

Chapter
21

Training for Performance

Objectives

1. Design a sport-specific training program based on an analysis of the energy system utilized by the activity.
2. Define the terms *overload*, *specificity*, & *reversibility*.
3. Compare & contrast the use of interval training & continuous training in the improvement of the maximal aerobic power in athletes.
4. Discuss the differences b/n training for anaerobic power & training for the improvement of strength.

Objectives

5. Discuss the advantages & disadvantages of different equipment types in weight training.
6. Define delayed-onset muscle soreness (DOMS). List the factors that contribute to its development.
7. Discuss the use of static & ballistic stretching to improve flexibility.
8. Discuss the differences b/n conditioning goals during: (1) the off-season, (2) the pre-season conditioning, & (3) in-season.
9. List & discuss several common training errors.

Training Principles

Aerobic & Anaerobic Energy Systems in Sports

TABLE 21.1 The Predominant Energy Systems for Selected Sports

Sport/Activity	% ATP CONTRIBUTION BY ENERGY SYSTEM		
	ATP-PC	Glycolysis	Aerobic
Baseball	80	15	5
Basketball	80	10	10
Field hockey	60	20	20
Football	30	10	—
Golf (swing)	100	—	—
Gymnastics	90	10	—
Ice hockey:			
Forwards/defense	80	20	—
Goalie	95	5	—
Rowing	20	30	50
Soccer:			
Goalie/wings/strikers	30	20	—
Halfbacks	60	20	20
Swimming:			
Diving	98	2	—
50 meters	95	5	—
100 meters	80	5	—
200 meters	30	65	5
400 meters	20	40	40
1500 meters	10	20	70
Tennis	70	20	10
Track and field:			
100/200 meters	98	2	—
Field events	90	10	—
400 meters	40	55	5
800 meters	10	60	30
1500 meters	5	35	60
5000 meters	2	28	70
Marathon	—	2	98
Volleyball	90	10	—
Wrestling	45	55	—

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Influence of Gender & Initial Fitness Level

Influence of Genetics

In Summary

- The general objective of sport conditioning is to improve performance by increasing the maximum energy output during a particular movement. A conditioning program should allocate the appropriate amount of training time to match the aerobic & anaerobic demands of the sport.
- Muscles respond to training as a result of progressive overload. When an athlete stops training, there is a rapid decline in fitness due to detraining (reversibility).
- In general, men & women respond to conditioning in a similar fashion. The amount of training improvement is always greater in those individuals who are less conditioned at the onset of the training program.

Components of a Training Session

In Summary

- Every training session should consist of a warm-up period, a workout session, & a cool-down period.
- Although limited data exist, it is believed that a warm-up reduces the risk of muscle &/or tendon injury during exercise.

Training to Improve Aerobic Power

Interval Training

Determining Intensity for Interval Training

TABLE 21.2 Guidelines for Determining the Intensity or Work Rate During Interval Training for Running and Swimming Different Distances

Interval Training Distances (Yards)		
Running	Swimming	Work Rate for Each Interval
100	25	One to five seconds slower than best time
220	50	Three seconds slower than best time
440	100	One to four seconds faster than average 440-yard run or 100-yard swim times recorded during a mile run or 440-yard swim
890–1,320	165–320	Three to four seconds slower than the average 440-yard run or 100-yard swim times recorded during a mile run or 440-yard swim

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Long, Slow Distance

High-Intensity, Continuous Exercise

Relationship b/n Training Intensity & Improvement in VO_{2max}

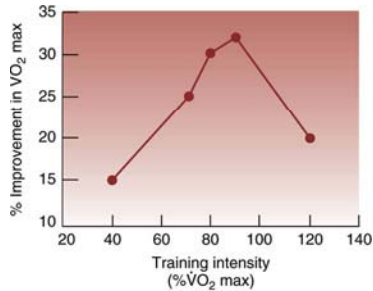


Figure 21.1

Altitude Training Improves Exercise Performance at Sea Level

In Summary

- Historically, training to improve VO_{2max} has used three methods: (1) interval training, (2) long, slow-distance, & (3) high-intensity, continuous exercise.
- Although controversy exists as to which of the training methods results in the greatest improvement in VO_{2max} , there is growing evidence that it is intensity & not duration that is the most important factor in improving VO_{2max} .
- The "Live-High, Train-Low" altitude training program provides significant endurance performance gains compared to training & living at sea level.

Injuries & Endurance Training

In Summary

- The majority of training injuries are a result of overtraining (e.g., overuse injuries) & can come from either short-term, high-intensity exercise or prolonged, low-intensity exercise.
- A useful rule of thumb for increasing the training load is the "ten percent rule." The ten percent rule states that training intensity or duration should not be ↑d more than 10% per week to avoid an overtraining injury.

Training to Improve Anaerobic Power

In Summary

- Training to improve anaerobic power involves a special type of interval training. In general, the intervals are of short duration & consist of high-intensity exercise (near-maximal effort).

Strength-Training Exercises

Strength Training Adaptations

Progressive Resistance Exercise

General Strength-Training Principles

The Winning Edge 21.1
Strength Training: Single Sets Versus
Multiple Sets for Maximal Strength Gains

Free Weights vs. Machines

Weight Training Equipment

Program	Equipment	Advantages	Disadvantages
Isometric	Variety of home-designed devices	Minimal cost; less time required	Not directly applicable to most sport activities; may become boring; progress is difficult to monitor
Isotonic	Free weights	Low cost; specialized exercises may be designed to simulate a particular sport movement; progress easy to monitor	Injury potential due to dropping weights; increase in workout time due to time required to change weights
Isotonic	Commercial weight machines (i.e., Universal [®])	Generally safe; progress easy to monitor; small amount of time required to change weight	Does not permit specialized exercise; high cost
Variable resistance	Commercial devices (e.g., Nautilus [®])	Has a cam system that provides a variable resistance that changes to match the joint's ability to produce force over the range of motion; progress easy to monitor; safety	High cost; limited specialized exercises
Isokinetic	Commercial isokinetic devices (e.g., Cybex [®])	Allows development of maximal resistance over full range of motion; exercises can be performed at a variety of speeds	High cost; limited specialized exercises

Modified from reference 8.

Combined Strength & Endurance Training Program

Gender Differences in Response to Strength Training

Strength as a Function of Muscle Cross-Sectional Area in Men & Women

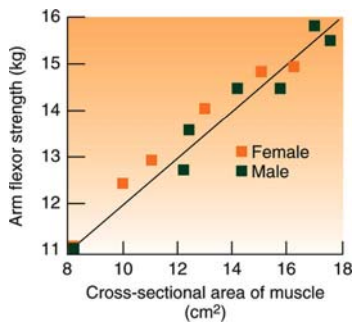


Figure 21.2

Training-Induced Strength Δ s in Men & Women

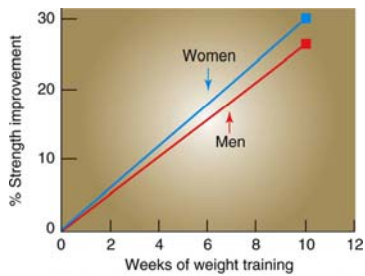


Figure 21.3

Muscle Soreness

Steps Leading to DOMS

Proposed Model for Delayed Onset Muscle Soreness

Proposed Steps Leading to Delayed Onset Muscle Soreness (DOMS)



Figure 21.4

Research Focus 21.1
The Repeated Bout Effect

Proposed Theories to Explain the
“Repeated Bout Effect”

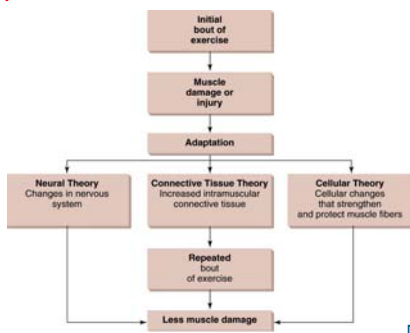


Figure 21.4

In Summary

- Improvement of muscular strength can be achieved via progressive overload by using either isometric, isotonic, or isokinetic exercise. Isotonic or isokinetic training seems preferable to isometric exercise in developing strength gains in athletes, since isometric strength gains occur only at specific joint angles that are held during isometric training.
- Although untrained men exhibit greater absolute strength than untrained females, there do not appear to be gender differences in strength gains during a short-term weight-training program.

In Summary

- Delayed-onset muscle soreness (DOMS) is thought to occur due to microscopic tears in muscle fibers or connective tissue. This results in cellular degradation & an inflammatory response, which results in pain w/in twenty-four to forty-eight hours after strenuous exercise.

Training to Improve Flexibility

Training to Improve Flexibility

In Summary

- Limited evidence exists to support the notion that improved joint mobility (flexibility) reduces the incidence of exercise-induced injury.
- Stretching exercises are often recommended to improve flexibility & optimize the efficiency of movement.
- Improvement in flexibility can be achieved via static or dynamic stretching, w/ static stretching being the preferred technique.

Year-Round Conditioning for Athletes

Year-Round Conditioning for Athletes



Figure 21.6

In Summary

- Year-round conditioning programs for athletes include an off-season program, a preseason program, & an in-season program.
- The general objectives of an off-season conditioning program are to prevent excessive fat weight gain, maintain muscular strength & endurance, maintain bone & ligament strength, & preserve a reasonable skill level in the athlete's specific sport.

Common Training Mistakes

Symptoms of Overtraining

Common Symptoms of Overtraining



Figure 21.7

Tapering

In Summary

- *Tapering* is the term applied to short-term reduction in training load prior to competition. Research has shown that tapering prior to a competition is useful in improving performance in both strength & endurance events.

In Summary

- Common mistakes in training include undertraining, overtraining, performing nonspecific exercises during training sessions, failure to carefully schedule a long-term training plan, & failure to taper prior to a competition.
- Symptoms of overtraining include: (1) elevated heart rate & bld lactate levels at a fixed submaximal work rate, (2) Loss in body weight due to reduction in appetite, (3) chronic fatigue, (4) psychological staleness (5) ↑d number of infections, &/or (6) a ↓ in performance.

Study Questions

1. Explain how knowledge of the energy systems used in a particular activity or sport might be useful in designing a sport-specific training program.
2. Provide an outline of the general principles of designing a training program for the following sports: (1) football, (2) soccer, (3) basketball, (4) volleyball, (5) distance running (5,000 meters), & (6) 200-meter dash.
3. Define the following terms as they relate to interval training: (1) *work interval*, (2) *rest interval*, (3) *work-to-rest ratio*, & (4) *set*.
4. How can interval training be used to improve both aerobic & anaerobic power?

Study Questions

5. List & discuss the three most common types of training programs used to improve VO_{2max} .
6. Discuss the practical & theoretical differences b/n an interval training program used to improve the ATP-PC system & a program designed to improve the lactic acid system.
7. List the general principles of strength development.
8. Define the terms *isometric*, *isotonic*, & *isokinetic*.
9. Outline the model to explain delayed-onset muscle soreness proposed by Armstrong.
10. Discuss the use of static & dynamic stretching to improve flexibility. Why is a high degree of flexibility not desired in all sports?

Study Questions

11. List & discuss the objective of: (1) off-season conditioning, (2) preseason conditioning, & (3) in-season conditioning.
12. What are some of the more common errors made in the training of athletes?
