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Scientific Principles for Conditioning Race and Performance Horses

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ABSTRACT

The equine athlete undergoes significant musculo-skeletal changes during conditioning and competition. Unfortunately, lameness and losses are higher than desirable and the industry is challenged to use field-and laboratory-based principles for improving the well-being of race and performance horses. Body condition can be adjusted to delay fatigue and influence thermal regulation. Body weight estimates can aid in feeding horses more effectively. Preride checks and adequate warm-up are vital to the initial conditioning and specificity of training phases horses must undergo to be competitive. Heart rate provides a good monitor of how horses respond to exercise and can be used to minimize injury through effectively regulated overloading techniques. Diet plays a major role in conditioning and energy can be provided in a fashion to increase time to fatigue and improve heat dissipation. Cardiovascular fitness remains with horses longer than skeletal strength during off-periods and both ground surfaces and exercise schedules impact the length of time needed to prepare for the rigors of competition.

(Key Words: Exercise, Conditioning, Heart Rate, Diet, Fatigue.)

INTRODUCTION

Successful conditioning of the equine athlete is dependant on several factors. Genetics must be considered in selection for specialized events, because the relative percentages of muscle fiber types in horses vary somewhat between breeds (16, 52).

Training (behavior modification and learning) is an important factor that must be considered in a conditioning program. Fitness must keep pace with increased learning in order to prevent fatigue and lameness from negatively affecting a horse's ability or willingness to learn. Conversely, training must be adequate in order to channel the level of fitness toward the competitive activity. In race horses, for instance, sprint work is essential in conditioning two-year-olds, but they are not mentally mature enough to handle very much of it (48). Conditioning programs must be initiated with ample time set aside to give a horse the proper training needed. However, trainers must exercise some caution to avoid "over training", because when this happens, a horse's desire to perform can be negatively affected.

Age and skeletal soundness are two factors that play a major role in conditioning. Younger individuals possess less blood volume and do not have the oxygen carrying capacity of older, mature horses (23). Exercise also delivers significant concussion and strain to the bone, and this is likely influenced by gait and speed (40), among other factors. The skeletal system of a performance horse adapts to exercise or the lack of exercise by forming or removing tissue (19). During the remodeling process, there is a period of time in which bone

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strength is actually decreased (36,39). In young horses, the skeletal system must lay down new bone in response to both growth and exercise. Young race and performance horses often have a high degree of stress placed on their skeletal system (34). Because the horse's skeleton does not usually reach full maturity until 4 years of age or older (11, 27), injuries to the bones can and do occur. Wastage rates in the population of young performance horses seem high, and both training and conditioning programs are challenged to minimize lameness through more effective exercise and behavioral modification techniques. A race track study indicates that 90% of 2-year-olds developed bucked shins (48). Another study shows that 85% of injured horses have problems of the musculo-skeletal system (21). Although exact figures are not available, higher-than-desirable wastage rates also affect young halter horses, and occur in other areas of the horse industry. A study of one 150-mile endurance ride indicates 33% of horses failed to finish because of lameness or injury (26). Therefore, even in older horses, proper bone maintenance must occur, because lameness represents significant economic loss and causes conditioning to be slowed or stopped.

The genetic base is a given for the particular individual and learning is influenced by the ability of the trainer and early environment. However, feeding and conditioning can be adjusted to realize the maximum genetic potential of any athlete. Horses often experience fatigue during a variety of performances and they must be conditioned in a fashion that will delay the onset of acute fatigue. There are some key conditioning concepts that can be applied to maintain skeletal integrity, promote muscular contraction and relaxation, and help horses reach a higher level of fitness.

IDEAL BODY CONDITION (FATNESS)

Body condition is important in terms of fuel storage capabilities and it influences how efficiently a horse can regulate temperature and cool off during or after hard work. Recent research compared performance of horses with various body condition scores (50). Results indicate that a body condition score of 5 appears to be the most desirable for contributing to maximum performance. At a score of 5, a horse's topline or backbone is level (17). The ribs cannot be seen, but can be easily felt. Aside from conformational differences, the withers usually appear slightly rounded and the shoulders start to blend smoothly into the body at this level of fatness. Horses in condition score 5 are able to store more useable energy than horses in thinner condition. The thinner horses are more prone to early fatigue because they have to rely almost entirely on that energy that is derived from the daily diet (50). Another study showed that fatter horses require more energy to dissipate heat and cool themselves, meaning that less fuel is available for the performance activity (46). Consequently, horses in moderate condition are better able to effectively use dietary and stored energy specifically toward the performance activity, with a slower onset of fatigue and improved thermal regulation.

It is important to recognize that some horses will enter a conditioning program with the correct amount of body fat, whereas others may need to gain weight or lose weight as exercise occurs. Therefore, it is necessary to monitor horse's on a regular basis. Many people improperly estimate a horse's weight (22). Because performance horses are fed on a body weight basis, good estimates of weight are important. Horse weight can be estimated using the following measurements and simple equation (6, 31). Measurements are recorded in inches.

$$\frac{[(\text{Heart girth})^2 \times \text{Body Length}]}{330} = \text{Wt (lbs)}$$

Although less accurate than a set of scales, this estimate will often be within 25 lb (12 kg) of actual weight (13) and will help in determining feed intake, which usually varies from 1.5 to 3% of body weight daily. Horses doing intense work will often require total daily feed on the upper end of this range to maintain body condition, whereas a score of 5 will usually be obtained in horses with a light work load at a daily feed intake in the 1.5-2% of body weight range. Of course, the energy density of the grain mix, the quality of roughage being fed, and the actual level of activity all influence these amounts (38).

INITIAL CONDITIONING

A conditioning program should be initiated with a predetermined goal in mind (58). It is important to start early, avoiding the tendency to force a fitness development program into a short time period. In general, a conditioning program should begin with lower speed, long distance exercise. This is commonly referred to as long, slow distance work. The distance will need to increase from a negligible amount to longer distances. Long, slow distance work does not necessarily refer to how far a horse goes. Rather, this type of work deals with the amount of time (days) a horse is exposed to low heart rate, aerobic exercise. This early phase of cardiovascular conditioning usually takes place over a period of about 30 days. Exercise consists of walking, slow trotting, introduction of extended trot, loping, cantering, and some galloping. These types of exercise are categorized as "aerobic" because the horse's heart rate will almost always be less than 150 beats per minute. Approximate heart rates at different paces are shown in Table 1.

During these first days of exercise a trainer can begin to develop suppleness and achieve increased mobility of joints and tendons in horses. Exercise contributes to skeletal maintenance and bone will lose its strength when not used. However, care should be taken to go slow to build a proper foundation during early stages of conditioning. For out-of-shape horses that are also too heavy, this aerobic work allows stored fat to be mobilized and burned as a fuel source. Horses that are too thin or horses that will eventually be competing at moderate to intense work loads can be slowly introduced to fat-supplemented diets during this stage of conditioning. It takes at least 1 week for the athlete to adapt to digestion of fat-supplemented diets and 3 weeks to 1 month until they are properly utilized to provide fuel (25,45). The previously mentioned aerobic work will provide the avenue for this energy metabolism. Although it only takes about 1 month to develop a significant amount of aerobic, cardiovascular fitness in horses, effects on tendons and bones often take much longer (36, 39). Therefore, one is challenged to spend enough time in the initial conditioning phase to set the proper background for higher intensity work that a horse will later become cardiovascularly conditioned to accomplish (54,55).

TABLE 1. Approximate heart rates at different paces.

Activity	**Beats per minute**
Standing[a]	40
Walking[b]	80
Slow trotting[b]	80 to 90
Slow loping[b]	100 to 120
Trotting	
238 m/min[a]	120
298 m/min[a]	140

[a]From Snow and Vogel (52).
[b]From Scott et al. (50).

PRE-RIDE CHECKS

Every work period should begin with a pre-ride assessment to determine how well the horse is responding to exercise. A daily workout can begin with a quick check of resting heart rate. Horses have average heart rates of 30-40 beats per minute at rest. Preconditioning checks can be made several times to determine what is normal for a given horse. This can be accomplished by use of the fingers to palpate the facial artery under the skin in the area of the horse's lower jaw (52). Counting the pulses for 15 seconds and then multiplying that number by 4 will produce the pulse rate, which is synonymous with heart rate in beats per minute. Generally speaking, an elevated resting heart rate represents one of two things. It can be an adrenalin response caused by a noise or object that startled the horse. However, an elevated heart rate can also be a signal that the horse is experiencing some level of discomfort because of pain, unnatural stress or illness (12).

A horse's respiration rate during rest will range from 8 to 16 breaths per minute. As with heart rate, it is important to determine what is normal for an individual horse. By watching the horse's nostrils and counting respirations per minute, the astute rider can use this as a signal for possible problems. Although changes in temperature and humidity will influence respiration rate, when these are constant, respiration will be in response to movement or activity. With practice, horsemen can become more aware of changes in both the rate and depth of respiration that is normal for a given horse.

A preride check should also involve visual observation of the horse at a walk and trot, either in a pen, on a walker, or while being led. Very often, some slight indication of stiffness may be the reason for an elevated heart rate. Other preride checks such as simple limb flexion tests can be good determinants of status.

One very important preride check involves that of identifying specific areas of sensitivity. While a horse is being brushed and groomed is the ideal time to evaluate back or loin soreness. Using the thumb and forefinger on each side of the withers, apply gentle pressure and move down the back, loin and croup. At some point in the conditioning program, many horses will exhibit loin soreness and will express it by dropping down away from the pressure that is applied. This type of soreness often results from backing, sidepassing, two tracking, and collection drills that work the muscles in a horse's back. Although it is common for some soreness to occur, regular checks will help determine the type and amount of work that can be conducted as the loin area becomes stronger. When pre-ride factors such as elevated resting heart rate, stiffness, and muscle soreness are detected, these are signs that exercise should be approached in moderation. Because of this, many conditioning programs frequently allow horses to have a day off with ample free exercise in a large corral, paddock or other enclosure.

Any soreness or stiffness not noticed during the preride check will often be felt or detected during the warm-up phase of a ride. This warm-up period is crucial to all conditioning programs and is one of the key components in minimizing chances for exercise-related injuries. A goal of warm-up is to raise body temperature and increase blood flow to working muscles (2). A recent study found that exercise and recovery levels of lactate were lower in horses that were warmed up, supporting the theory that oxygen availability is improved by proper warm-up. Exercise should ideally begin with a warm-up that involves walking for about five minutes. Some bending and other lateral movement drills as well as trotting should then be introduced. This walking and trotting limbers the horse up, loosening muscles and tendons. It also allows the muscles to warm up so they can accommodate harder work by more adequately relaxing and contracting (52, 54, 58).

ADVANCED STAGES OF FITNESS DEVELOPMENT

Once horses have been through the slow distance work, are being warmed up correctly, and respond positively to gradually increasing levels of exercise, the harder or more demanding types of exercise can be slowly introduced. The most effective conditioning programs are those that carefully introduce high intensity, short duration work. This type of exercise is considered to be "anaerobic", because the muscles are now working too hard or fast to rely solely on oxygen in the process of burning fuel. This anaerobic condition occurs, on the average, when a horse's heart rate goes above 150 beats per minute, but the exact point may vary between 120 and 180 beats per minute (15, 54). This is referred to as the "anaerobic threshold" and when horses cross it they become more subject to energy depletion and fatigue. However, this type of work must be accomplished in the process of conditioning a horse. Shown in table 2 are examples of various types of work that normally push heart rates above this threshold. When introduced correctly, these types of high intensity, short duration work add to the horse's level of fitness. However, to be effective, these exercises must be specific and must be increased in gradual, overload fashion. Being specific, or "specificity of exercise", means that the type of work must emulate the competitive event in which the horse will later be required to participate.

Race horse trainers utilize long, slow distance training in the early stages of conditioning, but sprinting must eventually be introduced. Otherwise, a race horse would become conditioned to last, but not conditioned to go fast. Speed work is important for bone remodeling. According to a study at New Bolton Center (48), gallop training alone, without breezing, results in bones that are similar in strength to horses on pasture. Bones remodel according to the type and amount of stress they receive. However, the skeletal system responds to exercise more slowly than do the muscular and cardiovascular systems (36). Specificity of training (e.g., sprinting a race horse or working cattle on a cutter) signals the bone to remodel in a fashion that will prepare the horse for the rigors of competition. The goal in this process is to increase stress gradually, using specificity and gradual overloading, without causing injury (19, 32, 36, 48).

TABLE 2. Approximate heart rates at more intense levels of exercise.

Activity	Beats per minute
Cantering (348 m/min)	160
Stop and rollback	160-170
Cutting a hard-turning cow	170-200
Stopping and rope work (calf roping)[c]	180
Cantering (500 m/min)	200
Galloping (800-1000 m/min)	200-250

[a]From Snow and Vogel (52).
[b]From Webb et al. (61).
[c]From Texas Agricultural Extension Service Method Demonstrations.

After 4-6 weeks of slow distance work, a race colt may only be sprinted for a short distance. However, by gradually overloading, interval training can effectively increase the amount of work a horse can perform prior to fatigue. Research shows that sprint training twice weekly over 6 weeks, with periods of rest between sprints in a workout, can increase the number of sprints a horse accomplishes before the onset of fatigue (10). However, for this type of conditioning to be effective, the trainer must utilize rest periods between sprints and must know when to cease sprinting for that day (61). A horse that is going to be raced in a 1¼ mile race may never run a full 1¼ miles at full speed. However, this horse can be conditioned for a 1¼ mile race by sprinting shorter distances with active rest periods in between sprints.

The same principle applies to a cutting horse. By working one cow for a shorter amount of time, then returning to the herd for a second cow, the horse can sharpen movement skills and improve ability more effectively than working one cow for an extended time period. The time in the herd serves as active rest that lets the horse work the second cow, or even a third cow more accurately.

A reining horse is yet another example of how this method can be used with success. Rather than continually being asked to run and slide, a reining horse will be galloped and stopped, then rested by some standing and walking before the next gallop/stop repetition. This allows each repetition to be accomplished with comparable effort and precision.

Unfortunately, many performance horses are never overloaded adequately for fear of break-downs prior to competition. However, the day of competition should represent a level of work that can be accomplished without injury. Horses must become fit enough to excel in performance without experiencing failure during the event. The harder a horse works, the greater the load to the bone (35) and the various stages in bone remodeling **do not** occur over night (36, 39). Therefore, decrease in load on the bone can be accomplished by withholding the hard work for a period of time (28). Current research has yet to determine exact exercise schedules and intervals between hard work. However, at this point it makes sense to stimulate the bone to remodel by introducing limited numbers of high loads for very short periods of time (3). Today, some exercise programs for performance horses utilize 3 days of slow distance work, 2 days of higher intensity, shorter duration work and 2 days of active rest (free exercise) in every week. One such example is shown in table 3.

It is also important to continue some slow distance type work even as higher intensity exercise is introduced (32). A study of young race horses provides one example of how this principal is applied. Thoroughbreds receiving daily work of 18-20-second furlongs also work

TABLE 3. An example of weekly exercise schedule[a].

Day	Activity
1	Long, slow distance
2	Higher intensity, short duration
3	Free exercise
4	Long, slow distance
5	Higher intensity, short duration
6	Free exercise
7	Long, slow distance

[a]Dependent upon preride checks, response during warm-up, and other factors.

two additional (17 second furlongs). However, the horses work only the additional distance at a faster speed and only twice weekly. All the other work is achieved at the regular speed that the horses are accustomed to galloping. This type of conditioning will target various maneuvers that may be a part of the competition. But more importantly, it will contribute to musculo-skeletal maintenance and strength.

Horse trainers who have access to an on-board heart rate monitor can conduct field tests to better assess improvement or changes in fitness (15). A velocity test (V_{HR}) is accomplished by accelerating a horse to a given heart rate, at which time the distance covered and the time required to cover that distance are both determined. Velocity can then be calculated as follows: V_{HR} = distance traveled divided by time. A V_{HR} during the fifth week of training can then be compared to a V_{HR} during the sixth week of training, and so on. As a horse becomes more fit, a higher velocity will be reached for that heart rate. With such tests, it is important to keep environmental influence as constant as possible. Changes in humidity, rider, time after feeding or drinking, amount of warm-up, footing (soft vs. hard, wet vs. dry) and other factors will give results that cannot be compared. Tests such as this will be even more useful when recovery rates are also monitored. Although, velocity may be improving, it may be jeopardizing musculo-skeletal integrity. Therefore, the recovery rates can tell the rider whether to proceed more carefully or continue at this level of increasing work.

RECOGNIZING FATIGUE

Specificity of training and proper use of the overload principle must involve the horseman's ability to recognize acute and chronic fatigue. Many working horses experience some degree of acute fatigue on a regular basis. A well fit reining horse is often acutely fatigued at the end of a reining pattern, as is a race horse at the end of a race. However, when fatigue occurs too early, it is important to recognize this and condition the horse in a fashion that will delay its onset.

Recovery heart rates provide information that can be very helpful in knowing when a horse has reached a level of fatigue that is significant enough to make it necessary to cease exercise. For example, team ropers often rope steers as a means of conditioning the horse. This certainly represents specificity of training, but excessive overload in a continuous fashion can bring about a level of fatigue significant enough to cause lameness or soreness. This is just one example of a situation in which modified interval training can be accomplished with success, provided the team roping runs are separated by recovery times. Shown in figure 1 is a series of heading horse runs that are separated by recovery times noted at 5 minute intervals. These are examples of heart rate curves for a relatively unfit horse.
The 5-minute recovery shows that the rate of recovery after the second steer is somewhat similar to the recovery after the first steer, indicating that this horse can continue. The peak heart rate for the second run is slightly higher than that observed during the first run, suggesting the horse is performing harder and that some overloading is actually occurring. However, this would not be recognized by the roper unless an on-board heart rate monitor is being used. What will be noticed, however, is that the heart rate after the third run remains elevated longer and there was less recovery than that observed for the first two runs. The roper is able to retrieve this data by palpating the artery under the jaw and can immediately stop roping for that day, before injury occurs to the horse. This is just one example of how recovery rate can be monitored and used as an

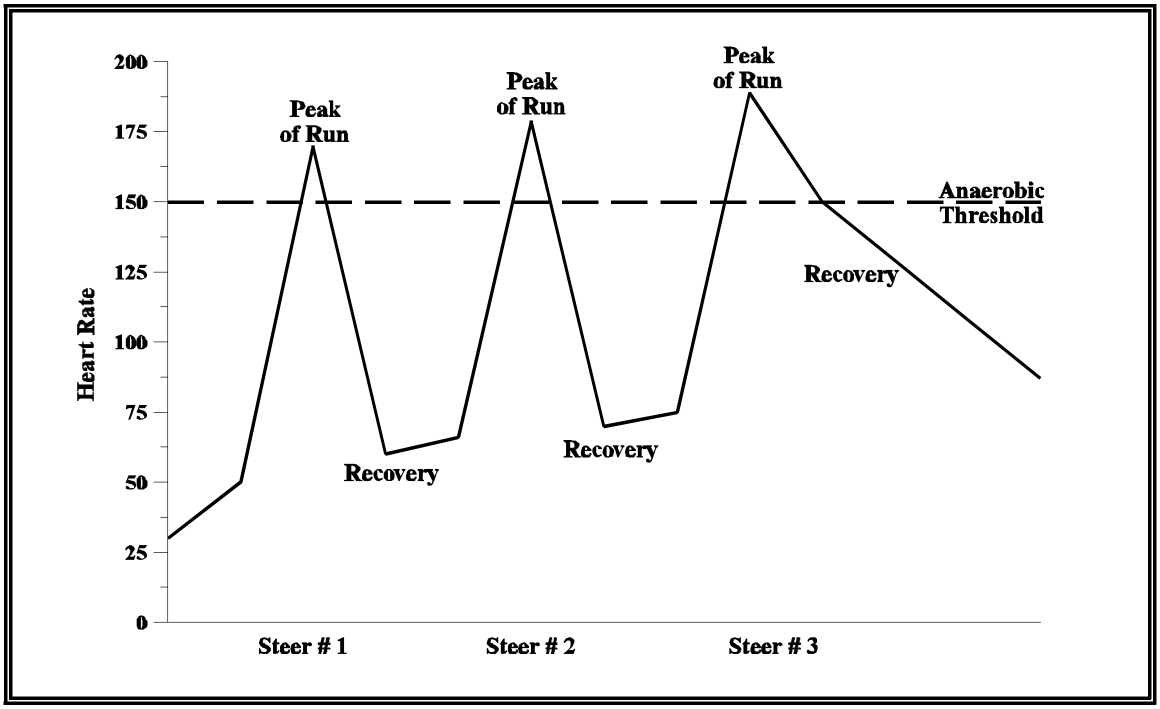

Figure 1. Example heart rate curves and 5 minute recovery heart rate of a relatively unfit heading horse roping three steers.

important signal, regardless of the event or horse. In many cases, a horse that stumbles slightly while setting a steer, has a difficult time pulling or is a little slower to face the steer is sending the signal to the rider that it is reaching fatigue. When this happens, it can be verified by comparing recovery heart rates. The bottom line in using recovery heart rate data is to look at 1) speed of recovery and 2) how low the heart rate falls during a specific recovery time.

EFFECT OF DIET

Muscle fatigue is thought to be brought about, at least in part, by the accumulation of lactic acid and ammonia that occurs in the muscle when glycogen is used for energy (4). Although lactate accumulation can be a problem, depletion of muscle glycogen is the most a significant factor (41, 50). It usually takes from one to five days for glycogen stores to be replenished in the muscle, depending on the amount of depletion. However, the amount of glycogen depletion can be controlled to some extent by bringing the exercise and feeding program into close synchronization. As previously mentioned, aerobic type work allows the horse's muscles to take in oxygen for use in burning carbohydrates or fat as an energy source. So, at a lower heart rate, the working horse can mobilize stored fat and can burn dietary fat such as vegetable oil or animal fat (30, 41, 45, 62). In fact, grain mixes can contain up to 10% added fat, offering some advantages for the horse. Fat contains over 2 times as much energy as typical carbohydrate diets (i.e. corn, oats, barley) meaning that the same amount of energy can be provided in lesser amounts of total feed. Fat is utilized differently than carbohydrates and can contribute directly to the athlete's demands for energy during long, slow distance work. Because of this, fat can indirectly contribute to the horse's need for quick energy (glucose, glycogen) by sparing the use of glycogen during many routine exercise. Recent research also shows that dietary fat can aid in thermal regulation by decreasing heat production, resulting in less heat that must be removed from the body (51).

If a horse has no stored fat or receives no dietary fat, exercise that occurs aerobically will result in the use of blood glucose and muscle glycogen as principle energy sources. As glucose and glycogen are used for this work, less remains available for anaerobic work. This is because higher intensity, short duration work (anaerobic work) is being attempted with a muscle glycogen supply that has already undergone substantial depletion. Conversely, when a source of dietary fat is available, it can be burned as energy during exercise that is of low enough intensity to let the muscles rely on use of oxygen. When fat is being used, less glycogen is being depleted from the muscle. Therefore, more quick energy remains readily available when needed for harder, more difficult maneuvers. Research shows that cutting horses work harder, executing a higher percentage of hindquarter turns, when conditioned on a fat-supplemented diet (25, 62). This work, as well as work with sprinters, also shows that proper utilization of fat in the diet actually increases time to fatigue. A recent study found that race horses were able to run faster at a constant heart rate when fed fat-supplemented diets (41). Therefore, dietary energy plays a vital role in the intensity and length of effort a horse can expend for a performance and is paramount to the effective conditioning of horses with decreased chances for injuries related to fatigue.

Studies to determine the optimum time for feeding prior to exercise are somewhat inconclusive at this point (42, 53), but other work suggests that feeding 1.5 hours after exercise helps prevent further depletion of muscle glycogen stores (1).

A variety of vitamins and minerals are integrally involved in muscular contraction and relaxation, and in skeletal maintenance (38). Because blood is involved in nutrient supply to both the muscles and the bones and in removal of waste products from the muscle, performance horse owners are often concerned about "building" the blood. Certain B-complex vitamins such as B_{12} are quickly voided in the urine, with no noticeable impact on blood parameters such as packed cell volume or hemoglobin content. Blood volume is increased with age and conditioning (23), and oxygen carrying capacity increases as blood volume increases. About 30% of the red cells are stored in the horse's spleen. During the excitement phase of competition, the spleen contracts, releasing red cells into circulation (44), causing packed cell volume to increase. As a result, the amount of hemoglobin that is available for oxygen transport also increases (59). Younger performance horses often have difficulty competing against older, seasoned horses simply because they have less blood, they have less splenic contraction, and their blood has less oxygen carrying capacity. It is therefore important to rely on exercise to improve these functions of the blood. Some B Vitamins such as thiamin (B_1) do play an important role in energy metabolism, partly by reducing the accumulation of lactic acid (57). Thiamin is usually synthesized in adequate amounts by the horse (5, 43), and uncalculated supplementation in the diet will not alleviate the need for a correct exercise program. Generally, thiamin supplementation will only be a consideration in limited cases in which heavily stressed, hard working horses show signs of a dull, lethargic attitude or of going off feed, and when these symptoms are not being caused by pain or injury.

Mineral balance is vital to bone remodeling and skeletal integrity. Bones of horses fed diets with inverted calcium:phosphorus ratios have less ultimate breaking strength (49). Therefore, total daily diets should contain more calcium than phosphorus. Sweating is an important way that horses regulate body temperature, but sodium, potassium, and chloride are lost in the process. Thus, it is important to maintain horses in electrolyte equilibrium (18), as electrolyte imbalances can ultimately lead to an osteoporosis or weakening of the bones (8, 56, 60). However, this is usually not a problem as long as horses receive a balanced diet that has been properly fortified with trace minerals and drink adequate amounts of water. The horse's muscles contain approximately 75% water, and horses must be allowed to drink adequately (14). Sweating causes blood volume to decrease, so water intake is important to keep blood flow adequate. The thicker the blood, the harder it is to pump (7). When this happens, cardiac output is reduced and oxygen carrying capacity of the blood is affected. Free access to water before an event probably helps the horse balance water and electrolyte metabolism during exercise (29).

CONDITIONING FOR MUSCLE

DEVELOPMENT AND BODY TONE

In some facets of the horse industry, exercise is used for purposes other than improving a horse's endurance, speed, or athletic potential. The main goal in fitting halter horses and sale horses is to maximize muscular development and improve overall body tone. Stock-type horses (i.e. Quarter, Paint, and Appaloosa) have a higher percentage of fast twitch muscle fibers which will increase in diameter more readily than the slow twitch fibers of a heavy hunter or endurance horse (52, 54). Halter horses will respond favorably to aerobic work that includes extended trotting or loping. This work will produce the overall tone required for conformation classes. But to really "fit" a halter horse, in terms of muscular development, exercise must also include maneuvers that target the fast twitch fibers. Round pen work that involves stops and rollbacks into the fence, and significant backing up, are examples of higher intensity, short duration work that can cause the diameter of these individual fibers to increase. Although these fast twitch fibers contract quickly, they have a low capacity for endurance. Therefore, this harder work must be introduced slowly and gradually. As with performance horses, such a conditioning program will need to consist of at least 30 days of slow distance work and up to 60 additional days to achieve the desired look. This usually works out well, because it takes a horse about 1 month to start shedding hair when placed on a lighting regime, and about 2 more months to completely "slick off". Care should be taken when overloading halter horses to get that optimum show ring look, because these young growing horses are receiving concussion on a juvenile skeleton. And many times, they are required to carry more weight (body condition score 6.0 to 8.0) than a performance horse. Consequently, musculo-skeletal injuries can sometimes be precipitated more easily.

WARM-DOWN OR COOL-DOWN EXERCISES

Regardless of the horse, the event, or the length of time into a conditioning program, success and longevity depend a great deal on how a work session is completed. For all horses, a workout must conclude with an appropriate warm-down period (9, 52). These closing minutes of an exercise bout or competition should include light work that will gradually bring the horse back to a resting state. In simplest terms, a warm-down should generally be conducted in the reverse order of the gaits and maneuvers used for the warm-up. Several minutes of slow trotting, followed by walking, will help the blood remove lactic acid from the muscle. One study of cross country event horses in France concluded that 10 or more minutes of trotting was needed to adequately remove lactic acid from the muscles at the completion of the event (24).

Controlled warm-down periods are equally important as warm-up periods to minimize stiffness and soreness.

MAINTENANCE OF CONDITION

Achieving fitness is much easier when a horse responds favorably to exercise and has a hearty appetite. Once a horse becomes conditioned, the biggest challenge is to maintain that degree of fitness. Periods of inclement weather sometimes force situations in which horses cannot be worked for several days and a slight injury can require rest for a period of time. These "time-off" periods normally do not have a serious affect on the level of cardiovascular fitness that has been achieved. In fact, even without continued training, fundamental fitness remains with a horse for 6 to 8 weeks (7). However even though cardiovascular conditioning does not fall off very quickly, it appears that the skeletal system is compromised during lay-offs that last several weeks (32, 48). Therefore, after a lengthy off-period, horses should be returned to the exercise program gradually. This can be a difficult task in those cases in which a horses wants to work harder than its skeletal system is ready to accommodate. For healthy horses in training, maintenance programs should strive to keep the horse legged up with just enough high intensity work to keep the harder maneuvers correct and coordinated. As long as the more difficult maneuvers are executed to satisfaction, the well conditioned athlete can normally receive slightly less high intensity work. In many cases, there is absolutely nothing wrong with giving a fit horse small amounts of time off. More often than not, this will improve behavior and some horses will seem to maintain a fresher attitude, being more responsive to the training program.

TYPES OF FOOTING

Surveys and studies of horses running on dirt tracks indicate that cannon bone problems occur in about 70% of horses, compared to less than 17% in horses trained and raced on grass (20, 37, 47). Research shows that horses running on a wood fiber track run over two times as many fast miles prior to injury than horses worked on a dirt track (33). Although the use of a wood chip surface might help reduce stress, the horse would be training on one type of footing and competing on another (33, 48). Consequently, the skeletal system might not remodel properly for dirt track racing if all of the conditioning occurred on a wood chip surface. A study at Fair Hill Training Center evaluating 2-year-old Thoroughbreds on both dirt and wood fiber surfaces suggests that the distance of fast work should be reduced by about 50% when horses are changed from a wood fiber to a dirt track (32). Such a change delays a horse's first race by 30 days as fast work distance is slowly increased on the firmer footing (32). Studies with Dutch Warmblood horses suggest that short, intense work should take place on firm footing as opposed to very soft, deep footing (3). Those surfaces that are more yielding seem to have practical use in early, preconditioning stages, as well as in conditioning horses as they first return to exercise after an illness or lengthy lay-off. Other methods of exercise, such as swimming, can also help target the cardiovascular system without putting unwanted stress on bone that is in the rehabilitative process. To date, the research that has been reported seems to support the concept of conditioning horses on the same kind of ground they compete on, while being careful to use high intensity work for short periods of time.

CONCLUSION

Conditioning of the performance horse is influenced by a variety of factors. Horses differ in ability, behavior, and strength, and performance events vary enough in duration and intensity to require specialized training programs. Regardless of the competition or the horse, there are several important concepts that should be employed to develop a well conditioned horse. As industry adopts principles based on field and laboratory research, the well-being of equine athletes will undoubtedly be improved and public perception of the industry will be enhanced.

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