

Team Physician Consensus Statement

The Team Physician and Strength and Conditioning of Athletes for Sports: A Consensus Statement

DEFINITION

Strength and conditioning uses exercise programs with the objective of producing a higher level of athletic function.

GOAL

The goal of strength and conditioning is to optimize the performance of the athlete and minimize the risk of injury and illness. To accomplish this goal, the team physician should have knowledge of and be involved with the following:

- Strength and conditioning principles
- Sport-specific strength and conditioning
- Strength and conditioning program implementation
- Injury and illness implications of strength and conditioning
- Selected current issues in strength and conditioning

SUMMARY

The objective of this consensus statement is to provide physicians who are responsible for the health care of teams with guidelines regarding conditioning for sports. This statement specifically addresses the role of exercise in conditioning. Nutrition and supplements are outside the scope of this statement. It is not intended as a standard of care and should not be interpreted as such. This statement is only a guide and, as such, is of a general nature, consistent with reasonable, objective practice of the health care professional. Individual conditioning issues will depend on the specific facts and circumstances presented to the physician. Adequate insurance should be in place to help protect the athlete, the sponsoring organization, and the physician. This statement was developed by a collaboration of six major professional associations concerned with clinical sports medicine issues;

they have committed to forming an ongoing project-based alliance to “bring together sports medicine organizations to best serve active people and athletes.” The organizations are the American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American College of Sports Medicine, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, and the American Osteopathic Academy of Sports Medicine.

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STRENGTH AND CONDITIONING PRINCIPLES

Specificity

Training adaptations are specific to the nature of the exercise stimulus (e.g., muscle contraction type, mechanics, and metabolic demand). Athletes are subject to specific demands in the performance of sport. Therefore, performance is dependent upon the individual athlete's ability to meet those demands.

Progressive Overload

Progressive overload is exercise and training programming designed to provide increasing stimuli to improve athletic strength, power, and endurance. A strength and conditioning program should begin at a comfortable level of exercise and

progress in frequency, intensity, duration, volume, and tempo toward a target goal for an individual athlete.

1. *Frequency* is the number of exercise or training sessions over the course of a specific timeframe.
2. *Intensity* is a percent of the maximal functional capacity of an exercise mode or a training session (e.g., percent of maximal HR, percent of one-repetition maximum (1RM), and rate of perceived exertion).
3. *Duration* is the amount of time spent in an exercise or training session.
4. *Volume* is the total amount of exercise performed in specific periods (e.g., total distance run and total amount of weight lifted).
5. *Tempo* is the speed of performing the exercise or training session.

Prioritization

Priorities should be developed according to the individual's capabilities, sport-specific demands, and multiple sport participation. Not all elements of a strength and conditioning program should be optimized at the same time, rate, or magnitude. Prioritization helps maximize performance, reduce risk of injury, minimize staleness and burnout, and enhance recovery.

Strength, Power, and Endurance Training

A given number of repetitions at a specific intensity determine the training effect on muscle tissue. Heavy loads train muscle for strength and power, and light loads train for muscular endurance. Heavy loads include exercises at about 85% of 1RM performing six repetitions or less. Light loads include exercises at approximately 60% of 1RM, performing 12 or more repetition.

Muscle hypertrophy enhances the capacity for maximizing strength and power. It is stimulated by exercises at moderate loads of approximately 65%–85% of 1RM performing 6–12 repetitions.

Guidelines for training for power can be based on the need for single-effort power (e.g., high jumper) or multiple-effort power (e.g., basketball player). Muscular adaptations to single-effort power are best trained with one to two repetitions at 80%–90% of 1RM. Muscular adaptations to improve multiple-effort power efforts should be trained using 75%–85% of 1RM with three to five repetitions.

Aerobic and Anaerobic Conditioning

Aerobic and anaerobic conditioning can be achieved with a multitude of programs (e.g., interval training and continuous training) and modes of exercise (e.g., running, cycling, swimming, and sprinting). It is important that the aerobic and anaerobic conditioning be specific to the sport. Conditioning should be progressive, periodized, prioritized, and compatible with other elements of the strength and conditioning program, practice, and competition. Continuous aerobic training is most

effective at improving performance in endurance events. High-intensity sprint interval training, while having some benefits for aerobic fitness, is more effective at improving performance in anaerobic events. The demands of the sport dictate the type of aerobic or anaerobic training (3,11).

Periodization

Periodized training is planned variation of exercise performed in sequenced and integrated phases to optimize performance at specific times in the competitive season. Planned variation is key to optimal athletic function and performance and includes modification of the total amount of exercise performed in a given period (frequency, intensity, duration, volume, and tempo of exercise).

All periodization terminologies describe a specific training plan, portion of a training cycle, or length of time within a training cycle. The results of periodization training has been shown to be more effective than low-volume, single-set training programs. Periodization programs have also been shown to be effective during both short- and long-term training cycles while avoiding plateaus in strengthening and conditioning and reducing the risk of overtraining. Several combinations of variables may be manipulated in order to produce an adaptation specific to training goals.

Periodization Cycles

- **Macrocycle** (long-length cycle): Generally a training year or competitive season. A training year includes off-season, preseason and in-season periods.
- **Mesocycle** (medium-length cycle): A training period generally lasting 1 to 6 months.
- **Microcycle** (short-length cycle): A training period generally lasting 1 to 4 weeks.

Types of Periodization Programs

- **Classical periodization:** Classical programs (sometimes referred to as linear programs) originally addressed conditioning for sports with a limited number of competitions in-season and a well-defined off-season (e.g., football). Classic periodization methods use a progressive increase in the intensity and a decrease in the volume of exercise from one microcycle to the next with variations in each microcycle. The classical method is generally used in training elite power athletes (e.g., the sport of weightlifting, pole vaulting) but has less application for inexperienced or younger athletes.
- **Undulating periodization:** Undulating programs (sometimes referred to as nonlinear) address conditioning for sports with long competitive seasons, multiple competitions, and year-round practice (e.g., tennis). Undulating programs are generally characterized as having greater variation in the intensity and volume within each microcycle by rotating different protocols over the course of the training program.

- Classical and undulating programs have been shown to accomplish similar training effects. Both are superior to constant intensity and volume training programs. The key to workout success is variation. Different approaches can be used during the macrocycle to accomplish this training need.
- Other models exist, such as *block periodization*. Block programs are focused on accumulating the benefits of one type of strength and conditioning training (e.g., power and endurance) for a mesocycle, ending with a microcycle of rest and recovery. This type of periodization is an adaptation of classical periodization to have broader application for a variety of athletes.

Strength and Conditioning Program Variables

Several variables in addition to progressive overload (frequency, intensity, duration, volume, and tempo as defined) may be periodized in order to alter the resistance-training stimulus to achieve the conditioning goal. Different combinations of these variables will create different training sessions.

- Exercise order: the sequence in which exercises are performed during a training session (e.g., large muscles before smaller ones and multijoint exercises performed before single-joint exercises).
- Exercise selection: any mode of exercise specific to the strength and conditioning goals of the athlete. These modes may include but are not limited to the following:
 - Resistance training (e.g., machines, free weights, and bands)
 - Sprint and endurance training
 - Plyometric training
 - Agility training
- Load: the amount of resistance per repetition or set.
- Muscle action
 - Concentric: developing tension while shortening muscle
 - Eccentric: developing tension while lengthening muscle
 - Isometric: developing tension with no change in muscle length
- Repetition speed: varying resistive training speed from slow (strength development) to fast (power development) while using the appropriate load.
- Rest periods: the amount of rest taken between sets, exercises, and/or repetitions.

Active Rest and Recovery

Active rest is a phase in which volume and intensity are significantly decreased to facilitate recovery from the training and competition cycle. Recovery includes healing and rehabilitation of any injuries that may have occurred as well as recovery from the emotional rigors of competition (2).

Conditioning Modifications

In certain populations, conditioning programs may need to be modified to optimize performance and minimize the risk of injury.

Youth. Aerobic and strength training can impart benefits to young athletes and is not associated with increased injury risk if performed correctly (4). However, physiological and biomechanical capabilities and skeletal and psychological immaturity in young athletes are different from those of adults. These factors require modification of strength and conditioning programs, including periods of active rest and recovery. Strength gains in the prepubertal population will be due to increases in recruitment and synchronization of muscle activation patterns. As the athlete matures, gains in muscle mass will play a more significant role in strength increases.

Modification considerations:

- Periodization program includes 2 to 3 months away each year from sport-specific training and competition.
- Most strength training equipment is designed for adult-size use and may not be safe or effective for the child/adolescent.
- Heavy weight lifting, including the snatch, clean, and jerk, and 1RM lifts are not recommended for skeletally immature athletes.
- Focus should be on supervision, technique, lower intensity, and volume of training.
- Aerobic conditioning, including distance running, may be acceptable. However, modifications to address issues such as physical fitness, self-motivation, heat/cold, and hydration are necessary.

Female athletes. Female athletes respond similarly to their male counterparts to aerobic and resistance training. Modification may be necessary during pregnancy (1,10). Disparities in strength are related to smaller average body size and cross-sectional area of muscle fibers in females. Both male and female athletes experience improvements in strength, power, and endurance; however, female athletes may not experience as much an increase in muscle hypertrophy. Female athletes, like their male counterparts, should be encouraged to participate in a comprehensive strength and conditioning program.

Multisport athletes. With overlapping seasons, multisport athletes have unique conditioning challenges. Multisport athletes need to maintain their general athletic fitness base and focus their sport-specific conditioning toward their current sport. A period of active rest and recovery between seasons is of particular importance to multisport athletes (4). Conditioning injuries and overtraining may occur when an athlete tries to prepare simultaneously for two different sports.

Athletes with physical and intellectual challenges. Athletes with physical and/or intellectual challenges often benefit from sports participation and physical activity. Sporting opportunities and participation have expanded significantly for these athletes. Conditioning for sports participation may involve modification of training program (exercise selection, frequency, intensity, duration, volume, and tempo) and use of adaptive sporting equipment, prosthetics, and other devices to enable participation, mitigate risk of injury, and optimize performance.

Modification considerations:

- There are a wide range of physical and intellectual disabilities that affect participation in a strength and conditioning program.
- Medical and musculoskeletal issues including temperature regulation, skin breakdown, cardiovascular function, joint instability, and spasticity may need to be addressed in the design of the strength and conditioning program.
- With use of specific exercise programs and adaptive equipment, most of these athletes can participate in strength and conditioning programs.
- Special equipment and medications may be needed at the training venue in case of medical urgency/emergency.

SPORT-SPECIFIC STRENGTH AND CONDITIONING

Sport-specific training is the application of strength and conditioning principles to prepare the athlete for the specific demands of their sport. Training should address intrinsic and extrinsic factors (5), which are specific to the individual and the sport.

Intrinsic factors include the athlete's strength, flexibility, aerobic/anaerobic capacity, previous injury, genetics, and psychological health making up the athlete's physical and psychological base. Extrinsic factors include the inherent demands of the sport, such as physiological and biomechanical forces and motions, environment stresses, and equipment.

The athlete's physical and psychological base interacts with the inherent demands of the sport (hitting/throwing the ball and foot hitting the ground in running) and affect performance and/or injury risk. By addressing the physical and psychological base and the inherent demands of the sport, a sport-specific strength and conditioning program improves sport-specific capability, leading to improved performance (e.g., ball velocity and running speed) and decreased injury risk factors (e.g., lack of acclimatization, site-specific inflexibility, and strength deficits) (Fig. 1).

Components of a sport-specific strength and conditioning program include the following:

- An evaluation to determine a fitness profile for the purpose of entering a strength and conditioning program. This includes both a general and a sport-specific evaluation of the

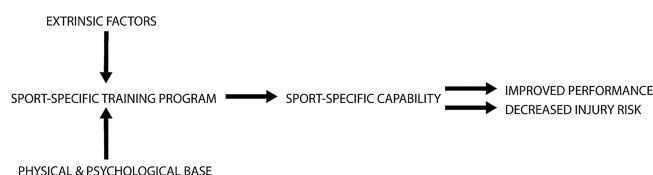


FIGURE 1—Interaction of athlete's physical and psychological base with the inherent demands of the sport.

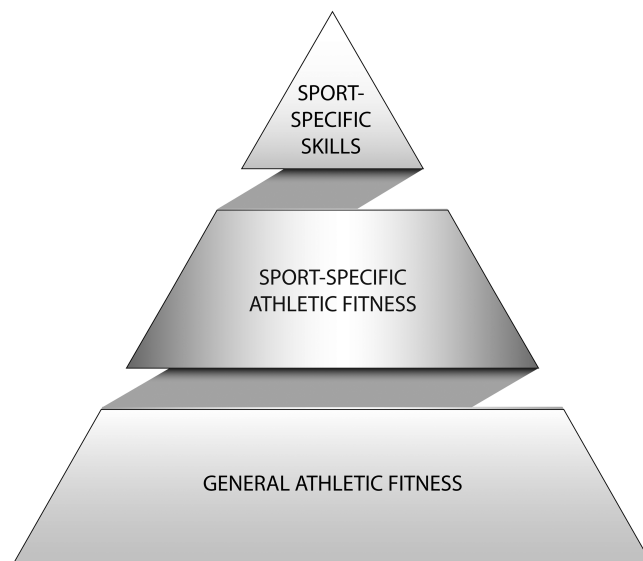


FIGURE 2—Pyramid of fitness and skills to optimize the physical and psychological base.

current physical and psychological base and extrinsic risk factors for injury (5).

- A periodized program to address the inherent demands of the athlete's sport.
- An evaluation process to determine efficacy of the conditioning program.

This program must be specific to the sport and the athlete's individual capabilities for that sport. A general principle is that a "one size fits all" program should not be used for conditioning (e.g., a program developed for the demands of football would be different than those developed for baseball).

Objectives of a Sport-Specific Strength and Conditioning Program

Sport-specific strength and conditioning can be described as a pyramid of fitness and skills to optimize the physical and psychological base (Fig. 2).

- *General athletic fitness* serves as a base for sport-specific fitness and includes total body flexibility, total body muscular strength, power and endurance, aerobic and anaerobic capacity, body composition, and psychological well-being.
- *Sport-specific athletic fitness* training affects physiological parameters, biomechanical actions, anatomical sites, and neuromuscular control requirements associated with the inherent demands of the specific sport. These components are addressed through specific flexibility, strength, power and endurance, and aerobic and anaerobic training.
- *Sport-specific performance* is the ultimate goal. Optimal performance demands a refinement of unique training and skill acquisition.

STRENGTH AND CONDITIONING PROGRAM IMPLEMENTATION

The team physician should be involved in the athletic care network that integrates expertise regarding strength and conditioning programs with certified strength and conditioning specialists, coaches, and health care providers, which may include certified athletic trainers (ATC/ATL), physical therapists, and medical specialists. Strength and conditioning includes the implementation of off-season, preseason, and in-season programs and a period of active rest and recovery. These programs vary depending on the sport, level of play, and age.

Off-Season Program

The off-season program takes place when strength and conditioning is performed by an athlete during the time when regular, scheduled participation of a sport is not occurring. This program should follow a period of active rest and recovery. It is also the period when an athlete gradually reaches the highest levels of progressive overload training and concentrates on general athletic fitness (Fig. 2).

Factors that influence the content of the off-season program include the following:

- Length of the off-season
- Planned participation in multiple sports
- Status of physical and psychological base
- Rehabilitation needs for injuries/illnesses
- Sport-specific goals and requirements
- Injury prevention strategies including the following:
 - Programs for athletes at risk for lower extremity injuries (females and anterior cruciate ligament).
 - Shoulder girdle strengthening for all overhead athletes.
 - Aerobic conditioning for off-season athletes involved in sports with long durations of activity
 - Preparticipation warm-up/conditioning programs (such as FIFA 11+)

Preseason Program

The preseason strength and conditioning program occurs before the onset of the competitive season. It is the period when an athlete's training decreases because of demands of practice. In this time period, the program is also focused on sport-specific athletic fitness while maintaining general athletic fitness and continuing injury prevention. The combination of time- and practice-intensive sport demand and need for conditioning is unique to the preseason and may increase the risk of illness or injury.

Factors that influence the content of the preseason program include the following:

- Length of preseason
- Intensity of preseason

- Number of practices per week
- Status of physical and psychological base
- Ongoing rehabilitation needs for injuries/illnesses
- Environmental issues (e.g., heat/cold and altitude)
- Weight management issues (e.g., weight goals and weight-restricted sports)

In-Season Program

The in-season program takes place after the preseason when strength and conditioning occurs during an athlete's main competitive season and/or greatest concentration of competitions. This period focuses on sport-specific performance while maintaining general athletic fitness and sport-specific fitness in addition to the modification of injury risk. Strength and conditioning training during the season is also relevant to meet criteria for return to play (RTP) (8).

Factors that influence the content of the in-season program include the following:

- Length of the competitive season
- Intensity of the competitive season
- Number of practices and competitions/games per week
- Status of physical and psychological base
- Ongoing or new injury or illness
- RTP criteria
- Ongoing weight management issues

INJURY AND ILLNESS IMPLICATIONS OF STRENGTH AND CONDITIONING

Injuries and illnesses may occur during strength and conditioning, some of which may occur more often during this training, particularly during transition phases. They may range from common, minor musculoskeletal, and medical problems to infrequent but life-threatening medical emergencies. Examples include the following:

Musculoskeletal injuries:

- Overload injury
- Traumatic injury

Medical issues:

- Overtraining syndrome
- Female athlete triad
- Dehydration
- Exertional headache

Life-threatening medical emergencies:

- Exertional rhabdomyolysis
- Exertional sickling
- Exertional heat stroke
- Sudden cardiac arrest

To minimize health risks, a sport-specific conditioning program should adhere to conditioning principles and be adjusted based on the individual's physical and psychological base and health status. An emergency medical action plan should be in place (9).

Treatment of injuries associated with strength and conditioning is best managed by the team physician (7,9). The team physician has the ultimate decision for RTP (8).

SELECTED CURRENT ISSUES IN STRENGTH AND CONDITIONING

An increasing number of athletes seek strength and conditioning training outside their team structure. Regardless of where and how this training occurs, all strength and conditioning programs should be supervised. Ideally, a professional who is a certified strength and conditioning specialist should supervise the program and be included in the athletic care network. Communication among members of this network is critical, especially related to injuries and illnesses that are caused by and/or affect the training program.

- Eccentric hamstring training as a targeted injury prevention program has shown value in injury risk reduction.
- Programs should be sport specific and contain components listed in this article. Some commercial high-intensity programs may not include these components, may be less valuable for enhancing performance in a specific sport, and may be associated with an increased risk of injury.
- Training with a variety of strength and conditioning equipment such as weighted sports implements and kettlebells may present specific injury risks.
- Athletes can meet their strength and conditioning goals with a balanced diet and without the need for supplements, except for certain medical conditions (6).
- Adequate sleep is critical in order to maximize strength and conditioning training.
- Conditioning should never be used to punish, bully, or harass an athlete.

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It is *essential* the team physician:

- Understand the strength and conditioning principles and programs described in this document.
- Understand the sport-specific and athlete-specific issues related to strength and conditioning, including how it relates to injury and illness rehabilitation.
- Understand the role of a strength and conditioning program as it relates to improved sports performance and decreased injury risk.
- Understand the role of ongoing assessment of the physical and psychological base in all phases of strength and conditioning.
- Understand injuries, illnesses, or other factors that may affect or result from an athlete's strength and conditioning program.
- Understand the importance of communication within the athletic care network.
- Is aware of or involved in the development and rehearsal of an emergency action plan (7).

It is *desirable* the team physician:

- Have a comprehensive knowledge of all inherent demands of the sport.
- Be involved in the ongoing assessment of the physical and psychological base in all phases of strength and conditioning.
- Be involved in the implementation of a sport-specific strength and conditioning program.
- Be involved in the education of the athlete, parents, and athletic care network about the importance of strength and conditioning programs for performance improvement and injury and illness risk reduction.
- Be involved in the integration of the strength and conditioning program for injury or illness rehabilitation.
- Be involved in the development of strategies to limit injury/illness risks associated with and/or exacerbated by strength and conditioning programs (e.g., exertional heat stroke and exertional rhabdomyolysis).