Women and exercise

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During the 1980s, general awareness of the benefits of exercise and fitness as a way to attain better health markedly increased. Due in large part to requests from women and recommendations in the media, the need for exercise programs for women grew rapidly and were followed by numerous questions to physicians. This Technical Bulletin gives a general overview of the physiology of exercise and fitness, reviews some basic principles of safety, and describes the effects of exercise on female reproductive health. It is meant to provide information about exercise in nonpregnant women only.

Components of General Fitness

General fitness is a broad term that includes cardiovascular fitness, weight control, strength, flexibility, and coordination. Other factors related to prevention of bone loss, alteration of lipid profile, and the prevention of heart disease are also important by-products that appear to be related to fitness (1). Exercise has an impact on each of these areas, and programmed exercise is the single most useful means of attaining fitness.

Cardiovascular Fitness

Cardiovascular fitness should be the major goal of most exercise programs (2). Cardiovascular fitness is the total body response that results in the ability of the individual to maintain a prolonged period of physical activity. The usual format consists of a low-intensity program that lasts for 30–60 minutes three to four times a week. A variety of programs can accomplish this goal, but all are designed to build aerobic capacity, or the ability of the body to supply adequate oxygen to permit prolonged activity.

Repeated exercise that depletes cellular oxygen places the body in a state of stress. In response to this stress, the body gradually increases the oxygen storage capacity in cells by increasing the number of mitochondria. The more prolonged the program, the greater the response. In the laboratory, this is referred to as aerobic capacity and is measured by determining the maximum oxygen uptake ($V_o_{2max}$) (3). As the exercise progresses, the use of oxygen increases, and the oxygen available at the cellular level for continued metabolism is depleted.

By aerobic conditioning, the individual can increase her $V_o_{2max}$. This increased oxygen access allows the individual to prolong her exercise or other physical activity and to perform more efficiently. When exercise has continued long enough to deplete cellular oxygen, the anaerobic pathways begin to dominate, with a resultant buildup in lactic acid (1). Determination of lactic acid values is used to evaluate the effectiveness of aerobic training programs, just as $V_o_{2max}$ is used by exercise physiologists to measure fitness. When lactic acid levels (measured as serum lactate) increase, it is an indication that the maximum level of aerobic fitness has been reached. In this situation, the individual has greater difficulty performing physical activity and exhaustion is imminent. As training progresses, the time needed to increase serum lactate will increase, and thus aerobic training time will increase. However, for the average physician, neither $V_o_{2max}$ nor lactic acid determinations are readily available nor are they necessary in counseling patients. Other methods, such as heart rate, can be utilized effectively.

Measurement of the heart rate during exercise is an excellent method by which to evaluate cardiovascular fitness and estimate the $V_o_{2max}$ (3). As conditioning, (ie, cardiovascular fitness) improves, the heart rate will stabilize at a fixed level of exercise. Since it is possible to establish the heart rate at which conditioning will develop, this value can be calculated to obtain the goal necessary to produce conditioning. The level of exercise that needs to be attained is determined by a simple formula:

$$(220 - \text{age}) \times 60-80\% = \text{target heart rate range}$$

By using this formula, a woman can determine her own target heart rate based on her age and then find a
suitable program that will help her reach this goal. For instance, a 35-year-old woman will have a target heart rate of 111–148 beats per minute. The target rate must be maintained for a period of at least 20–30 minutes and repeated at least three times per week. By following this exercise program, the average woman will take 12 or more weeks to develop significant fitness.

Since any exercise program results in increased blood supply to the muscles, a cool-down period should be added to the end of each exercise program. During the cool-down period, light activity, such as walking, should be continued until the heart rate has returned to near-normal levels. The cool-down period allows the large quantities of blood diverted to the muscle and skin to gradually return to the central vasculature. This gradual decrease in activity level effects a more even return of the blood supply and prevents dizziness, fainting, and nausea. As conditioning occurs, this return will occur more rapidly, but the length of the cool-down period should remain unchanged. Hot tub baths, showers, and saunas should be avoided until the heart rate is back to the resting level; they will cause further shifting of blood to peripheral pooling and thus result in reduced blood flow to the heart and brain. It has been suggested that this may be part of the etiology of postexercise hypotension, with resultant cardiac and central nervous system ischemia.

**Weight Control**

Exercise can be successfully used by nonpregnant women for weight reduction and weight maintenance. A weight reduction program that combines both exercise and diet is more effective and results in maintaining weight loss longer than a program based on either one alone. It has also been reported that exercise alters the pattern of fat distribution by reducing the abdominal fat component to a greater extent than other body areas. Since abdominal fat has a more significant correlation with heart disease, this is a significant finding even if total weight loss is less than desired.

Weight loss from exercise is slow, and the woman who starts an exercise program to achieve rapid weight loss is likely to be disappointed. Depending upon the intensity, it takes an hour to utilize 300–600 calories. Table 1 indicates the average kilocalories utilized during exercise by an average 60–70-kg (132–154-lb) individual in various physical activities. If the woman weighs less, the utilization will be slightly less, and if she weighs more, the utilization will increase. In addition, utilization during the active exercise period will extend through the postexercise period; the elevated heart rate and metabolism may utilize an additional 50–100 kcal during the 10–20 minutes that it takes for the body to return to normal. As conditioning improves, however, this additional calorie expenditure will decline due to the decreased time required for the body to return to resting levels.

The expenditure of 3,500 calories is required to lose 1 pound of fat. This many calories will be burned by 5–10 exercise sessions, assuming the woman has no increase in caloric intake. In addition, muscle hypertrophy will occur in the early phases of exercise. Since muscle is twice the weight of fat per unit volume, a patient can lose fat without losing weight. This fact must be explained to any woman who is using exercise for weight loss. An excellent measure is the fit of her clothing. If it is becoming looser without appreciable weight loss, she is losing fat.

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**TABLE 1. AVERAGE CALORIE EXPENDITURE FOR COMMON ACTIVITIES**

| Activity          | Calories/Minute (kcal) |
|-------------------|------------------------|
| Canoeing, leisure | 3.0                    |
| Climbing stairs   | 8.4                    |
| Gardening, weeding| 5.6                    |
| Cycling, 9.4 mph  | 7.0                    |
| Dancing, waltz    | 5.7                    |
| Golf              | 5.0                    |
| Running           |                        |
| 9 minutes/mile    | 20.0                   |
| 14 minutes/mile   | 9.0                    |
| Sitting, eating   | 1.5                    |
| Skiing, leisure   | 9.9                    |
| Swimming          |                        |
| Slow              | 11.5                   |
| Fast              | 14.0                   |
| Tennis            | 7.1                    |
| Walking, 3 mph    | 4.0                    |

*Approximate caloric expenditure based on an average 60–70-kg (132–154-lb) person
Adapted from: Passmore R, Durnin JVGA. Human energy expenditure. Physiol Rev 1955;35:801–840
Some women will attempt to lose weight by dieting strenuously while in an aerobic exercise program. While this may seem at first to be an ideal method of weight loss, it should be avoided since the resulting energy loss will make exercise difficult and may result in a feeling of exhaustion that prohibits further exercise. A better method is to slightly reduce caloric intake only after establishing an exercise habit; then, gradually increase that reduction over several weeks or until the sensation of being acutely tired no longer persists beyond 2 hours after exercise.

**Muscle Strength**

In order to strengthen a muscle, the muscle must be subjected to repeated contraction against resistance. As a result, the muscle will begin to hypertrophy and thus be capable of greater force or strength. Most exercise programs result in an increase in muscle strength. However, strength is restricted to those muscles that are actively involved in the exercise program. There is very little crossover of training benefits from one set of limbs to the other (7). Since many of the currently popular exercise programs predominantly involve the lower extremities, a woman will need to engage in a program involving the upper extremities if she wishes to develop arm strength (7). Evidence is accumulating that individuals who participate in appropriately planned programs involving the upper arms can also develop some cardiovascular fitness. Most weight-training programs, however, do not accomplish a significant improvement in cardiovascular fitness, even with significant gains in strength. As a result, a woman who is seeking cardiovascular fitness should concentrate on an aerobic type of program and avoid those designed only to increase strength.

**Bone Density**

Recent studies have shown that women who engage in active fitness programs that include weight-bearing exercises have higher bone densities than sedentary women (8). These exercises include impact aerobics, resistance training, and other activities that involve the use of large muscle groups to resist counter pressures; in contrast, swimming and casual walking cause only minimal changes in bone density. The basis for the resulting bone increase is related to the stress placed on the bone by the muscles during the exercise; stress on the bone causes an increase in osteoblastic activity, which results in a buildup of bone density. It occurs regardless of the individual's calcium intake or her estrogen status, although the presence of estrogen certainly decreases bone resorption (9).

Even postmenopausal women can increase their bone density with a moderate exercise program. There are still questions as to how long the effect lasts and how much exercise is necessary to prevent osteoporosis. Until adequate long-term research becomes available, the current opinion is that continual exercise may be necessary to maintain the result.

Osteoporosis is also an important consideration for premenopausal women who have become amenorrheic due to an endocrine disorder. The presence of estrogen is essential to osteoblastic activity as well as reduced osteoclastic activity, and the lack of estrogen—regardless of the reason—is a major reason for calcium loss in these individuals. Therefore, they need the same counseling as postmenopausal women. An active program that includes weight-bearing exercises may be useful to prevent or reduce loss of bone density in any patient who has reduced or absent levels of estrogen (10). Even when the amenorrhea is secondary to exercise itself, bone loss will be minimal in those patients who are participating in weight-bearing exercise programs.

**Flexibility**

Flexibility depends on ligaments, muscles, and the bony skeleton. Since flexibility is measured by the movement that occurs at any joint or group of joints, any of these areas will be a factor in the flexibility of an individual. In most exercise programs, improved flexibility is accomplished through a routine of systematic stretching of the muscles and slowly warming up (2).

Disagreement exists over the appropriate time to stretch. Some researchers recommend that it be done before the exercise, while others recommend stretching afterwards. Although some of the most recent evidence appears to favor the latter approach (3), it is still recommended that stretching be performed before and after an exercise program. The type of stretching depends upon the anticipated exercise. Stretching is of most value to those muscles and joints that have just been or will be used. For any patient who has severe problems of flexibility, referral for therapy is indicated. Self-directed programs are usually unsatisfactory and can even be dangerous.
Coordination and Balance
The more a muscle repeats an activity, the more efficient the muscle becomes. The more a group of muscles or several groups of muscles perform an activity, the more efficient that activity becomes. As the same activity occurs repetitively over a prolonged time period, the neuromuscular pathways develop patterns that become reflex in nature. This same pattern is seen with any type of coordinative activity (eg, typing, throwing, hitting); as the individual becomes better trained, the ability to perform improves greatly. For this reason, exercises that are designed to improve a specific function and are used repeatedly will improve the individual’s ability to perform that function. In the same fashion, any exercise program will improve the overall ability of the person to perform tasks that require similar or related activity.

Designing a General Fitness Program
Any successful exercise program should be designed to fit the needs of the individual by taking into consideration her desires and motivation. The goals of women who exercise vary according to individual preferences. Many women exercise for weight control, while others just wish to feel better. The physician should therefore carefully determine the individual’s goals prior to recommending or encouraging any specific program and make necessary adjustments at periodic intervals as her goals change.

Activities to Promote Aerobic Endurance
Any exercise program that requires the body to utilize its oxygen stores for a prolonged period of time will result in an increase in the body’s oxygen storage capacity. As the program continues over time, the capability to perform greater activity increases. Many exercises fall in this category, including swimming; running or jogging; bicycling; walking; skiing, especially cross-country; and aerobic dancing (3). Other activities, such as racquetball or tennis, can accomplish the same goal, but frequent periods of rest within the game diminish effectiveness. Golf is a poor exercise for conditioning unless it includes rapid, prolonged walking. Team sports such as volleyball and basketball are effective when there is prolonged activity.

Swimming is an ideal program for exercise of both upper and lower extremities. It is an excellent aerobic conditioner and has the added advantage of minimal impact. The water buoyancy can be very helpful for individuals with minor orthopedic problems. Because of its low impact and low risk of fractures, swimming is an activity that is especially well suited for elderly women with osteoporosis, although it is not weight bearing and has no effect on bone density. The rapid increase in the numbers of women of all ages participating in Masters swimming programs attests to its popularity and ability to satisfy a competitive spirit. Masters swimming programs are designed for individuals wishing to maintain an active fitness program, using competitive swimming as its basis. These programs for adults aged 19 to 95-plus provide active competition within 5-year age groups. (U.S. Masters Swimming may be contacted at Two Peter Avenue, Rutland, MA 01543.)

Bicycling can provide both an enjoyable activity and good aerobic exercise. While bicycling primarily uses the legs, riding at an active pace will exercise the abdomen, lower back, and parts of the upper body as well. Cross-country skiing and rowing are also effective exercise activities. The highest $VO_{2\max}$ ever recorded was in a cross-country skier.

For most individuals, running or jogging and walking is the major exercise program. A walking or jogging program has the advantage that it can be done virtually anywhere and in any weather. Most current aerobic research has been performed on joggers. A 20–30-minute jog or 45–60-minute walk three to four times a week will accomplish aerobic fitness for almost any person.

A recent innovation has been circuit training. Now available in many public parks and recreation areas, circuit training offers running, jumping, climbing, pulling, and pushing exercises at regular intervals. Recommended levels or times are listed for each activity. By combining several types of exercise, the individual is able to develop muscular strength and aerobic fitness in a combined fashion. A major advantage of circuit training is that the change in activity helps to avoid the boredom of a single program and thus encourages continued participation. For the woman who is interested in increasing strength as well as fitness, circuit training is an appropriate format.

Indoor exercise machines that imitate outdoor activities offer another type of exercise program. These devices include rowing machines, stationary bicycles,
machines that imitate cross-country skiing, a variety of treadmills, and combinations of these. They have been used for years in rehabilitation programs, so their aerobic and strength-building benefits are proven (11). An advantage of using exercise machines is that they allow the individual to exercise in a secure, protected environment. This becomes very important when inclement weather or personal safety is a factor. Another advantage is resistance features that allow exercising at the same speed but that require greater effort as conditioning improves. The disadvantage most often cited is boredom with the activity. Some have overcome this boredom by watching television, reading a book, or listening to music during the activity. Another disadvantage, ironically, is the concern for safety. The machines all come with manufacturer’s advice for use. However, the individual should be aware that these machines can cause harm if used inappropriately. For example, by setting the tension too high on an exercise bicycle, muscle tears or ligament damage may occur; setting a treadmill too fast can result in injuries during attempted dismount; rowing machines used improperly can cause lower back problems. However, in most circumstances, the stationary exerciser will reach fitness goals as safely and efficiently as the exerciser following any other program.

Activities to Promote Muscle Strength and Toning
Since strength is muscle specific, any activity that is undertaken to develop a particular area of strength will require an exercise designed for that muscle or muscle group. All such exercises are based on the principle of resistance. A muscle must have a resistance to its action to stimulate it to hypertrophy. This can be accomplished by a number of methods. These include: free weights, isometric exercises, elastic resistance, body weight resistance (as with push-ups), or weight-training machines. All of these methods will accomplish the goal of increasing strength. For safety reasons, weight training should always be supervised by a trained instructor. Not only can the individual harm herself if she attempts to perform inappropriate exercises with weights, but she can also strengthen the wrong muscle groups. This can result in an outcome far different from her initial goal.

Toning or improving the appearance of the body by increasing muscle mass and shape is another reason some women undertake weight training. There are now contests for women body builders. However, for most women, participating in such contests is not a goal. They simply want to look better, usually with a flatter stomach, smaller hips and thighs, and firmer upper body. These women will use weight training to hypertrophy muscles in these areas and improve their perception of their appearance. This appearance is further enhanced if total body fat is also reduced, thus making the increased musculature more noticeable. Regardless of the effort, most women will not assume a masculine musculature appearance. An exception is with the use of anabolic steroids which have known and theoretic risks associated with their use.

Although weight training will increase strength and alter appearance, it is not an efficient method of increasing aerobic fitness. Most of these programs have only a slight aerobic component. An individual who wishes to develop aerobic fitness as well as strength needs to adopt a general fitness program in addition to weight training.

Prevention of Injury
The most important measures for preventing injuries are those of good common sense. Start gradually, don’t overdo, maintain adequate hydration, avoid high impact, wear appropriate attire, and be aware of bodily responses. Specific safety guidelines for aerobic exercise, strengthening exercises, and stretching exercises should be noted (see the box: Safety Guidelines). It is extremely important to use proper footwear. In most exercise programs, the feet are a key component. Shoes are designed for specific purposes, such as running,
walking, or aerobics; they are not transferable. Women should wear a shoe that is specifically designed for their form of exercise. Usually a moderately priced shoe will suffice; for strenuous programs and active competition, better-quality footwear may be necessary.

During any exercise program, certain warning signs that signal overexertion (4) should not be ignored (see the box: Warning Signs of Overexertion). If any of these signs occur, the exercise program should be stopped and then modified; if the symptom reoccurs or remains, an evaluation is required. Muscle pain is usually caused by a buildup of lactic acid in the muscle, resulting from excessive anaerobic metabolism, or by damage to the muscle fibers themselves. When a woman is exercising for fitness, pain has no place. The adage “no pain, no gain” is out of place in a well-designed exercise program for fitness.

Exercise can be overdone. Any activity that is practiced to the extreme can result in injury. For the average woman, attaining fitness is the only goal; once she reaches a satisfactory level, usually in 12–16 weeks, she can maintain her level of fitness without increasing the amount of exercise. The elite athlete (ie, one who is training for a competitive program) will require different counseling than the woman who is just attempting to acquire fitness. Elite athletes need to exercise strenuously over prolonged periods of time in order to accomplish their goals. Such women should be encouraged to seek the help of a competent coach for their sport and, if an injury occurs, be referred to a physician who has special interests not only in sports medicine but also in the problems related to their sport.

Any exercise program can result in an injury. Not only may this harm the individual, it can also interfere with the exercise program. Depending upon the seriousness of the injury, the patient could be permanently prevented from future exercise. However, a more likely result is failure to resume exercising. Individuals who are exercising regularly and then experience a prolonged period away from exercise may find it difficult to start again.

**Effects on Reproduction**

Strenuous exercise can have a major impact on the reproductive system. Reproductive complications were the first reported nonorthopedic problems related to exercise.

**Menarche**

It has been questioned whether exercise affects the timing of menarche. In studies of Olympic athletes, athletes had a later menarche relative to a comparable population for their country (12). Although this study appeared to indicate that vigorous exercise was related to a delayed onset of menses, many investigators questioned whether this finding was not so much a reflection of the effect of exercise as it was a finding that larger, stronger women were those who had later menarche. Very few studies have been performed that were designed to answer this question. In the few that have been reported, there appears to be a correlation between prepubertal exercise programs and a delayed onset of menses (13).

Attempts to study this phenomenon have concentrated on the hypothalamic–pituitary axis and the effect that exercise has on this hormonal relationship. Initial reports attempted to implicate fat loss secondary to exercise and establish a critical fat level which affected the pituitary hormones (14). Subsequent research has failed to support this theory (15). At this time, no one has been able to identify an etiology. Until further research can define an etiologic factor, the only advice that can be given to the patient or her parents is that the cause is unknown. However, they can be reassured that this delay does not appear to have any significant impact on the woman’s future reproductive capacity (16).

**Menstrual Irregularities**

Exercise alters the amount and frequency of menstrual flow for many women (16). Although dysfunction in the hypothalamic–pituitary axis can affect menstrual function, the causative factor for irregularities related to exercise has not been found to date. In addition to the disproven fat loss theory, other proposed causes have included effects of elevated core temperature on the ovaries, stress reaction, altered central levels of endorphins and other neuropeptides, changes in energy levels, and modification of gonadotropin output (17–20).

Oligomenorrhea and amenorrhea are related to the amount of exercise. Menstrual changes occur when the woman exceeds a specific level of exercise, such as running 20 miles or more per week (21). Since this level varies from woman to woman and depends on her activity, it is impossible to develop a general formula for predicting at what intensity of exercise these irregularities will occur.
Data indicate that exercising women who become amenorrheic have a significant reduction in their circulating estrogen level and thus are at a greater risk for osteoporosis than women with regular cycles (22). Since the relationship between bone loss and reduced levels of estrogen is well established in postmenopausal women, there is little doubt that this same causative factor is at work in amenorrheic women who exercise (22, 23). The major question, as yet unanswered, is how low the estrogen levels must drop for bone loss to begin and whether amenorrhea itself is sufficient to constitute a potential problem. There is some evidence to indicate that women may vary widely in this regard and that not all women with amenorrhea or low estrogen levels will develop osteoporosis. If there is significant bone loss, fractures can become a health problem for women who become amenorrheic with exercise (24). However, most studies now show that once exercise is reduced or stopped, menses resume and bone loss is halted or even reversed.

**Dysmenorrhea**

Several studies (25) have shown that women who exercise have more, or at least a greater awareness of, dysmenorrhea. This is especially true of high-intensity exercise programs found at the intercollegiate or national level. Objective data to support these findings have not been readily available. It is known that exercise and, especially, the injuries occurring with exercise increase the amount of circulating prostaglandins (26). This is the basis of antiprostaglandin therapy for the minor pains and inflammations associated with exercise. Since prostaglandins are also released from the endometrium during the menstrual cycle, it is at least theoretically possible that the total amount of circulating prostaglandin would greatly increase uterine muscle contractions and thus result in significant ischemia and resultant pain. As a result, in exercising women who complain of severe dysmenorrhea that is not relieved by antiprostaglandin therapy, a prolonged suppressive regimen of one of the estrogen–progestrone combinations may be necessary to alleviate discomfort.

**Infertility**

Many women who develop amenorrhea or irregular cycles as the result of an exercise program become concerned about their ability to conceive. With the possible exception of oligomenorrhea and anovulation (27), there is currently no evidence to indicate that exercise is a cause of infertility. Since oligomenorrhea has been reported to occur with greater frequency in nulliparous women, as compared with multiparous women, there has been speculation that development of oligomenorrhea may also indicate that these women are more likely to have difficulty conceiving (28). Since there have been few studies of this potential problem, there is no conclusive evidence.

Regardless, any woman who is infertile requires a complete work-up of her problem. All known causes of infertility should be excluded before exercise is considered. If exercise is suspected after this evaluation, specific areas of investigation should include establishment of regular ovulation and determination of luteal phase adequacy, both of which can be affected by low estrogen levels as the result of exercise. Timing of intercourse is also important. A woman who is exercising strenuously may not be having adequate opportunities for intercourse during her ovulatory phase because of the demands of her training schedule.

Once it is established that there is a possibility that exercise may be a contributing factor, the initial therapy is to reduce the amount of exercise or stop it completely. If exercise is the only factor, this should allow pregnancy to occur. If conception has not occurred within 6 months, further evaluation or therapy or both are indicated.

**Contraception**

There are no contraindications to any of the currently approved contraceptive methods because a woman engages in exercise. Many physicians feel a hemoglobin level of 12 mg/dl should be the minimum in an exercising woman; therefore, the woman using an intrauterine device should be monitored closely. If hemoglobin concentration drops below this level, supplemental iron and folate are indicated. Oral contraceptives have been used by athletes at all levels of competition, and no reports have been published that indicate an adverse effect on performance (25).

**Breast**

There are no reports of any serious adverse effects of exercise on the breasts, although minor problems such as nipple abrasions may occur. Women should be advised to wear a sports bra while exercising.
Summary

Exercise programs for women can serve many purposes, including developing fitness; controlling weight; improving strength, flexibility, and coordination; enhancing competition with other athletes, and promoting general good health. Depending upon the goal, a realistic method of exercise should be chosen and a program should be developed and followed carefully. Most programs will require aerobic training, which is best maintained by using training heart rates.

Exercise is not without the potential for problems, and any warning signs should not be ignored. As the intensity of the program increases, it may have effects on the reproductive system varying from minor menstrual changes to amenorrhea. The physician needs to be aware of these occurrences, and evaluation is necessary to ensure that no other pathology has occurred. When carefully selected and appropriately followed, an exercise program will result in a healthier patient.

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Safety Guidelines

The following guidelines will help the ob-gyn counsel the average woman seeking to improve her physical fitness through exercise without incurring excessive risk of injury.

Guidelines for Aerobic Exercise

1. For impact activities, it is recommended that exercise routines involving repeated foot impacts be limited to 30 minutes in duration at intensities not exceeding 75% of maximal heart rate. There should be a day of rest between such sessions.
2. A resilient floor should be selected for exercise that involves repeated foot impacts. If such a surface is not available, the exercise routines should be modified to ensure that the feet remain close to the floor throughout the program.
3. Aerobic exercise should be preceded by a gentle warm-up routine that utilizes the full range of motion of the joints. This increases the elasticity of the muscles and will help prevent potentially injurious movements.
4. Muscles that are used repeatedly during aerobic exercise must be carefully stretched before and afterward.
5. To reduce the severity of impact shock on the lower extremities, repetitive jumping on the same foot should not exceed four consecutive jumps.
6. Extremes of joint flexion and extension (such as deep knee bends and ballistic hyperextension of the knee) should be avoided.
7. The feet should be moved repeatedly to prevent cramping in the intrinsic muscles of the foot.
8. Trunk rotation should be avoided while on the feet with hips or lower spine flexed. Rotational activity in this position subjects the intervertebral disks to very high mechanical stress.
9. Intense physical activity should always be followed by a cool-down period of at least 10 minutes of lighter activity to prevent pooling of blood in the extremities. Hot showers and baths should be avoided immediately after intense physical activity.
10. Participants should be given a specific means of assessing physical status and progress. Working heart rate should be measured during peak levels of exercise to ensure that the intensity of activity is within the desired range. Regular measurement of the recovery heart rate will motivate participants by documenting their progress. Failure to progress as measured by this method may indicate the need for more intense activity during the aerobic phase or may signal the presence of other problems.

Guidelines for Strengthening Exercises

1. Strengthening exercises should not be performed on the same muscles on consecutive days.
2. A general warm-up routine should be performed before muscles are made to work against resistance.
3. Muscle-strengthening exercises should be preceded and followed by stretching exercises that are specific for the muscles that are made to work against resistance.
4. All strengthening exercises should be performed in a slow and controlled manner. Ballistic (rapid or jerky) movements increase the risk of injury.
5. The most efficient way to improve strength is to allow brief rest periods between bouts of vigorous exercise. Repetitions should be limited to short sets (10 or fewer) that are repeated later.
6. When the strength of one muscle or muscle group is disproportionate to that of the antagonist(s) for that muscle or group, the weaker muscle should be strengthened to restore balance around the joint.
7. The breath should not be held during strength-training exercises. Exhalation should take place during the exertion phase of each repetition.

Guidelines for Stretching Exercises

1. Stretching exercises may be performed as often as desired, preferably at least once a day.
2. A general warm-up routine should be performed before muscles are stretched.
3. Stretching routines should be performed statically, without holding the breath. Rapid, jerky movements should be avoided.
4. Each stretch should be held long enough so that relaxation will occur sufficiently to achieve the maximum benefit of the stretch. This can vary from as little as 6 seconds in some individuals to 20 seconds in others.
5. Muscles should be stretched only to the point of tension. Pain should be regarded as a signal that a stretch has gone too far.