those already active or exercising, the all-cause mortality rate is lower in those who perform higher-intensity exercises compared to those who perform less vigorous activity. Collectively, these studies indicate that a certain type of physical activity is less significant for general mortality benefits than the volume and intensity of the physical activity.

Progressive Overload

To derive benefits from cardiorespiratory training, people must follow the principle of progressive overload, which involves the appropriate application of frequency, intensity, and duration (or time).

Frequency

For the increase of the client's cardiorespiratory fitness, a physical activity frequency of at least 5 d/week of moderate-intensity exercise training, at least 3 d/week of vigorous-intensity training, or a mixture of 3-to-5 d/week is suggested. This frequency of exercise is sufficient to stimulate increases in cardiorespiratory fitness. Exercise completed one or two times per week at a moderate to vigorous intensity may induce improvements in health and fitness, particularly if each session is performed for a long duration (e.g., 60 minutes).

Relative to improving cardiorespiratory fitness, studies have suggested that exercising > 3 d/week may not be time efficient for the nonathlete with limited time. Moreover, a classical study by Sidney and colleagues (1972) found that if total exercise volume was held constant, there was no difference in O_{2peak} for those subjects who exercised 3 versus 5 d/week. That said, exercising 5 or more d/week may play a positive role by increasing total caloric expenditure, optimizing health improvements, and reducing all-cause mortality rates.

Intensity and Duration

Intensity and duration of exercise are frequently interdependent regarding the overall cardiorespiratory exercise loading and physiological adaptations. Normally, the greater the intensity [effort] of an exercise training session, the shorter the duration, and vice versa. The range of the intensity and duration for a given client should focus on various factors, including the current cardiorespiratory conditioning level of the person, the presence of underlying chronic disorders (such as COPD and cancer), CAD, chronic heart failure, or obesity; the risk of an adverse event; and the client's goals.

To attain a sufficient exercise training response, most individuals must exercise at an intensity between 50% and 85% of their oxygen uptake reserve (O_{2R}, calculated as O_{2peak} – O_{2rest}) for the cardiorespiratory system to be suitably stimulated to adapt and for the clients, the aerobic capacity to increase. In individuals with a clinically evident syndrome and suffering from evident deconditioning (e.g., those currently undergoing cancer treatment), improvements in aerobic fitness may be observed with training intensities as low as 40% of O_{2R}.

Typically, the lower an individual's baseline physical fitness level, the lower the necessary intensity level to generate preliminary adaptations. The upper-level intensity for continuous training for presently active, healthy individuals who want to improve O_{2peak} can be set as high as 90% of O_{2R}. This upper ceiling might be considered the threshold between optimal gains in fitness and increased risk of orthopaedic injury or adverse cardiovascular events. However, training at too high an intensity level may be excessively

Various influential groups suggest a minimum of 30 minutes of moderate exercise per exercise session (≥150 min/week), or 15 to 20 minutes per exercise session if a more vigorous exercise program (≥75 min/week) is applied. These recommended training durations can be accrued in one continuous exercise session or sessions of 10 minutes or more during the day. Like training at an exercise intensity < 40% of O_{2R}, in clients suffering from noticeable deconditioning, starting with shorter exercise durations of just 5 to 10 min/d will probably be appropriate to improve fitness and health initially.

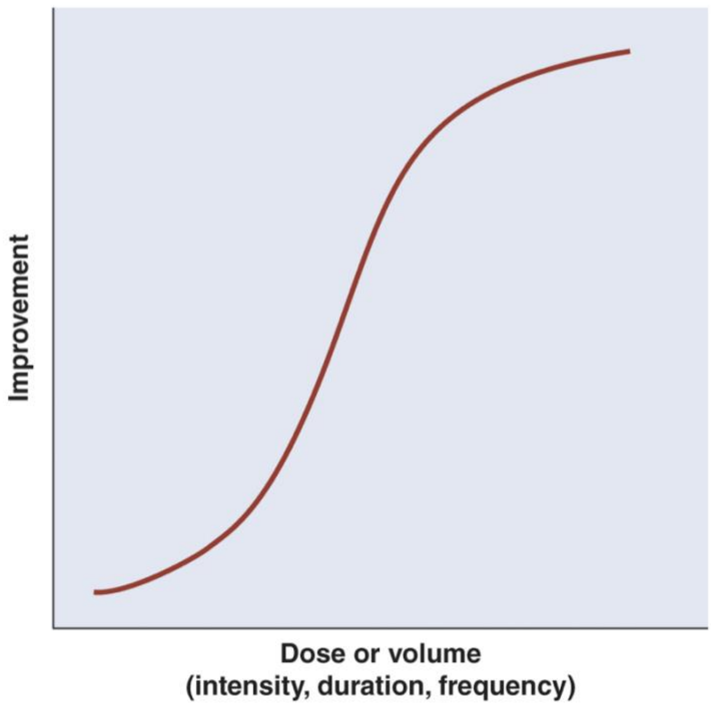

Figure 2. Associations between exercise volume or dose and physiological improvement (e.g., O_2, resting HR). it is important to consider that both the initial and terminal segments of the curve are relatively level, signifying that very low and high volumes of exercise are related to relatively mild improvements.

Figure 2 above provides a reference point to much of the conversation regarding the frequency, duration, and intensity of exercise training intended at improving cardiorespiratory fitness. It can be observed that among very physically fit individuals (e.g., athletes) that train > 7 times per week, more exercise is related to continuous development, but the degree of the improvements begins to reduce (see the upper flat segment of **Figure 2**). For these people, even small improvements in fitness are valued and may be enough to progress from their previous best performance.

Equally, although other individuals with a chronic disorder who are poorly fit can experience an increase in fitness from training only 2 d/week, in general, a low dose of exercise is not related to much improvement (see the lower flat segment of **Figure 2**). Consequently, most health and fitness groups have specified that three sessions per week are the minimum number of sessions required. A 3 d/week training frequency may be, therefore, necessary if the intensity of effort is vigorous, whereas a 5 d/week routine may be required for a moderate-intensity training program.

Another method typically applied to prescribe exercise safely, particularly in clients with a chronic disease, is a rating of perceived exertion (RPE). Normally, for aerobic-type activities, an RPE between 12 and 16 on the 6 to 20 scale is used to guide exercise intensity. Additionally, the RPE during exercise testing that is related to a subsequent prescribed training HR range can help the clinician to establish whether the client can attain and tolerate that level of intensity during exercise training. The ESI must understand that variances may occur when the mode of assessment varies from the mode of training (e.g., the client was evaluated on a cycle ergometer but walks on the treadmill for exercise training).

Muscle Strength and Endurance

Resistance training develops an individual's muscular strength, and power, and diminishes levels of muscular fatigue. The definition of muscular strength is the maximum ability of a muscle to generate force or tension. The definition of muscular power is the maximum ability to employ a force or tension per a specified unit of time.

Conventional resistance training normally includes both eccentric (lengthening) and concentric (shortening) segments of movement across a set of repetitions, with the importance of improving the concentric phase. Generally, the emphasis of a resistance training program should be on the primary (agonist) muscle groups. Correct movement mechanics and technique is critical to reducing the risk of injury and increasing the effectiveness of an exercise. Typical recommendations include some of the following:

- Move the load lifted through the range of motion unless otherwise stated.
- Breathe out (exhale) during the concentric phase and breathe in (inhale) during the eccentric phase.
- Do not allow weights to “crash down” before beginning the next lift (i.e., always control the eccentric phase of the lift).

In the clinical populations, it may be sensible for the ESI to follow these general recommendations:

- Monitor blood pressure before and after a resistance training bout and intermittently during a session.
- Involve (where possible) the same exercise professional who helped with the client’s initial orientation and evaluation with regular reviews of movement technique.
- Consistently evaluate the client for signs and symptoms of exercise intolerance during resistance training (e.g., excessive fatigue, decreased ability to maintain similar or increasing workloads, light-headedness).

Resistance exercises should be structured and arranged so that large muscle groups are stimulated first and smaller groups afterwards. If smaller muscle groups are engaged first (i.e., those linked with fine motor control movement), the large muscle groups may become fatigued earlier when they are used.

In circuit-style resistance training, the client completes a sequence of planned exercises and then repeats the first exercise to begin another circuit. Such an approach is a valid method (to conventional resistance training) to increase muscle strength and may also improve adherence in middle-aged and senior clients.

Resistance training, like other types of exercise training, can be broad or focused (e.g., for well-trained athletes) which results in the specific adaptations that different populations seek. A typical resistance training program for clients with a chronic disorder is more than necessary to increase muscle strength and endurance. Circuit programs that integrate both aerobic and resistance training are a standard method of adding a cardiorespiratory stimulus to a resistance training program. However, although strength increases have been reported, improvement in cardiorespiratory fitness may be only mild to moderate at best.

Specificity of Training

Resistance training for developing specific muscles should adhere to a lifting schedule that closely mirrors the metabolic profile or muscular actions in which increases in muscular fitness are required. Since the components of muscle fitness are connected, any type of resistance training program will provide several benefits in each part of muscular fitness (i.e., strength, power, endurance). The resistance training program for general health should focus on dynamic exercises involving concentric and eccentric muscle actions that recruit multiple muscle groups and target the main muscle groups of the chest, shoulders, back, hips, legs, midsection, and arms.

Progressive Overload

Resistance training programs that appropriately load the eccentric phase of movement are an effective stimulus for increasing muscle mechanical function and the muscle-tendon unit. Eccentric muscle training has been applied to enhance athletic performances that entail speed, power, and strength. However, for the special population client pursuing general or overall muscular fitness, the ACSM and the American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) advocate conventional resistance training, which focuses on improving concentric strength. Regarding training repetitions, the ACSM recommends 8 to 12 repetitions per set, while the AACVPR recommends 10 to 15. Generally, the greater the overload, the greater the improvement, however, disproportionate, and prolonged overload can lead to deteriorating performance or increased risk of skeletal muscle injury.

Frequency

Various studies suggest that optimum improvements are when clients engage in resistance training 1 to 3 d/week, which supports the 2 or 3 d/week recommendation from the ACSM and AACVPR when executing a conventional or circuit resistance training plan. There is limited evidence that considerable improvements are achieved from performing resistance exercises on > 3 d/week.

Intensity and Duration

Resistance training intensity is critical in deciding the load or overload placed on the muscular system to change. For improvements in muscular strength and endurance, the resistance should be at 40% to 60% of an individual's one-repetition maximum (1RM), with progression up to 70% or 80% of 1RM for leg exercises in particular clients. An alternative approach is to lift at an intensity that can be established at an RPE of 11 to 13. Another method is to prescribe 8RM to 12RM, such that the client is at or near maximal exertion at the end of these repetitions. However, please note that this level of resistance may be too strenuous for some clinical conditions. The RM for the client can be determined using either a direct or an indirect method.

The total training load employed on the muscle system is a mixture of the number of repetitions performed per set and the number of sets per resistance exercise, with evidence suggesting that between one and three sets per exercise are favourable. Various well-designed studies suggest that there are limited benefits from performing resistance training for >1 set per resistance exercise. If >1 set is performed per exercise, it may be practical to keep the between-set recovery period to a minimum to lower the total exercise session time. Usually, this recovery period is a 2-minute rest between sets.

Flexibility Training

Flexibility is the ability to move a joint or series of joints through their full range of motion (ROM). Correct flexibility is related to good postural stability and balance, particularly when exercises intended to improve flexibility are performed in combination with a resistance training program. At present, there is limited evidence connected between regular flexibility exercise and the reduction of the occurrence of musculotendinous injuries or prevention of low back pain.

Several devices can be applied to assess a client's ROM. These include (i) a goniometer, which is a protractor-type device; (ii) the Leighton flexometer, which is attached to an individual’s limb and reveals the ROM in degrees as the limb moves around its joint; and (iii) the sit-and-reach box, which measures the ability to forward flex the torso while in a seated position and measures lower back, hamstring, and calf flexibility.

In clients with certain diseases, flexibility may decline as the development of the disease advances (e.g., multiple sclerosis, osteoporosis, obesity). These and other special population groups benefit from regular ROM assessment and an exercise training program intended to enhance flexibility. A comprehensive flexibility program should focus on the neck, shoulders, upper trunk, lower trunk and back, hips, knees, and ankles.

The following section provides a is a summary of the three main modes of flexibility training, usually performed after 4 to 10 minutes of slower full-body activity such as walking or cycling to increase the temperature within the muscle and muscle-tendon unit.

- **Static:** A stretch of the muscles surrounding a joint that is held without movement for a period (e.g., 10-30 seconds) and may be repeated numerous times. Within 3 to 10 weeks, static stretching may produce improvements in the joint ROM of approximately 5° to 20°.

- **Ballistic:** A method of rapidly moving (“bouncing”) a muscle to stretch and relax swiftly for several repetitions, often applied in sports that involve ballistic movements. This method uses the momentum of the body segment to generate the stretch.

- **Proprioceptive neuromuscular facilitation (PNF):** A method where a muscle is isometrically contracted, relaxed, and then stretched. The hypothesis behind this is that the contraction activates the muscle spindle receptors, or Golgi tendon organs, which results in a reflex relaxation (i.e., inhibition of contraction) of either the agonist or the antagonist's muscle. There are two varieties of PNF stretching:

Contract relaxation (CR) occurs when a muscle is contracted at 20% to 75% of the maximum for 3 to 6 seconds and then relaxed and passively stretched. Enhanced relaxation is notionally produced through the muscle spindle reflex.

Contract relaxation with agonist contraction (CRAC) commences in the same way as contract relaxation, but during the static stretch, the opposing muscle is contracted. This action is believed to induce more relaxation in the stretched muscle through a reflex of the Golgi tendon organs.

Static and ballistic variety of stretching is easy for the client to perform and requires only simple instructions. Proprioceptive neuromuscular facilitation stretching is, however, complex and requires a training partner, and may require close supervision by ESI. Static stretching is usually the safest method for enhancing the ROM of a joint. Both ballistic and PNF stretching may increase the risk of experiencing delayed-onset muscle soreness and muscle fibre injury. Usually, PNF is the most effective of the three methods of stretching for improving joint ROM.

Specificity of Training

The flexibility of a joint or muscle-tendon unit is contingent on the joint structure, the surrounding muscles and tendons, and the use of that joint for activities. Increased flexibility and ROM of a joint are developed through a flexibility training plan that is specific to that joint. A joint used during a specific activity, especially if it requires good ROM, usually demonstrates good flexibility.

Progressive Overload

As ROM increases, clients should increase the stretch to a comfortable level. This method will produce optimum increases in ROM.

Frequency

An applicable stretching routine should be performed a minimum of 2 or 3 d/week. As previously stated, however, daily stretching is recommended for optimal improvement in ROM.

Intensity and Duration

Static and PNF stretches should be held for 10 to 30 seconds. For PNF, this should follow a 6-second contraction period. Each stretch should be performed for 3 to 5 repetitions and a point of only mild discomfort or a feeling of tension.

Summary

Any type of exercise training program, whether it is cardiorespiratory conditioning, resistance training, or ROM training, should adhere to the FITT principle to ensure an optimal rate of improvement and safety during exercise training. When an exercise professional is working with specific clinical populations, modifications of these general principles may be required to accommodate any distinctive features or concerns related to the clinical disorder. Subsequent modules and courses provide information relevant to adapting the general exercise training principles discussed here to specific client populations.

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