Fitness and Conditioning in Sporting Dogs

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The purpose of this document is present information on the prevention of injuries and initial response to these injuries in dogs engaged in sporting activities. This text contains information described by the author in a chapter in Veterinary Clinics of North America Small Animal Practice.1

Prevention

Exercise carries inherent risks, including the risk of physical injury. Injury may occur because a dog may be hit by a motor vehicle, may hit a stationary object (i.e., fence post, tree, etc.), or may slip. Dog could also get lost during an exercise session. Exercise should be done with great caution when the ground is slippery (i.e., when exercising on ice, wet grass). The risk of a traumatic incident or loss appears greatly minimized when the dogs exercising are properly socialized and supervised. There is a risk associated with having dogs play together. For example, owners take their dogs to dog parks where dogs of various sizes run together in groups. Several steps should be implemented to minimize the risks of injuries when dogs play together: the dogs should be of similar size and weight, they should be evenly tired (injuries seemingly are more likely when a dog is more tired than other dogs he is playing with), the field of play should be free of obstacles, and the ground should provide good traction. Dogs with undiagnosed or asymptomatic orthopedic problems may exhibit signs of lameness after exercise. These dogs may have osteoarthritis — secondary to hip or elbow dysplasia, for example — a patellar luxation, a partial tear to a cranial cruciate ligament, or another problem. These orthopedic problems are very unlikely to be the result of exercise. Rather, the clinical signs may indicate a flare-up or an increase in the severity of the disease. In most cases, a period of rest followed by a return to low impact exercises is sufficient to control the flare-up.

Strength and conditioning

Although dogs have been used extensively as a research model for human studies in the field of exercise physiology, little research has been conducted to determine the optimal amount of exercise needed for dogs in terms of the frequency, intensity, and duration of exercise that can help to optimize their health, fitness level, and recovery from orthopedic injuries. Studies to help determine this optimal level of exercise have been performed in human beings. Sporting dogs are dogs that perform a variety of physical activities, including racing short and long distances with or without a lure, field trials, herding, tracking, agility, flyball, and Frisbee catching (disk dogs). The purpose of this article is to review the principles and applications of fitness training, rehabilitation, and reconditioning applying to sporting dogs.

Fitness is a general term used to describe the ability to perform physical work. It requires cardiorespiratory function, muscle strength, endurance, and flexibility. Fitness is a lifelong adaptation of the cardiovascular and musculoskeletal systems to exercise. Conditioning is the performance of specific physical exercises to prepare mentally and physically for the performance strenuous activity. A fit and conditioned athlete requires an owner, trainer, or handler's conscientious commitment to a well-rounded conditioning program. Training of the musculoskeletal and cardiopulmonary systems is a fundamental part of conditioning.

Training is used to teach sporting dogs the specifics of sporting activities (Table 1). Training also influences the dog's behavior. Conditioning starts early in life. Strenuous exercise is not recommended before closure of the growth plates of long bones so as to avoid fractures or trauma to these growth plates. Physeal closure occurs at approximately 10 months of age in large dog breeds, a few months earlier in small dog breeds, and a few months later in giant dog breeds. Before physeal closure, the conditioning of sporting dogs involves play with siblings and self-motivated activities (eg, walks, runs). It is important to make efforts to rule out developmental orthopedic diseases (DODs) in dogs chosen as future sporting dogs. This may be done by assessing the sire and dam, by performing an orthopedic examination at approximately 4 months of age, and by making radiographs of hip and elbow joints. Many physical attributes important to sporting dogs are inherited. These include size, speed, strength, endurance, and agility. The relative importance of these attributes varies greatly between sports (Table 1). Conditioning may be effective around puberty, when a surge in androgen hormones occurs in male dogs. This surge in androgens may help to promote muscle development. Despite differences in muscle mass and size between male and female sporting dogs, there are no clear differences in performance between male and female dogs, including racing Greyhounds. The response to aerobic training increases after puberty in human beings. Similarly, sexual maturity likely has an impact on the response to training in dogs. Complete and balanced nutrition is critical to the conditioning and maintenance of sporting dogs. Nutrition is particularly important during growth, because excessive energy and calcium may increase the expression of faulty genes in dogs genetically predisposed to DODs. Nutrition has to be adapted to the metabolic needs of working dogs during training and during the competitive period. These requirements may be dramatically increased during competitive periods (ie, a sled dog running 12 hours per day). Sled dogs have unique nutritional requirements resulting from their exercise profile. One study reported that sled dogs fed an extreme diet with no carbohydrate (39% protein and

61% fat on an energy basis) fared better than dogs receiving diets rich in carbohydrate (23% and 38% carbohydrate). Feeding of sporting dogs should not occur during periods of strenuous exercise. Gastric emptying was delayed by exercise lasting more than 1 hour in untrained dogs. Hydration is also critical to sporting dogs, particularly when exercising in hot conditions.

Table 1. Desirable physical skills for canine sporting activities

Sport	Physical skills required
Racing Greyhounds	Speed, strength
Sled dogs	Muscle and cardio-respiratory endurance
Field trial	Speed, strength, agility
Hunting	Muscle endurance
Herding	Speed, muscle endurance
Agility	Speed, balance, agility
Search and rescue	Endurance, balance
Flyball/disc	Speed, strength, agility, balance

Conditioning involves a physical effort placed on the cardiopulmonary system. Exercise increases heart rate and influences blood pressure in dogs. Over time, exercise also increases red blood cell counts. Conditioning lowered the thyroid hormone concentration (T4 and free T4) in sled dogs in one study. Heart rate monitoring during exercise has been used in dogs. Exercise more than doubled the incidence of cardiac arrhythmias in Greyhounds in one study. Heart rate during exercise is higher in overweight dogs than in lean dogs. Training leads to an adaptation of the cardiovascular system over time. Although little is known about the specific changes occurring in heart rate at rest, during, and after exercise in sporting dogs, training leads to a lower resting heart rate and a lower resting blood pressure in people. This is particularly true for endurance training, but it also occurs in response to strength training. Training also boosts aerobic fitness in children and adolescents. Although little is known about the relation between fitness and body fat in dogs, people with lower body fat tend to be fitter than people with higher body fat. Exercise leads to a decrease in body fat in people. The parameters evaluated when assessing a dog that is destined to be a working dog include its size, conformation, gait during general and specific activities, past and current orthopedic health, body condition score, fitness level, and behavior (eg, level of socialization, drive to perform, extraverted or introverted nature). Fitness and endurance may be evaluated in dogs by running on a treadmill, doing a 6-minute walk test, or by assessing performance during outdoor activities. In one report, control dogs walked 573 ft (85.5 m) in 6 minutes. Physiologic (eg, heart rate, rectal temperature) and hematologic (eg, plasma creatine kinase, plasma lactate) factors are evaluated during fitness tests. Endurance is adversely affected by restricted activity. Endurance decreased by 41% in 10 dogs whose activity was restricted for 8 weeks. These changes were reversible in 8 weeks of retraining.

When designing a training program, frequency, intensity, and duration of exercises are chosen. The frequency is the number of exercise bouts per time period (per session, day, or week). The intensity is the load applied (eg, speed of trotting or galloping, weight used). The duration is the number of repetitions (in range of motion [ROM], jumping, or catching) or the length of time of exercise. Excessive frequency, intensity, or duration may have a negative impact on training, irritate an existing condition, or cause an injury because of insufficient rest, excessive muscle or cardiovascular fatigue, or excessive stress placed on tissues during activity. To our knowledge, there is no scientific information describing the optimal training amount for conditioning and maintenance of sporting dogs. In people, recommendations for maintenance of fitness include 30 minutes of moderate-intensity activity per day.

Strength can be defined as the ability of a muscle or muscle group to produce tension and a resulting force. Strength is required in sporting dogs that need speed (Fig. 1). These dogs have a higher muscle mass–to–body weight ratio than other dogs. Strength is closely linked to speed, for example, in racing Greyhounds, which are extremely strong and may run faster than 70 km/h (45 mph). Growth hormone increases muscle mass in dogs. Strengthening exercises follow a number of basic principles, including the principle of specificity and the overload principle. The principle of specificity refers to the need to train emphasizing the body systems that are used during the sport, and to train them in a manner consistent with how they are used during the sporting activity. In terms of strengthening exercises, the specific muscle groups whose strength is required to perform the desired activities need to be trained. These muscles also need to be strengthened in a way similar to how they are used during the activity (eg, aerobic versus anaerobic, duration of exercise). As an example, a dog involved in flyball needs to accelerate as quickly as possible in a straight line for just a few seconds and then jump four times, decelerate rapidly, turn, accelerate as quickly as possible, and jump over the hurdles again. In designing a strengthening program, there is a need to focus on strengthening pelvic limbs for acceleration and jumping and on strengthening the forelimbs for braking and turning. Specificity also should be present in the exercising environment (ie, surfaces, temperature, humidity, surroundings). The overload principle is arguably the most critical factor in training. It states that to increase strength (or endurance), a load that exceeds the metabolic capacity of the muscle system or cardiopulmonary system must be achieved during exercise. The systems must also be exercised to fatigue to promote improvement. The principles of specificity and overload apply to conditioning sled dogs, in which pulling is an important specific exercise to illustrate the overload principle. A conditioned sled dog does not improve its fitness level by running on a treadmill or outside at 3 mph for 1 hour five times per week. This level of exercise does not increase its cardiopulmonary endurance or strength for competition, because it does not stress these systems enough

to cause adaptation. If improving fitness is the goal, these dogs should exercise while pulling a sled at reasonably high intensities (race speed) for reasonably long periods. If time available during training is an issue and the dog has only 3 hours per training session, the speed could be increased 10% over normal race speeds to stress these systems adequately. Swimming, although a good endurance exercise, does not work the musculoskeletal system of a sled dog in the same manner as the sport. The stresses and subsequent adaptations on the bones, ligaments, and cartilage that occur with weight-bearing exercises are not provided to the same degree with swimming or underwater treadmills. Strengthening exercises include trotting, trotting uphill, pulling weight or a cart, swimming, galloping, controlled ball playing, retrieving, dancing, and wheelbarrowing. Speed exercises include rapid acceleration and deceleration on level uphill and downhill terrain, ball playing, and playing and racing with other dogs.

Endurance is critically important to sporting dogs that perform prolonged efforts, for example, long-distance races (ie, sled dogs) and herding. Aerobic endurance exercises usually target large muscle groups for a prolonged period (more than 15 minutes). They are performed several times per week. Long-term changes occurring in muscle undergoing aerobic training include increased vascularization, which increases the amount of oxygen brought to muscle. In conditioned endurance athletes, several other important changes occur. These changes include decreased resting heart rate and increased stroke volume because of increased vagal tone, which allows greater time for ventricular filling; decreased resting blood pressure, thought to be attributable to a decrease in circulating catecholamines in the bloodstream; an increase in enzymes involved in the oxidative pathways so that ATP can be generated more rapidly; and increased capillary density within the muscle to allow for more efficient delivery of oxygen and greater oxygen uptake, resulting in improved performance. Training also positively affects the strength and stiffness of all musculoskeletal tissues. It makes cartilage and ligaments stiffer, and bones, muscle, and tendons are stronger. Exercise does not seem to increase the likelihood of osteoarthritis in dogs free of predisposing factors (ie, obesity, limb malalignment). Endurance exercises are performed for sustained periods of 15 minutes or more. They include trotting, swimming, land or water treadmill activity, and sled pulling. Monitoring of variables, such as heart rate, during exercise is commonly performed in people but rarely done in dogs. Recommendations of percentage of maximum heart rate that dogs should train at for optimal conditioning are unknown but may help to determine more efficient training regimens.

Exercise enhances balance and proprioception. Balance is the ability to adjust equilibrium at a stance or during locomotion to adjust to a change in direction or ground surfaces. Proprioception is the unconscious perception of movement and spatial orientation originating from the body. Sporting dogs need to have well-developed balance and proprioception to adjust to the specific challenges of their activities. Proprioception decreases with age in people. Proprioceptive training includes activities that may be performed at low or high speed and require an awareness of limb position in space. They include walking in circles or a figure-of-eight and walking across obstacles of various shape, height, and spacing. Balance exercises are exercises requiring rapid responses to changes in slopes, such as walking on a trampoline, balance or wobble board, and swimming. Other balance and agility exercises include Cavaletti rails, exercise balls, rapid changes of direction while trotting and galloping, ball playing, tug-of-war, dancing, and wheelbarrowing. Adequate rest is important during conditioning to prevent muscle fatigue and lower the likelihood of overuse injuries. Conditioning, however, decreases rest requirements in dogs. Conditioning also minimizes the circulating lactic acid after intense muscular activity. It decreases the likelihood of rhabdomyolysis, a syndrome resulting from hydrogen ion accumulation in muscles during exercise; muscle swelling and ischemia; erythrocyte death in muscles; myoglobinuria; and potential renal failure. Rhabdomyolysis is primarily seen after intense exercise in poorly conditioned dogs. Sporting dogs often exercise all year long, with periodic higher intensity times corresponding to their competition season.

Sports injuries

Sporting dogs may experience a variety of orthopedic injuries and problems affecting their bones, joints, ligaments, muscles, and tendons (Table 2), resulting from the increased physical demands placed on them. Overall, specific sports injuries are unusual in most sporting dogs. Injuries in sporting dogs result from trauma induced by the activity (ie, a disk dog rupturing a lateral collateral ligament while landing after a jump) or trauma induced by an accident occurring during activity (ie, a racing Greyhound catching the lure at high speed during a race, leading to a pile-up of the racers within that race), (2) chronic overload injuries (ie, fatigue fracture of a central tarsal bone fracture in a racing Greyhound or contracture of the tendon of insertion of the infraspinatus muscle in a hunting dog), and (3) preexisting orthopedic diseases (ie, a field trial dog with hip dysplasia showing signs of the disease after a field event).

Table 2. Common orthopedic injuries and problems linked to sporting activities in dogs

Structure	Injury	Dogs affected	Treatment
Bone	Tarsal and carpal fractures	Racing Greyhounds	Sx, bone screws
	Acetabular fractures	Racing Greyhounds	Sx, bone plate
Joint	Interphalangeal luxations	Racing Greyhounds	Sx (when severe)
Carpus	Accessory carpal bone fracture	Racing Greyhounds	Sx, bone screws
Elbow	Traumatic FMCP	Racing Greyhounds	Sx, excision
Shoulder	Medial glenohumeral ligament sprain	Agility, hunting dogs	No Sx
Hock	Distal tibial fracture	Racing Greyhound	Sx, bone plate
	Central tarsal bone fracture	Racing Greyhound	Sx, bone screw(s)
Stifle	Traumatic cruciate ligament avulsions	All sporting dogs	Sx, stabilization
Hip	Craniodorsal luxation	All sporting dogs	Sx, stabilization
Ligaments	Cranial cruciate ligament injuries	Flyball dogs, Disc dogs	Sx, stabilization
Muscle	Tear: gracillis mm., tensor fascia lata mm	Racing Greyhounds	Sx, repair
	Tear, long head of triceps mm	Racing Greyhounds	No Sx
	Contracture: infraspinatus mm	Hunting dogs	Sx, release
Tendon	(Partial) common calcanean tendon tear	Hunting dogs	Sx (when severe)
	Superficial digital flexor tendon	Agility, herding	Sx, stabilization

Abbreviations: FMCP, fragmentation of the medial coronoid process; mm, muscle; Sx, surgical treatment.

Overall, few surveys have reported the relative incidence of injuries and problems caused by trauma, overuse, and preexisting diseases in sporting dogs. Traumatic injuries seem to be relatively unusual in sporting dogs, with the exception of dogs performing extremely intense activities (ie, racing Greyhounds). Stress fractures are also relatively unusual in sporting dogs, with the exception of racing Greyhounds, which have stress fractures of the acetabulum, metacarpal, radius, central tarsal bone, and possibly other bones. Most orthopedic problems encountered in sporting dogs seem to result from classic DODs (ie, hip dysplasia, elbow dysplasia, patellar luxation, osteochondritis dissecans). These diseases often remain undiagnosed for months to years until intense activity promotes the development of clinical signs. In most instances, changes, such as osteoarthritis, are present in the affected joints when the problem is diagnosed, confirming the chronicity of the problem. It is important to avoid overtraining high-performance dogs so as to avoid traumatic injuries resulting from high-impact activities performed while dogs are fatigued and to lower the likelihood of stress fractures. Sports requiring strength and speed require shorter training sessions than endurance sports. Overall, overtraining is difficult to define and is specific to each individual within each sport. The most effective protection against overtraining is to screen training dogs routinely for signs of lameness, pain, or tenderness while palpating joints and limbs or for exercise intolerance occurring during training and high-performance activities and to provide rest in fatigued dogs.

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