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ABSTRACT

Track and field coaches have a large variety of training tools to use in the strength and conditioning of their athletes. Each of these tools have advantages, disadvantages, and are supported by varying degrees of research. It is important for the coach to carefully weigh the advantages and disadvantages so as to make the most effective use of an athlete’s training time. This article will cover the Olympic lifts, the power lifts, kettlebells, suspension training, battle ropes, and sandbags.

Track and field coaches have a number of tools that can be used in the strength and conditioning of their athletes. Regardless of the level of athlete that a coach works with, there is only a finite amount of time for training and a finite amount of ability to recover from training. As a result, it is important for a coach to understand why these tools are used and to carefully weigh their advantages and disadvantages. This article will cover the following tools:

- **OLYMPIC LIFTS**
- **POWER LIFTS**
- **KETTLEBELLS**
- **SUSPENSION TRAINING**
- **BATTLE ROPES**
- **SANDBAGS**

OLYMPIC LIFTS

Used for track and field athletes, the Olympic lifts involve variations of the snatch, clean, and jerk exercises. These exercises are performed at a high velocity (generally 2-4 meters/second), are performed standing, involve most of the muscles of the body, and result in significant power outputs (values as high as 50 watts/kg have been recorded during certain phases of the lifts) (Garhammer 1976, 1991, 1993). For all these reasons, strength and conditioning coaches favor these lifts in the training of athletes (Stone 1993). The Olympic lifts and their variations can be performed with barbells and dumbbells. The snatch and clean can be performed in a “squat” style, which involves the athlete receiving the barbell in a full squat. They can be performed in a “power” style, during which the athlete receives the barbell in a quarter squat. They can be performed “split” style, in which the athlete receives the barbell in a position where one foot is forward and one is backward. The Olympic lifts can also be performed off one leg. Jerks can be performed “split” style, they can be done “power” style where the athlete receives the barbell in a quarter squat, or they can be done “push” style where the athlete uses his/her legs to drive the bar off their shoulders (Cissik 2003).

The Olympic lifts are used to enhance total body power in track and field athletes. Due to their technique and speed, they are performed towards the beginning of a strength training workout. The volume
is low (usually no more than six repetitions per set) with weights anywhere between 50% and 90% of 1-RM (Cormie, et al 2007).

For all of their benefits, the Olympic lifts have shortcomings. First, they are enormously technical which means that there is a long learning curve before an athlete masters the lifts. Because they are technical they also require specialized coaching and equipment. Second, while the velocities and power outputs sound large, they don’t necessarily match up well with track and field performances. For example, release velocities of between 14 and 29 meters/second have been reported in the throws event (Badura 2010, Isle and Nicdorf 2010, Lehmann 2010, Mackala 2007, Schaa 2010) and power outputs of 60 watts per kilogram have been reported in sprinting (Majumdar and Robergs 2011). Third, much of the research on the Olympic lifts is based upon studies of elite weightlifters, this data may or may not be reproducible for other kinds of athletes (Cissik 2011).

**POWER LIFTS**

The power lifts are variations of the three exercises contested in the sport of power lifting. These include the squat exercise (where the athlete squats down and then stands up against resistance), the bench press (the athlete lies down and lowers a weight to the chest, then presses it up), and the deadlift (the athlete squats down, grips a barbell, then stands up with it). These exercises can be performed at a high velocity (2-4 meters/second), two of them are performed standing, athletes can develop significant levels of strength with these exercises, and between the three lifts most of the muscles of the body are trained. For all these reasons, many of these lifts are featured prominently in a track and field athlete’s training. The power lifts and their variations can be performed with barbells and dumbbells. The squat can be done with the bar on the back of the shoulders (i.e. “back squats”), with the bar on the front of the shoulders (“front squats”), split style, or even one-legged. The bench press can be performed on a flat bench, on an incline bench, or on a decline bench. All variations of the bench press and the squat can be performed with an exaggerated eccentric phase (called an “eccentric squat” or “eccentric bench press”) or with a pause at the bottom of the lift (called a “pause squat” or a “pause bench press”). The deadlift can be performed with a narrow foot stance (called a “conventional deadlift”) or a wide foot stance (called a “sumo deadlift”). It can be performed standing on a raised platform or with the barbell at a raised height.

All the power lifts and their variations can use chains or elastic bands to supplement the exercises. Both are designed to take advantage of features which are unique to free weights. Chains involve wrapping chain links on the ends of the barbell and allowing them to droop towards the floor. The idea being that as the barbell is lowered, chain links accumulate on the floor reducing the load on the barbell. Then as the barbell is lifted, the links are lifted off the floor increasing the load on the barbell. Bands involve wrapping large rubber bands around the ends of barbells and attaching them to either the floor or attaching them above the bar. The bands “want” to remain shortened, so as they are stretched out they increase the resistance on the bar. Then as they are shortened, the athlete must control the barbell to resist the fact that the bands will attempt to shorten quickly. Originally bands and chains were designed to train specific weaknesses associated with the power lifts, but they have made their way into mainstream strength and conditioning. Research on the effectiveness of bands on both the bench press and squats seems promising and shows that they increase strength more than training without bands (Anderson, et al 2008; Bellar et al 2010). There is not as much research looking at how chains impact the results of training (McCurdy et al 2009).

The power lifts have shortcomings. First, extremely heavy strength training carries risks and rewards.
The reward is that to a point strength will probably enhance acceleration, speed, jumping, and throwing. However, there is also probably a point of diminishing returns with regards to strength (i.e. past a certain strength level added strength may not enhance performance in track and field). As an athlete increases his or her strength, there is a risk of injury that increases as the athlete gets closer to his/her genetic potential (Cissik 2010). Second, there are inherent dangers to the athlete with many of the power lifts and their variations. This means that these lifts require spotters to help protect the athlete. Third, the velocity of the barbell (~2 meters/second and the power output of the lifts (4-11 watts/kg) do not match up well to those seen in track and field (Garhammer, 1993).

The volume and intensity of the power lifts depends upon the goal behind using them. When training for maximum strength, the volume is low (less than eight repetitions per set) with a high intensity (up to 100% of one repetition maximum). If the power lifts are primarily being used for hypertrophy training, then the volume is moderate (eight to twelve repetitions per set) with a moderate intensity (70-85% of 1-RM). Regardless of the reason for using them, these exercises are done towards the beginning of a training session while the athlete is still fresh.

**KETTLEBELLS**

Kettlebells are weighted metal balls with a handle on top (Brummitt 2010). Any exercise that can be performed with a barbell or a dumbbell can be performed with a kettlebell (Harrison et al 2011). In fact, some authors promote the use of kettlebells with the Olympic lifts (Brummitt 2010). In addition, the unique design of the kettlebell allows for a range of exercises not possible with the barbell or the dumbbell. These include swings, get ups (lie down, press the kettlebell up, keeping the arm extended with the kettlebell overhead), and windmills (stand up, press the kettlebell up, keeping the arm extended and the kettlebell overhead lean to one side, reverse directions).

Kettlebells have mass, which means that an athlete becomes stronger a heavier kettlebell can be used. As a result, they can be used to improve strength, hypertrophy, and power. They can also be used for metabolic conditioning. Some exercises may be done for time or circuit-style to help improve endurance. There is a lot of anecdotal information on kettlebells, but there is almost no research on this tool (Farrar et al 2010). Two studies in particular represent the current state of the literature. Farrar et al (2010) found that swinging a 16 kilogram kettlebell for twelve minutes would increase heart rate and oxygen consumption. This suggests that it might be a tool for training aerobic capacity. Manocchia et al (2010) found that ten weeks of kettlebell training would increase barbell bench press, barbell clean and jerk, and lower back endurance. This study reinforces the ability of the kettlebell to increase strength, power, and endurance.

The programming for kettlebells resembles that for the Olympic lifts or the power lifts if the desire is to train for power, maximal strength, or hypertrophy. They can also be used for metabolic conditioning, in which case the exercises are performed for periods of time with a recovery period that is carefully chosen to make the session more difficult or less.

**SUSPENSION TRAINING**

Suspension training involves performing bodyweight exercise with one part of the body suspended in the air. Body weight exercises from push-ups to modified pull-ups to bicep/tricep exercise, gymnastics exercises, core training, and lower body exercises can be performed using suspension training. This training tool has the benefit of requiring the athlete to develop his or her balance as well as develop a number of stabilizing muscles in order to perform the exercises.
successfully (Quelch and Lichter 2008). Suspension training is performed circuit-style and often performed for time (for example, perform push-ups for 30 seconds). It lends itself to metabolic conditioning. Suspension training does have a number of concerns. While there is a great deal of anecdotal information on suspension training, there is a lack of research on this training tool. Two abstracts from the 2011 National Strength and Conditioning Annual Conference show that suspension training may be effective at elevating growth hormone, testosterone, and insulin-like growth factor (Dudgeon et al 2011, Scheet et al 2011).

**BATTLE ROPES**

Battle ropes are long, thick ropes that are used for metabolic conditioning. Essentially athletes perform a variety of total body exercises for time. Anecdotally, this training tool allows the athlete to do something else besides just sprinting for metabolic conditioning. It is a total body exercise and can be a lot of fun. On the other hand, there is not a lot of overload possible with this exercise. The weight and length of the rope is fixed. While the athlete can perform the exercise for longer periods of time, this may soon cause the wrong qualities to be developed. Currently, there is no research on battle ropes.

**SANDBAGS**

Sandbags represent another new mode of exercise that is open to the track and field athlete. Sandbags are just what the name implies, bags filled with differing amounts of sand. As the bag is lifted, it must be gripped so that the athlete has to develop his or her grip strength. As the bag is lifted, the weight shifts around. This instability may be more transferable to real-life than the fixed barbell, dumbbell, or kettlebell (Roozen 2008, Sell et al 2011). Any exercise that can be performed with a barbell or dumbbell can be performed with sandbags (Roozen 2008). They can be used to train hypertrophy, strength, power, and endurance depending upon the resistance, volume, and amount of recovery between sets. While there are coaching articles on sandbag training (see Roozen 2008 and Sell et al 2011), there is no research on this subject.

A track and field coach has a large number of tools that he or she can use in the strength and conditioning of their athletes. While there are many tools, it is not clear that all are as equally effective in the development of the athlete’s potential. It is important for the coach to be a good consumer of information in order to be able to make the best use of an athlete’s limited training time and ability to recover from exercise.

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AUTHOR BIOGRAPHIC INFORMATION

John Cissik is the president of Human Performance Services, LLC which helps athletics professionals solve their strength and conditioning problems. He has written ten books and more than 70 publications on strength and speed training and frequently speaks on these topics. John can be contacted at: cissik@yourhpservices.com.

NOTES
The purpose of this investigation was to evaluate the potentiating effect of warming up with a heavy shot put on subsequent standing shot put performance. The participants were eight high school-aged female shot putters (age: 170±1.7yr, ht: 168.3±9.9cm, wt: 95.5±21.5kg, best competition shot put performance: 12.2±1.5m). The treatments included a standing throw with either a 4.5kg or 5kg shot put, or competition weight 4kg (control). The repeated measures ANOVA did not reveal any differences by treatment (F=0.495, p=0.612). The means for each treatment were very similar (4k warm-up: 10.82m±1.6m; 4.5k warm-up: 10.57m±1.7m; 5k warm-up: 10.35m±1.6m). Although the differences were not significant there was a trend from reduction in performance at the weight of the warm-up implement increased. In moderately trained female athletes the use of heavy shot puts as part of the pre-activity warm-up does not enhance shot put performance based upon the data from the present investigation.

INTRODUCTION

In recent years, competition in the women’s shot put has developed to such a high level that no athlete or coach can afford to neglect the application of scientific principles to the event. By utilizing a critical scientific approach to the shot put event, the throws coach will be able to determine more accurate adjustments and devise training stimuli to better accommodate the athlete ensuring improved and successful performances. Objective data on the shot put can be quantified, measured, and studied by researchers. As the knowledge base for the shot put continues to evolve, coaches must adapt their practices to ensure their athletes are being properly prepared for training and competition. Coaches must always consider scientifically supported evidence based pre-activity preparation routines when training their athletes.

Shot putting places a premium on being able to create very large forces over a relatively short period of time. It is of the extreme importance that athletes participating in the shot put are prepared to perform in an explosive fashion upon entering into the competitive venue (Judge, 2008). Problems with technique are usually the result of deficiencies in strength; as the athlete becomes stronger, he or she is typically able to perform better technically (Stone, Sands, Pierce, Ramsey, & Haff, 2008). Athletes participating in throwing events require extraordinary strength levels, as weight room one repetition maximums (1RM)
have been shown to be related to performance (Reis, & Ferreira, 2003). However, the throwing implement is much lighter (4 kg for girls, 5.44 kg for boys) than the loads used frequently during weight training sessions.

It is therefore advantageous to perform training that overloads the athlete near the specific force velocity requirements for the improved shot put performance. This overload will eventually allow the athlete to advance technically and perform more efficiently. This concept is well-known among knowledgeable coaches, and has in the past been referred to as special strength exercises (Judge, 2008). The part of technical training that remains a focus all year long, however, involves training specific throwing strength. Training to improve throwing strength that is specific to the technical positions in the throw can only be accomplished by incorporating special strength work into the strength and conditioning program of the thrower. The methodology for achieving this goal for athletes has been a throws training prescription involving the use of strength-power potentiating complexes (SPPC) utilizing overweight throwing implements (Robbins, 2005; Stone, Sands, Pierce, Ramsey & Haff, 2008). The SPPC includes the enactment of a high force or high power movement in order to potentiate a subsequent high power or high velocity movement (Robbins, 2005; Stone, Sands, Pierce, Ramsey & Haff, 2008). For example, a female athlete could warm-up with a 5.44 kilogram shot put in order to produce a post-activation potentiation (PAP) effect when throwing a 4 kilogram shot put directly after in competition.

What precisely is PAP and by what means does it work? The contractile history of a muscle influences the mechanical performance of subsequent muscle contractions. Strenuous/fatiguing muscle contractions impair muscle performance; whereas, non-fatiguing muscle contractions, typically at high loads of brief duration, may boost muscle performance (Stone, Sands, Pierce, Ramsey & Haff, 2008). Thus PAP is the intensification in muscle force and rate of force development that occurs as a result of previous activation of the muscle. The suggested mechanism for PAP is the phosphorylation of myosin regulatory light chains, which renders actin-myosin more sensitive to Ca2+ released from the sarcoplasmic reticulum during subsequent muscle contractions (Grange, Cory, Vandenboom, & Houston, 1995; Grange, Vandenboom, & Houston, 1993; Grange, Vandenboom, Xeni & Houston, 1998; Sweeney, Bowman & Stull, 1993; Vandenboom, Grange & Houston, 1995).

Although Post Activation Potentiation (PAP) is a recognized property of muscle, the influence of PAP on human performance is less implicit (Bishop, 2003; Robbins, 2005; Sale, 2002). The research is ambivalent to date as to whether PAP boosts human performance (Bishop, 2003; Robbins, 2005; Sale, 2002). One investigation shows an increase in jump squat performance 5 to 18.5 minutes following a heavy-load SPPC warm-up in power-trained athletes without a concomitant effect in recreationally trained individuals (Chiu, Fry, Weiss, Schilling, Brown & Smith, 2003). Results of a recent study by Stone, Sands, Pierce, Ramsey and Haff, (2008) suggest that manipulation of the set loading configuration can result in a potentiation effect in weight lifters when heavier sets are followed by a lighter set. In theory, PAP would increase the rate of force development, (RFD) that would lead to an increase in acceleration and velocity (Sale, 2002). The PAP effect would shift the traditional force-velocity curve upwards and to the right, which may potentially enhance strength and speed performance (Sale, 2002). Brief high-intensity contractions preceding a brief maximal effort during an athletic event that involves jumping or throwing may increase the rapid force development (RFD) (Robbins, 2005; Sale, 2002). Aggregate RFD would in turn increase the strength and speed attained during the performance of an athletic event that involves a short-term maximal effort. For example, the distance of a throwing implement could be
improved using the PAP techniques (Robbins, 2005; Sale, 2002).

It has become increasingly customary for track and field throws’ coaches to employ heavy implements in a strength-power potentiating complex (SPPC) (Judge, 2009; Stone, Sands, Pierce, Ramsey & Haff, 2008) as part of the pre-activity warm-up in an attempt to enhance shot put performance. The advantage of utilizing PAP in training is clear in theory, but research utilizing SPPC has not been able to simplify its practical application. Typical research in this area has included an experiment design where the first SPPC activity is not exactly the same as the second (Stone, Sands, Pierce, Ramsey & Haff, 2008). Typical SPPC experiments include a mid-thigh pull followed by a snatch (Stone, Sands, Pierce, Ramsey & Haff, 2008) or a heavy half squat followed by a vertical jump (Mangus, Takahashi, Mercer, Holcomb, McWhorter, & Sanchez, 2006). Additionally, a much greater load has been used (Stone, Sands, Pierce, Ramsey & Haff, 2008; Weber, Brown, Coburn, Zinder, 2008; Mangus, Takahashi, Mercer, Holcomb, McWhorter, & Sanchez, 2006) that is not practical in sport specific situations like shot putting. Though the technique is accepted and used by coaches, weaker and inexperienced athletes do not always show evidence for potentiation and may not benefit from SPPC (Sale, 2002; Stone, Sands, Pierce, Ramsey & Haff, 2008; Chiu, Fry, Weiss, Schilling, Brown & Smith, 2003).

The most relevant study to the present investigation involved the use of overweight implements for the warm-up of high school aged weight throw athletes and examined the effects on subsequent throwing distance with the competition implement (Judge, Bellar & Judge, 2010). The results of this study suggested that performing a warm-up with an implement that was 1.37kg heavier than the one used for competition was an effective means of acutely enhancing performance. As with all studies on youth athletes, it is unclear if the results will translate to a different event (the shot put).

Research also highlights the effect of PAP and categorical variables. These factors include training status, training age, chronological age, genetics (e.g., fiber-type composition), anthropometrics, gender, relative strength, and absolute strength (Stone, Sands, Pierce, Ramsey & Haff, 2008). The purpose of this study is to examine the potentiation effect of throwing a heavy shot put in warm-ups on subsequent standing shot put performance in female athletes.

METHODS

PARTICIPANTS

The participants were eight moderately trained high school-aged female shot putters (Table 1). The present investigation was conducted as part of practice for a local Track and Field club team. All participants gave informed consent before participating in the study. IRB approval was granted before any data was collected. The participants had the following weight room one repetition maximums (1RM bench press: 77.5±11.4kg; 1RM back squat: 154.2±18.1kg; 1RM power clean: 77.1±8.7kg).

Table 1

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<td>Personal Best Power Clean (1RM)</td>
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Table 1: Reported participant characteristics listed in means and standard deviations.
A randomized within subjects design was used to compare the possible potentiation effects of throwing a heavy shot put prior to a competition shot put. The participants were required to report to the track and field complex on four separate occasions. On the first visit, participants became familiar with the standing shot put throw technique. On the second through fourth visits participants were asked to perform a general warm-up that consisted of 15 minutes of dynamic movements. Following the general warm-up the athletes took three warm-up standing throws (Figure 1) in a competition shot put venue with one of three implements: the standard 4kg shot put, a 4.5kg shot put, or a 5 kg shot put. The order of assignment of warm-up implements was randomized and fatigue was assessed after each warm up using a ten point visual analogue scale (VAS). Following warm-up with the assigned implement, the athletes completed three attempts with the standard competition implement, that were measured with an open real tape measure.

Figure 1

The Standing Throw in the Shot Put

The three measured attempts for each treatment were averaged, and a one-way repeated measures ANOVA was used to test for differences by treatment. A similar ANOVA was used to assess the effect of the treatments on measured fatigue via VAS. A modern statistical software package (SPSS ver 20.0) was utilized for all analysis. Statistical significance was set a priori at alpha<0.05.

RESULTS

The repeated measures ANOVA did not reveal any differences by treatment (F=0.495, p=0.612). The means for each treatment were very similar (4k warm-up: 10.82m±1.6m; 4.5k warm-up: 10.57m±1.7m; 5k warm-up: 10.35m±1.6m). Although the differences were not significant there was a trend from reduction in performance at the weight of the warm-up implement that increased. A graphic depiction of the mean distance by attempt for treatment is shown in Figure 2.

The one way repeated measures ANOVA did reveal a significant difference by treatment for fatigue (F=261.1, p≤0.001). Subsequent Bonferroni corrected pairwise comparison revealed all treatments to have produced significantly different levels of fatigue (p<0.05). The warm-up with the competition shot put (4k) resulted in the lowest fatigue (1.25±0.44) followed by the 4.5k (3.86±0.61) with the 5k shot put resulting in the highest fatigue (5.62±0.83). Bar graph in figure 3 depicts fatigue by warm-up treatment the effects of the three treatments by the PR of each of the athletes for the distance thrown.
DISCUSSION

The principal finding of this pilot study is that in moderately trained female athletes the use of heavy shot puts as part of the pre-activity warm-up does not enhance subsequent performance in the standing shot put. Though non-significant, the trend existed for a reduction in performance using the heavy shot put for athletes with the lowest personal bests in the shot put. Debate about the effectiveness of PAP is mostly attributed to the characteristics of the conditioning activity (CA) and the training status of the subjects (Batista, Ugrinowitsch, Roschel, Lotufo, Ricard & Tricoli, 2007). Typical research in this area has utilized an experiment where the first SPPC activity is not exactly the same as the second (Stone, Sands, Pierce, Ramsey & Haff, 2008) and in many cases the study has also included a much higher load. The first activity (standing shot put throw) in the present study was identical to the second (standing shot put throw) therefore the temporal pattern of the first activity could not have had a negative effect on the second.

The weight of the SP in each of the treatments (4.5kg and 5 kg) was significantly greater than the weight of the 4 kilogram implement used in competition. Though the findings were not significant, a trend existed for a reduction in performance with the increased weight of the pre-throw shot put. Evidence indicates that training background and maximum strength level are related to the capability for potentiation (Sale, 2002; Chiu, Fry, Weiss, Schilling, Brown & Smith, 2003). It was apparent in this observation that the weaker and inexperienced athletes do not always show evidence for potentiation. The moderately trained female shot putters (12.2m±1.5) were well below the IAAF World Championships A (18.20m) and B (17.20m) qualifying standards and may not have had the initial strength levels or training experience (Table 1) to take advantage of the pre-activity protocol. Stronger athletes appear to generate potentiation effects to a larger degree than weaker athletes (Stone, Sands, Pierce, Ramsey & Haff, 2008).

Some debate exists among the coaching community concerning the validity of the use of heavy implements in training and during the throwing warm-
up prior to competition (Judge, 2009). The biggest criticism is the effect on the rhythm and timing of the movement. Critics believe heavy implements will disrupt the timing of the movement and set the nervous system to a slower speed (Judge, 2009). This could explain reduction in performance in the present study. It is also important to introduce the SPPC concept in training by incorporating overweight implements in practice (Judge, 2009). The relatively inexperienced subjects in the present study were probably not very familiar with the heavy (45k) and the very heavy (5k) shot put as the heavy (5k) shot put is not a common implement used in female shot put training. Heavy shot puts also put a lot of stress on the wrist and hand and the weight of the (5k) shot put in the present study is outside the weight variance recommended by the literature (Judge, 2008; Dunn & McGill, 1991). An implement that is too heavy can break down the confidence of a young, inexperienced thrower with low levels of absolute strength and may impact their motivation to throw the competitive implement. Thus, strength levels and experience with the protocol may play an important psychological role in potentiation capability (Stone, Sands, Pierce, Ramsey & Haff, 2008).

**PRACTICE MAKES PERFECT**

Before any conclusions can be made as to the efficacy of exploiting PAP in a pre-competition warm-up protocol designed to enhance performance, it is important to introduce the concept in training by incorporating overweight implements in practice. The athletes need to become familiar with the implements and the movement pattern of the conditioning activity (CA). One of the most helpful tools for the coach and athlete is comparing the distances achieved under training conditions with implements of various weights (Judge, 2008). The relationship of distance thrown when comparing the light, normal, and heavy implements can reveal what the priority should be for the specific training. The expected relationship is approximately 10 percent of distance per kilogram of weight change (Judge, 2008). If you know what distances to expect from each implement, you know what to change about the training based on deviations from the expected pattern. The coach then can determine the appropriate weight based on the athletes training background and strength levels to create the SPPC. Keep in mind that the shot putting literature recommends trained athletes using between 10% over and under the competition weight for maximum results (Judge, 2009; Dunn & McGill, 1991). But, for beginning and moderately trained athletes 5% over and under the competition weight may be more effective.

It is important to acknowledge the SPPC is part of a complete warm up. If SPPC is to be used for enhancing athletic performance the specifics of the conditioning or warm-up protocol need to be addressed (Robbins, 2005; Sale, 2002). Thowers should perform a pre-activity protocol that systematically and progressively stimulates the musculature they will utilize during training or competition. A well-designed pre-activity protocol will bring about various physiological changes that enhance the training activity or competition (Judge, Craig, Bautendistal & Bodey, 2009). Although the need for a pre-activity protocol might be clear, the precise components that should be included may be less evident and may vary based on the sporting activity. The training variables necessitating consideration include type of contraction (e.g., isometric, concentric-eccentric, etc.), intensity, volume (e.g., repetitions, sets, cadence, time under tension), rest interval(s) between possible multiple sets, rest interval within the complex pair, and possible varying responses of different muscle groups (Stone, Sands, Pierce, Ramsey & Haff, 2008). To be used properly athletes also should employ in event-specific dynamic warm-up activities prior to the SPPC. Throwing heavy implements within the acceptable weight range is a physically demanding activity that sets up a sport specific SPPC that provides a high force load and creates PAP.
Future research needs to address the impact of PAP on human performance and provide evidence for warm-up routines with heavy implements that may enhance athletic performance for track and field throwers. Coaches and researchers should work together in an effort to collect and report sport specific data on effective PAP protocols.

PRACTICAL APPLICATIONS

Shot put competitions are often won and lost by only centimeters making the investigation of methods of enhancing performance at the competition venue increasingly important. As the knowledge base for warm-up strategies continues to evolve, coaches must adapt their practices to ensure their athletes are being properly prepared for training and competition. One such method of possible enhancement in the shot put event is a SPPC using heavy implements. The problem with most track and field throwing implements is they feel heavy; so a pre-activity strategy that helps make the throwing implement feel light could subsequently help improve performance (Judge, 2009). The goal of the SPPC is to create an increase in muscle force and RFD as a result of previous activation of the muscle (Stone, Sands, Pierce, Ramsey & Haff, 2008). The challenge for the track and field coach is being able to produce a SPPC at the competitive throwing venue.

Procedures for enhancing performance at the competition venue should be examined further. Three issues that might impact the degree of potentiation are initial strength levels, (Stone, Sands, Pierce, Ramsey & Haff, 2008; Young, Jenner & Griffiths, 1998) previous training background (Young, Jenner & Griffiths, 1998), and the current level of fatigue (Sale 2002; Stone, Sands, Pierce, Ramsey & Haff, 2008). The proper load for the SPPC must be determined as weaker and inexperienced athletes do not always have capability for potentiation (Stone, Sands, Pierce, Ramsey & Haff, 2008). This investigation and related findings of additional research (Sale, 2002; Chiu, Fry, Weiss, Schilling, Brown & Smith, 2003) have practical implications for coaches’ desiring to employ SPCC methods. The SPPC protocol has to be tailored to fit the training status of the athletes.

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Pole Vault: Effective Pole Carry and Transfer, the Foundation for Success

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ABSTRACT

The purpose of the article is to examine the guiding principles regarding the pole carry and transfer of the pole in preparation for takeoff in the pole vault through discussion of the seminal paper by the preeminent pole vault coach Vitali Petrov presented at the European Athletics Coaches’ Association Clinic in Birmingham, England in January 1985. The introduction follows the emergence of coach Petrov’s technical philosophy as discussed in this 1985 lecture.

The discussion is broken into two sections. Section I explains the advantages of the proper pole carry and transfer as described by Petrov and Section II details the actions of the proper technique. The principles espoused by Petrov enhance the athlete’s ability to run during the approach and effectively increase the speed of the run-up and power at takeoff by using a high initial pole carry and the momentum of the pole itself dropping throughout the approach. The authors conclude the discussion by reiterating that the benefits of the Petrov philosophy should be fully explored and practiced to realize the advantages of the technique. The primary author is the coach of the 2004 Olympic Champion and has coached athletes in the pole vault who have broken the Olympic, World Athletic Final, American, and NCAA records.

He has spoken nationally and internationally numerous times regarding pole vault technique and was highly influenced by the 1985 Birmingham lecture and Petrov’s subsequent writings on pole vault technique.

EFFECTIVE POLE CARRY AND TRANSFER IN THE POLE VAULT

The impetus for this article is to provide insight into what I consider an overlooked or underdeveloped fundamental aspect of coaching the pole vault. I took part in a USA National Pole Vault Development Seminar as a graduate student in 1987 and was provided with much of the material that formed the basis of my technical philosophy as a novice coach. The material presented included the seminal paper by the Soviet coach Vitali Petrov presented at the European Athletics Coaches’ Association Clinic in Birmingham, England in January 1985 (Petrov, 1985).

The presentation and post lecture comments were published in the 1985 winter edition of Track and Field Quarterly Review (Petrov, 1985). This was significant because prior to the advent of the Internet and the widespread dissemination and discussion of coaching information and video, coaches were limited in the opportunity and scope of available information. Beginning coaches at that time relied on mentoring from regional coaches or a few technical journals that did not specialize in event disciplines prior to the Internet revolution which made information much more readily available (Pederson, 2007).
Petrov’s 1985 Birmingham paper was fascinating because his star pupil, Sergey Bubka, had burst onto the world stage winning the 1983 World Championships in Helsinki, Finland, at the age of 19 in his first major international competition and followed that with continued dominance throughout the next decade. Bubka’s mastery of the vault would culminate in an unprecedented six world championships, the 1988 Olympic gold medal and 35 world records. Other outstanding Soviet vaulters including Konstantin Volkov, Rodion Gautallin, and Maksim Tarasov, added to the Soviet mystique. Therefore, the Birmingham paper was a unique insight into Petrov’s general principles regarding the event. I found myself dissecting this paper on a regular basis and developed a habit of reviewing it each year in preparation for the upcoming season. The paper is now often cited and discussed as its reach has expanded due to communication technologies. Most of the discussion during the past 25 years has been dominated by the explanation of the in-air portion of the event, i.e. the free takeoff, pre-jump, proper arm action, trail leg swing, and lead knee position. Questions I receive from coaches and athletes during clinics and film study are framed almost exclusively around the planting of the pole and the in-air movements. I have also observed that it has become a common practice for many coaches to set up a stationary camera which captures the vault from takeoff through landing but omits the approach run. I would contend that these emphases in coaching, discussion and observations indicate that we may be intentionally or unintentionally excluding or under developing a significant portion of the philosophy Petrov first presented in his original paper and subsequent presentations.

Coaches would be well served to concentrate more of our attention on the phases leading to the take-off to fully realize the effectiveness of the general principles or philosophy espoused by Petrov. Therefore, this discussion will focus on the pole carry and transfer to the overhead position in preparation for takeoff. Petrov’s Birmingham article is the foundation for this article as the first part will discuss why the proper pole carry is critical. The second part discusses the specific characteristics of technique that should be sought during this phase.

1) ADVANTAGES OF PROPER POLE CARRY AND TRANSFER

The Birmingham article is broken into a brief introduction followed by five sequential sections: 1. Holding the Pole; 2. Run-up and Pole Plant; 3. Pole Plant into the Box; 4. Take-off and 5. Swing/Rock Back. A brief conclusion and post lecture comments follow. Interestingly, the shortest section by far is section 3. Pole Plant into the Box, and this section contains very succinct information but no description of the actual movement or the traditional description of the pole planting action. The section does contain Petrov’s answer as to the proper takeoff position relative to the upper grip on the pole, “…the position of take-off must be strictly beneath the grip of the upper arm…insofar as the vaulter can raise the pole to the maximum above the track only standing on the vertical beneath the grip” (Petrov, 2005 p. 30). This was an important part of the discussion at the time because many vaulters had been taught or allowed to take off inside this optimal position and effectively pre-bending the pole before their takeoff foot left the ground. The rest of Section 3 discusses a test for establishing optimal grip height in competition based on a correlation to a six step straight pole exercise. This is significant because there is no description of the actual movement during the plant which resembles traditional explanations of the pole planting action usually found under descriptions of the planting phase. Petrov combined the Run-up and Pole Plant into a single section in a perceived effort to emphasize the coordinated importance of the merging of these two phases. Petrov (1985) states “The time has come when a precise and correct execution of lowering of the pole and take-off is determining a vaulter’s class and potential. No matter what the talent of your athlete, if he does not master the element of
lowering and planting the pole he will never become a top-class vaulter” (p. 30). The importance of the lowering of the pole during the approach and transfer to the take-off position is apparent by the priorities mentioned in Petrov’s introductory and concluding remarks. He posits during his introduction that the two aspects which will constantly improve as performance improves are the continual increase in grip on the pole and the stiffness of the pole rated above the vaulters body weight. Elite vaulters had already exceeded five meters in grip and were using poles rated at least 10 kilograms above their body weight during the time of Petrov’s article (Petrov, 1985). Therefore, higher grip height and heavier poles would require the most efficient carry technique.

The pole carry before Petrov had been relatively static and was considered an impediment to overcome. The 1980 and 1984 Olympic Champions Wladyslaw Kozakiewicz and Pierre Quinon respectively exhibited the traditional static carry with the pole tip held above the head height and the pole carried at a 45 to 60 degree angle until the last half of the approach when it was gradually lowered into the plant box. All three Olympic medalists in 1988 – Bubka, Gataullin, and Grigoriy Yegorov – employed the much higher initial vertical carry and what appeared as a continuous pole drop. The Soviets’ medal sweep exhibited the fundamental changes in the approach and pole transfer that Petrov discussed in 1985, and his general principles had transformed the event.

He reiterates these fundamental principles in his summation – “Having analyzed all that has been said we may conclude that the principle criterion in attaining record heights will be development of speed of run-up and power at takeoff” (Petrov, 1985 p. 33). His post lecture comments were revolutionary with regard to the development of speed of the approach – “The pole does not hamper but helps to gather speed. The pole is a continuation of the vaulter and he is able to sprint in a normal sprint posture. The pole helps to increase speed as it lowers going to the box” (Petrov, 1985 p. 33).

Although the vertical pole carry has become essentially universal for vaulters of all ages the full potential of coach Petrov’s rethinking of the effectiveness of the pole carry has not been realized. The effect of making the pole lighter to carry is obvious to the vaulter. This by itself would appear to increase the speed of the approach, but if the carry and lowering of the pole during the approach is not integrated correctly the athlete’s posture and power at takeoff are not necessarily improved. The lower, static pole carry caused rigidity in the upper body which inhibited the natural sprinting form and posture in preparation for takeoff. Most athletes today have not honed the lowering of the pole, effectively synchronized with the approach run of the athlete to achieve the result Petrov described, in which the pole drop increases the speed of the vaulter-pole system through the takeoff. The high initial carry can produce its own problems of preparing for takeoff with effective posture and sprint mechanics without proper synchronization of the timing of the pole drop with the speed of the approach run.

Understanding the details of the proper carry is of utmost importance to realize the full potential of Petrov’s philosophy. He states, “We have thereby simplified one of the most intricate elements of pole vaulting – the planting of the pole - by combining the speed of lowering the pole and the speed of the vaulter’s run into a single movement. That requires a great deal of work, but the work is worth it when you sense that you can take at once 15-20 cm higher grip and use a pole of 5-6kg heavier weight” (Petrov, 1985 p. 30). As coaches, we must critically assess whether we have fully implemented this philosophy of the continuous active pole carry or active pole drop into our training and technique objectives to realize the true benefits of which Petrov spoke.
2) PROPER POLE CARRY AND TRANSFER

Holding the Pole and Starting the Approach

The effective pole carry begins with establishing the proper grip. Holding the pole properly allows effective running mechanics and the opportunity to efficiently move the pole through takeoff and finally swing efficiently on the pole. Petrov’s work indicates that the width of the grip will vary depending on the physical characteristics of the athlete’s height, length of arms, strength, and shoulder and wrist flexibility/mobility (Petrov, 2007). He postulates that the grip should correlate to the natural width needed to swing effectively on the gymnastics high bar. He indicates that this grip ranges from 60 to 70 centimeters (23.6 to 27.6 inches) between the thumbs while holding the pole for elite males (Petrov, 2007). This grip width can also be established by the width of the athlete’s arms hanging closely at his side and approximates his shoulder width.

The proper width of the grip while holding the pole is of utmost importance and often overlooked by the inexperienced athlete and coach. A proper grip is essential first and foremost in establishing proper technique just as in swinging a golf club or tennis racquet. Petrov (2007) believed the “grip of the pole during the approach is one of the most important details in a modern vaulter’s technical gear” (p. 2). The grip must be properly established because of its sequential effect on the running posture, transferring the pole through takeoff and the ability to effectively swing on the pole. Effectively holding the pole with the proper grip width allows the vaulter to closely approximate running posture and arm carry of a sprinter during the approach, and optimally controlling the pole throughout the transfer and takeoff. An excessively narrow grip creates tension in the upper body, limits the planting technique and reduces the effectiveness of the takeoff. Too wide a grip disrupts the posture and rhythm of the sprint approach, makes the lowering and transfer of the pole through takeoff difficult by pulling the athlete off balance and excessively forward, and blocks the vaulter’s body as it penetrates through the takeoff phase (Petrov, 2003).

The initial start position of the pole carry is stated at the conclusion of Section 1 by Petrov (1985):
With such a pole position and handgrip during the initial position at the start of the run-up, the right hand is located by the right hip and slightly touches it, while the left hand is at the height of the left side of the chest at a distance of 10cm (4 inches) from the trunk. This position is natural and is regarded as such throughout their run by sprinters and long jumpers. Freedom of holding the pole enabled us at the start to control the vaulter’s posture from the very beginning of the run-up (p. 29).

By raising the pole tip to almost vertical initially (80 degrees above the runway), and assuming the proper posture and arm position Petrov is setting what he termed as the vaulter-pole system for optimal performance of the subsequent phases of the approach and takeoff. This initial starting position is balanced by placing the left foot on the starting mark which balances the arm carriage and weight of the pole naturally across the vaulter’s body. Implementing the high pole carry and proper grip optimizes the erect posture of the athlete which allows a smooth acceleration throughout the approach. The position of the arms, established through the proper grip, mimics the natural carriage of the arms while sprinting.

Once the optimal width of the hand spread is established attention should be focused on the hand grip itself. With the pole held initially in an almost vertical position the left/bottom hand should hold the pole loosely with the wrist in a flexed or cocked position such that the pole rests on the relaxed hand. The left elbow and arm should remain close to the athlete’s body. The right/top hand should take a strong, closed grip on the pole also with a flexed wrist positioned. The right arm is slightly bent and posi-
tioned along or slightly in front of the right hip close to the body. The position of the hands and arms is crucial to establishing the vaulter-pole system and enabling the athlete to control the pole throughout the carry and takeoff. These positions allow the pole to be carried efficiently on the frame of the body with arm positions similar to proper sprinting for balance and symmetry. Failure to establish the proper grip and carry, by making the mistake of holding the pole away from the body or holding the pole with weak wrists, relaxed or in the supine position, destroys the balance and control of the vaulter-pole system and slows the rhythm and power of pole acceleration through takeoff. “The correct pole carry is extremely important to the movement of the pole to takeoff. The “old” elbow out, tight wrist (bottom hand), open hand (top hand) carry creates tension and the inability to control the pole’s weight as it drops towards the box. Rather, the vaulter should have the bottom arm, elbow tucked, wrist cocked with the pole resting in a relaxed, open handed grip. The top hand has a full grip on the pole. This allows the vaulter to be one with the pole” (Butler, n.d.b p. 1).

The weight of the pole and high hand hold is controlled by setting the posture from the first steps of the approach with the ultimate goal of moving through the takeoff with maximum speed and in an optimal takeoff position to move the pole to vertical (see Figure 1). Please note that figures noted with “a” are of Sergey Bubka. The images are screen captures from a video of the first 6 meter vault which occurred in 1985. Figures noted with a “b” are of a collegiate pole vaulter at the University of Tennessee.

The weight of the pole during the initial starting position will be on the right hand. To break inertia the athlete rocks back onto the right foot (6-14 inches behind the left foot) and pushes forward over the left foot making sure to maintain the hips forward and the tall posture of the vaulter-pole system. Improperly starting the approach by over striding, quick steps or breaking at the waist disrupts the carrying of the pole on the frame of the vaulter’s body, and adversely affects posture, the proper lowering the pole, and ultimately diminishes the optimal takeoff position (Fraley, 1995).
The Birmingham lecture emphasizes the fluidity of the approach and molding the various aspects of the run-up into a singular whole. “The run-up and pole plant in the box should be seen as a single integral movement; one must not think that the pole plant begins directly before the box” (Petrov, 1985 p. 29). The lowering of the pole and acceleration of the approach are synchronized and form a natural rhythm to achieve maximal speed and body position through the takeoff. Petrov (1985) stated that with practice the vaulter’s runway speed for elite vaulters (10 meters per second) could be matched with the speed of the pole falling freely. This was a concept which had not been discussed previously and the implications were that a properly synchronized approach and active pole drop would combine to free the vaulter from the weight and unwieldy properties of manipulating the pole and allow the vaulter to improve runway speed and takeoff position by working with the natural drop of the pole (Petrov, 1985). He emphasized the gradual increased rhythm of the approach and stride pattern to maintain the integrated vaulter-pole system.

In these brief seven sentences Petrov has established his general principles of technique for an effective approach and active pole drop. In later writings and presentations Petrov and other prominent coaches has expanded on this brief explanation to fully characterize these general principles (Butler, n.d.a, b) (Falk, 1998) (Fraley, 1995) (McGinnis, 1997) (Petrov, 2003, 2007, 2010).

The first part of the approach consists of the first 4 to 6 steps. The vaulter maintains an erect posture without disturbing the vaulter-pole system. The right hand controls the active drop of the pole tip and the position of the pole in relation to the vaulter’s body. Ideally, the athlete should have the grip strength and wrist flexibility to take a strong closed grip on the pole with the right hand. The right hand moves gradually and continuously throughout the approach. As the athlete controls the drop of the pole tip through movement of the right hand it will travel from the front right hip toward and above the back of the hip as the pole tip is lowered from 80 degrees to 60-65 degrees in relation to the runway. The left hand grip is more relaxed to allow rotation of the pole. The left arm functions as a fulcrum or bearing point upon which the dropping pole is guided (Butler, n.d.b, Petrov, 2007). The left arm must remain relatively in place and should never be dropped below the left elbow or extended toward the plant box. Any drastic motion of the left hand (forward, back, down or sideways) will disrupt the posture and the vaulter-pole system (Petrov, 2007). The stride length of the approach will shorten and quicken prematurely if the pole is dropped too low during this stage of the run.
which will hamper the gradual acceleration of the approach. A low carry at this point will also hinder the vaulter-pole system and cause the athlete's posture and relaxation of the upper body to suffer because of muscle rigidity caused by holding the pole too low. An excessively high carry will also hinder acceleration (Petrov, 2007) (see Figure 2).

Figure 2a. Steps 4 to 6

Figure 2b. Steps 4 to 6

The second part of the approach covers the next 8 to 10 steps and is characterized by the gradual continuation of the active pole drop and the acceleration to maximum speed by the end of the phase. The pole smoothly moves through the 60 to 45 degree angle as the athlete builds to an active sprint with erect posture. The pole drop is fluid and continues to be controlled by the right hand as it gradually moves above the right hip (Petrov, 2007) (see Figure 3).

Figure 3a. Steps 8 to 10

Figure 3b. Steps 8 to 10

**DROP AND PUSH**

The next phase of the approach and pole carry takes place during the final six steps of the approach. This phase is the most critical to effective transfer of momentum from the approach run through an effective takeoff. Petrov (2007) writes the key to the correct vaulting technique lies in practically all the movements of the drop and push part of the run-up – both for beginners and for more advanced vaulters” (p. 3). This part of the approach is vital because if the drop and transfer of the pole is done incorrectly the lowering weight of the pole will severely inhibit the stride pattern and pole transfer to the takeoff. The Birmingham paper is direct in describing the general principles of the final portion of the approach and pole drop, “By the end of the run-up the pole is taking a horizontal position in a relation to the track,
and in raising the upper end of the pole both arms at once play an active part…” (Petrov, 1985 p. 30). This general description reflects the overall theme of integrating the approach and traditional notion of a separate plant phase into a singular holistic movement from the beginning of the approach. Petrov’s later discussions give insight into the details of creating a smooth transition from the approach through the takeoff. Petrov uses the terms “Pole Drop” and “drop and push part of the run-up” and “Pole Drop and Plant” (Petrov, 2003, 2007) in later writings describing the final stages of the approach. This should be an important reminder that synchronization of the approach and lowering of the pole is a critical component of his principle of the effective plant and takeoff.

As the athlete moves through the approach six steps before takeoff the pole has been lowered through the 45 degree range and the vaulter maintains an upright running posture. The left arm remains stable, with the left hand above the left elbow. The right arm has bent more and the right hand has moved up behind the athlete’s hip to lower the tip of the pole. The weight of the pole is centered on the athlete’s body as not to disrupt his posture. The stride length is slightly shorter than sprinting without the pole and stride frequency is increased (Petrov, 2010). The athlete continues the active drop of the pole 5 to 6 steps from takeoff by maintaining an erect posture and running velocity and initiates the critical phase of the pole drop with the right hand actively pulling the top of the pole up as the tip of the pole drops toward the horizontal position in relation to the runway. “While the right hand is being pulled, the right elbow is gradually drawn behind the back, thus making it possible during the last two steps to lift the right hand with the pole up to the right shoulder” (Petrov, 2007 p.3). The right hand moves straight up along the back ribs toward the right armpit and is actively stretched controlling the weight of the falling pole. This action has been described as “releasing the hip.” Rice University coach David Butler described it as, “The top hand ‘Releases the Hip’ as the pole drops off of six steps out from the takeoff. Releasing the hip means not holding the pole to the hip but focusing on keeping the top arm within the line of the body, the top hand slightly behind the vaulter. This centering of balance with the pole allows the drop to be free and the vaulter to stay upright and in the position to jump at takeoff” (Butler, n.d.b p. 2). The left hand moves slightly ahead to guide the pole but must remain at the same level above the left elbow as the pole rotates in the left hand. Most importantly the accomplishment of these movements and positions should not be static; they are descriptions of the details occurring during the continual active drop of the pole in rhythm with the last six strides of the approach. The actions of the vaulter facilitate the natural dropping of the pole without disturbing the posture and running mechanics in preparation for the push of the pole overhead in the final steps of the approach. The athlete’s posture over the last 6 strides remains erect and detail must be given to a slight thrust of the hips forward and keeping the abdominal muscles tight to maintain the proper position of the shoulders through takeoff (Petrov, 2003).

The final two steps of the approach complete the transfer of the top of the pole to an overhead position as the tip of the pole is smoothly slid into the center of the planting box. Two steps before takeoff, which for the right handed vaulter begins with the athlete passing over the second to last left step, the pole tip has fallen approximately below the level of the athlete’s eyes but has not reached a horizontal position with the track. The pole is positioned slightly higher (10 to15 centimeters) than the vaulter’s center of mass (Petrov, 2007) (see Figure 4).
Beginning the final two steps of the approach, as the athlete moves through the support of the left leg, the right hand is being pulled in a straight line up the athlete’s side along the back ribs as the right elbow is drawn behind the back. The right shoulder is opened to facilitate the movement of the hand in raising the top of the pole through shoulder level. The left hand should remain at approximately the same level as its original position, with the hand above the left elbow, under and supporting the pole. The vaulter must not make the fundamental mistake of casting or extending the left arm forward, losing control of the pole and destroying the balance of the vaulter – pole system by extending the left arm away from the body toward the box (Petrov, 2007). As the tip of the pole passes through the horizontal plane the top of the pole rises by the right hand rotating to a pushing position underneath the pole. Both hands should be underneath the pole and actively raising or pushing the top of the pole over the vaulter’s head before the vaulter moves through the vertical support position of the right, penultimate step (see Figure 5). Therefore, as the right hand rises above the shoulders it works together with the left hand to accelerate the top of the pole slightly in front and above the vaulter’s head in rhythm with the approach run. Petrov warns that if the right hand and top of the pole is not overhead before the vertical support position of the right leg the athlete will be out of rhythm with the dropping pole and will sink through this penultimate step. Conversely, if the drop has been timed correctly and the top arm is over the vaulter’s head the penultimate step will be active and assist in accelerating the pole transfer (Petrov, 2007).
The final action through the takeoff step is a culmination of the preceding dropping of the tip and raising of the top of the pole synchronized through the approach run. As the vaulter moves through the support phase of the left, takeoff, step both arms are aggressively extended resulting in a complete extension of the body. “The plant is a key element in transferring from the run-up to vault, and the plant ends in a swift body extension which must take place before the pole touches the back wall of the box” (Petrov, 1985 p. 30). Both arms and shoulders should finish extended and elastic, raising the top of the pole as high as possible as the vaulter leaves the ground (Butler, n.d.a). The right arm and shoulder will be fully extended above the vaulter’s head while the left arm should be extended such that as the vaulter leaves the takeoff the left hand is positioned to extend above the vaulter’s forehead as the pole begins to bend. “One gains the impression that the vaulter is not planting the pole in the final two steps of the run-up, but somehow “runs into” a position where the pole drops naturally” (Petrov, 1985 p. 30) (see Figure 6).

**Figure 6a. Takeoff**

![Figure 6a. Takeoff](image)

**Figure 6b. Takeoff**

![Figure 6b. Takeoff](image)

**CONCLUSION**

Although this discussion has taken the general principles first espoused by Petrov in 1985 and attempted to articulate in further detail the approach and pole carry in preparation for takeoff, the underlying holistic philosophy should not be overshadowed by these details. With much practice, the benefits of controlling the active continuous pole drop in preparation for takeoff significantly increase the ability of the vaulter in transferring the momentum of the run-up through the takeoff and assists in moving the pole to vertical. The benefits of the general principles of the continuous pole drop are fundamental and beautiful in their simplicity. A proper carry, as described by Petrov allows the vaulter to run efficiently and use the falling pole to aid in the acceleration of the vaulter on the runway and to positively contribute to the initial pole speed through takeoff toward the vertical plane of the crossbar (McGinnis, 1997).

Many athletes only partially master these general principles and likely do not spend enough practice time perfecting the proper run and carry technique. Petrov’s 1984 training plan for Sergey Bubka showed that in a 4-day training cycle during a foundational training phase, Bubka completed 30 pole runs compared to 20 jumps in the micro cycle. Thus in two micro cycles of foundational training (8 day period) Petrov planned 60 approaches practicing the pole carry compared to 40 practice jumps (Petrov, 1984). Obviously the training volume of Bubka as a twenty year old reigning World Champion may seem extreme for most non elite athletes, but the ratio of practice pole carries to actual jumping should not be ignored. For every vault taken in the foundational phase of training the athlete performed 15 practice approaches working on the mastery of the effective pole carry. Most young athletes do not approach this ratio and would rather practice jumping than the approach run and pole carry, but I would speculate that at an earlier developmental age Petrov’s training plan for Bubka exceeded this ratio of approach runs compared to actual jumps.
The sequential attention to detail of the entire process of the approach and active drop of the pole will allow the vaulter to capitalize on the benefits of Petrov’s philosophy of using the pole carry to the athlete’s advantage. Analogous to other sports, such as golf or tennis, once the proper grip and stance are acquired, the athlete must properly execute the correct take away or backswing to effectively maximize their potential through impact. Technical flaws in the process prior to impact lead to compensations and deviations from the most advantageous position. Similarly, the vaulter must actively control the pole throughout the run-up to maximize the speed of the run up and position of takeoff. Attention to the details of Petrov’s concept of the athlete working with the pole as a melded system and the holistic view of the approach and plant as a continuous singular process will only be achieved with much intentional practice. Partial mastery of the effective carry will benefit the athlete because the initial weight of the pole will be reduced by a high carry, but unless the athlete becomes competent in the technique throughout the approach they will not benefit from the general principles of the effective pole carry. Mastery of these general principles have the benefit of allowing the athlete to more freely sprint in the approach and move through the takeoff in optimal position and most importantly utilize the momentum of the dropping pole to give added assistance to both the run-up speed and pole speed through takeoff. Only then have we applied Petrov’s general principles in full.

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AUTHOR BIOGRAPHIC INFORMATION

Jim Bemiller, J.D. is an assistant professor and licensed attorney. Jim teaches courses in sport law and sport governance in the Sport Management program at The University of Tennessee. His primary legal research interests include negligence and risk management in sport settings and constitutional issues in sport. He serves on the USATF Pole Vault Development Staff and has written and presented extensively on the development of athletes in the pole vault. He is the coach of the 2004 Olympic champion in the pole vault, Timothy Mack, and has coached athletes in the pole vault who have won 5 NCAA Championships and 15 Southeastern Conference Championships. His athletes have broken the SEC, NCAA, American Junior, American, World Athletic Final and Olympic records. UT Alumni he coached won the pole vault at three consecutive U.S. Olympic Trials, (’96, ’00, and ’04) and won Gold (2004) and Silver (2000) Olympic Medals.

Dr. Robin Hardin, PhD, is an associate professor in the Sport Management program at the University of Tennessee. His research interests lie within all areas of intercollegiate athletics particular within the areas of governance, organizational structure, and fan interaction. Dr. Hardin also assists in the athletic department’s media relations office with game-day and event operations. He has more than 30 refereed publications in the profession’s top journals including the International Journal of Sport Management, Journal of Contemporary Athletics, International Journal of Sport Communication, Journal of Intercollegiate Sport, Journal of Physical Education, Recreation & Dance, Sport Marketing Quarterly, and Applied Research in Coaching and Athletics Annual. He also has made more than 100 scholarly presentations.
For optimal performance among distance runners, training should be based on sound, scientific evidence. For example, among adult distance runners, consistent empirical evidence indicates that improving key physiological determinants of endurance performance, namely maximum oxygen consumption (VO2max), lactate threshold and running economy, may play an important role in enhancing distance running performance. To improve VO2max among adults, Loprinzi, Cardinal and Brodowicz (2011) suggest that, for novice adult runners, training should be performed at the speed associated with approximately 60-80% of VO2max, with more experienced runners training at the speed associated with 95-100% of VO2max may be necessary. To target improvements in the speed associated with lactate threshold, or the point that demarcates the transition from aerobic to anaerobic metabolism, adult runners should perform a variety of different forms of training at moderate to high intensities, typically occurring around 85-90% of maximum heart rate. Lastly, to elicit improvements in running economy, or oxygen consumption at a submaximal intensity, adult runners should train at a variety of different intensities, as individuals become more economical at the speed at which they consistently train at.

These guidelines have been developed from numerous empirical studies among adult distance runners and may not be suitable for younger populations, as children and adults may respond differently to exercise. For example, children and adolescents, compared to adults, exhibit higher respiratory rates and lower tidal volume, exhibit lower stroke volume (amount of blood pumped by the heart per beat) and higher heart rates, and because of their greater body surface area to body mass ratio, their tolerance to exercise in hot conditions may not be as great. Consequently, it is uncertain as to whether these adult training guidelines are appropriate for younger populations, such as adolescent distance runners. In addition to reviewing the extant peer-reviewed literature on evidence-based strategies to elicit improvements in physiological and performance-related parameters among adolescent distance runners, the narrative that follows will also address other important areas that may influence the running performance of an adolescent distance runner. Specifically, we will first start out discussing training theory and periodization. Then we will discuss training methodology during the off-season and in-season periods. Following this will include a brief discussion on different tapering protocols, markers of over-training, and prevention of injuries. Lastly, we will discuss other important areas influencing distance running performance, including nutrition and transitioning from high school running to competing in college.
**TRAINING THEORY**

Many of the adaptations from training can be reversed with detraining, or the cessation of training. However, in order for running-related adaptations—both physiological and neuromuscular—to occur, the running stimulus must exceed its preceding stimulus. For example, if, after consistently running a 12 mile long run on the weekends a runner modifies their training program to include consistent 15 mile long runs, the muscles will adapt by increasing their glycogen storing capacity, which may ultimately positively influence endurance performance.6 Similarly, with greater amounts of training, increases in mitochondria, important organelles that facilitate aerobic metabolism, will occur. Importantly, though, for such training-induced adaptations to occur, training must be carefully planned and executed. For optimal training-induced adaptations, training specificity, sufficient recovery periods, individual responses to training and periodization should be given particular attention.6

With respect to the principle of training specificity,7 a variety of performance-dependent parameters, such as energy systems, muscle fiber types and neuromuscular responses, adapt specifically to the mode, duration and intensity of the training stimulus. For example, to increase maximum oxygen consumption, and ultimately endurance performance, runners should engage in endurance-based activities that result in favorable changes to important parameters related to endurance performance, such as mitochondria proliferation, increased capillarization and augmented aerobic enzymes.

However, for optimal training-induced adaptations, sufficient recovery is needed. It is difficult to identify an optimal recovery period as, consistent with the principle of individuality,8 adolescents runners may respond differentially to varying lengths of recovery. With that said, Midgley and McNaughton9 recommend that runners allow for at least 48 hours of recovery between high intensity workouts. Using a validated rating of perceived exertion scale may be a useful and feasible strategy to help identify the physiological stress of a workout, which may help in ascertaining the amount of recovery time needed.10

**PERIODIZATION**

When designing a distance training program, it is important to develop workouts in a systematic and organized manner over different training periods or cycles within the overall program. The overall training program, partitioned into several periods or cycles, consists of microcycles, which typically last one week, mesocycles, which often last several weeks to several months, and a macrocycle, which is comprised of the different micro- and mesocycles. Although somewhat dependent on the competitive level of the athlete, a macrocycle often constitutes a one-year training period or can be subdivided into two macrocycles per year: one for cross-country and another for track-and-field.

When developing a macrocycle, it is important to first identify the different training periods, often considered the mesocycles, which may include off-season training, training during the season, and a brief recovery or restoration period immediately following the season of training. After identifying these training periods, a year-long systematic prescription of training intensity, duration and frequency can be developed. The following narrative will briefly discuss examples of training methodology during these training periods.

**TRAINING METHODOLOGY DURING THE OFF-SEASON**

Arguably, the off-season training period may play an important role in the progression of workouts during the season, which ultimately may influence a runner’s success during the season. Additionally, the off-season period may serve as an important rest-and-recovery...
period to minimize the likelihood developing burn-out, often characterized by increased perceptions of effort during exercise, frequent upper respiratory tract infections, muscle soreness, sleep disturbances, loss of appetite, mood disturbances, shortness of temper, decreased interest in training and competition, decrease self-confidence, and inability to concentrate.\(^\text{11}\) So how much time should an adolescent distance runner take off after their cross-country or track season? Unfortunately, it is difficult to make an evidence-based recommendation, as, to our knowledge, no study has examined this issue. However, we do know that the detraining effects can occur fairly rapidly. Although there is some individual variability, after about 12 days of inactivity, VO\(_2\)max can decrease by approximately 5-10%.\(^\text{12}\) Influencing VO\(_2\)max, stroke volume can decrease by as much as 10% over this 12-day period, with cardiac output, or the amount of blood pumped by the heart per minute, decreasing by about 7-8%. Notably, arterial-venous oxygen difference, or the difference in oxygen saturation between the arteries and veins, which is an important product of VO\(_2\)max, only starts to show decrements after about 21 days.\(^\text{12}\) Based on our experience, coaches often suggest that their runners take a couple of days to even two or three weeks off to recover from the season. Occasionally, the suggestion is to not take any time off from running if the athlete is healthy and not showing any signs of overtraining or burnout. With that said, and according to the principle of training periodization, if the runner does not take any time “off” after the season, the intensity and volume of training should be minimal, for at least several weeks.

With respect to the optimal training methodology to employ during the off-season period, unfortunately, after reviewing the extant literature, we were unable to identify any empirically-based studies investigating this issue. Providing some insights into the off-season training methodology among high school distance runners, Loprinzi and Brodowicz\(^\text{13}\) reported that, prior to a cross-country season, relatively inexperienced runners (14 years of competitive running experience) followed an unsupervised summer training program that involved light-intensity running approximating less than 10 miles per week. Plank et al.\(^\text{14}\) who reported that, among more experienced adolescent runners (4.2 years of running experience), the runners participated in a training program involving low- to moderate-intensity training approximately 40 kilometers per week.

Anecdotal evidence indicates that establishing an aerobic base during the off-season period may play an important role in running performance during the season, as, for example, even in middle distance races such as the 1500 meter event, approximately 76-80% of the energy is produced through aerobic metabolism,\(^\text{15}\) with even a greater proportion of aerobic metabolism in longer events. Some of the common adaptations occurring from aerobic-based training include improvements in maximal cardiac output, stroke volume, artero-venous oxygen difference, capillarization and myocardial contractility.\(^\text{12}\)

Given that the high school season is relatively short (approximately 10-weeks), establishing an adequate aerobic base, through a progressive increase in low- to moderate-intensity running, is pivotal during the off-season period not only for performance enhancement during the season, but to also build up the strength of the bones, tendons and ligaments to handle the strain of the arduous workouts during the season. Importantly, there is some evidence that individuals differentially respond and adapt to exercise training\(^\text{16-18}\); therefore, running coaches should, when feasible, attempt to tailor the training to the individual profile of their runners. When prescribing an off-season training program, coaches are encouraged to make such prescriptions based on the runner’s experience (i.e., grade level or years running), fitness level, and psychological state. To avoid injury, the dimensions of training (i.e., frequency, intensity and duration) should not increase by more than 10% each week, with each parameter changing one at a
time. Importantly, if the volume or intensity of the off-season training is too high, or if training is not periodized, then it is possible that the runner may peak prematurely during the season. For example, Kurz et al.\textsuperscript{19} showed that the pre-season phase of training (May to August) of collegiate runners had an influence on the performance during the peak phase (November). Collegiate teams that qualified for the national championships took more rest days during the pre-season training phase and ran shorter weekly runs than the teams that did not qualify. Of course, a similar study in adolescent runners is needed to confirm whether these findings generalize to younger populations.

In addition to establishing an aerobic base through the correct intensity of running (i.e., below the runner’s lactate threshold, which typically corresponds to less than 85-90\% of heart rate max), the off-season period is an important time to develop core abdominal strength. Developing abdominal strength is vital to proper biomechanics of running and injury prevention.\textsuperscript{20} This can be accomplished by doing a variety of abdominal exercises as well as leg-strengthening exercises, mainly focusing on the abductor and adductor muscles.

**TRAINING METHODOLOGY DURING THE SEASON**

Most all cross country/track programs employ some combination of these workouts: interval training, long runs, tempo runs, fartleks, hill repeats, and recovery runs; the challenge each coach faces is finding the right balance to this combination, with consideration not only to which of these workouts to do, but also to factors such as frequency, intensity, and duration of each workout. With adolescent runners, there is also often an added element of needing to make the workouts fun and interesting.

Just as most programs use the previously mentioned workouts, most follow a Lydiard style, hard-easy method of training, and in our experiences, we have found this to be an effective method of training. The classic opposing method of training would be one which focuses on a consistent progression of quantity/volume of training, and while this may be effective at improving fitness specific to running, it may lead to burn out and injury, especially in athletes with a limited background in running, such as adolescent distance runners. Unfortunately, limited research has examined the optimal training distribution during the season for adolescent runners. Plank et al.\textsuperscript{14} showed that 13-weeks of training in nine male adolescent runners improved VO\text{\textsubscript{2}}\text{max} by 6\%. However, they failed to quantify the subjects’ training load. More recently, Loprinzi and Brodowicz\textsuperscript{13} showed that among male adolescent runners who engaged in a 9-week cross-country training program with 45\%, 24\%, and 31\% of training occurring in zones below, near and above the heart rate corresponding to ventilatory threshold, respectively, VO\text{\textsubscript{2}}\text{max} increased by 51\%, 5-km race time by 46 seconds and 2-km time trial performance by 54 seconds.

In designing the training plan, many coaches begin the season with longer slower intervals, as well as fartlek (speed play) type workouts whether they be structured such as two minutes fast, one minute slow, or unstructured where the athlete chooses when and how long to run fast based on perception of effort. Also nearing the early stages of the season, anecdotal evidence indicates that coaches often utilize 10-30 minute tempo runs designed to get the athlete to run at or slightly below, but not exceeding ones anaerobic threshold. As the season progresses, the workouts may progress towards shorter and faster runs, with a greater focus on intervals rather than fartleks, tempo runs, hill repeats etc. Some coaches prefer to start with shorter intervals at only a moderate intensity, quickly progressing to longer intervals, then just as most coaches do, gradually progress towards shorter faster intervals. As to the volume/frequency, that is often predetermined by the racing schedule and the abilities of the athletes. Each athlete is different so the
more individually tailored each workout can be, the better. Although a systematic progression of training may be important in performance enhancement and injury prevention, arguably, training the athlete mentally, primarily concerning attitude and motivation, is necessary and just as equally important. For an athlete to utilize as much of their potential as possible, they must have the proper motivation and attitude in all facets of mental and physical preparation throughout each day and throughout the year.

**TAPERING**

Tapering, which is a reduction in training volume and an increase in intensity, is one method coaches often employ to enhance performance during selected races (e.g., championship meet). The expected increase in performance from tapering is usually in the range of 0.5—6.0% for competition, with an average of 3%, but can possibly reach 25% in noncompetitive criterion measures. Although not an exhaustive list, the mechanisms through which tapering may positively influence performance is likely through favorable changes in testosterone/cortisol ratio, catecholamines, creatine kinase, glycogen, VO2max, and economy of movement.

There are four common types of tapers used to enhance performance, which usually range from less than 7 days to more than 22 days. These include linear tapers, slow decay tapers, fast decay tapers, and step tapers. Linear tapers are a constant gradual decrease in volume each day for the entire taper. Exponential slow decay tapers decrease rapidly at first, but the volume decreases slower towards the end of the taper. Whereas exponential fast decay tapers decrease rapidly at first too, but the volume decreases faster than the slow decay taper. Finally, the step taper immediately reduces the intensity and remains the same throughout the entire length of the taper.

Based on the study by Mujika and Padilla, it was concluded that the exponential taper is more efficient than a step taper and further that the fast decay taper was more beneficial for performance than the slow decay taper. Additionally, based on the meta-analysis by Bosquet et al., optimal performance may be achieved by a 2-week taper, with the training volume exponentially decreasing by 41-60%, without any modification of either training intensity or frequency. However, given that these findings were from athletes of multiple sports (i.e., swimming, running and cycling) with few in the younger population, the generalizability of these findings to adolescent distance runners is questionable. Before strong conclusions can be made regarding the optimal tapering strategy for adolescent distance runners, studies in this population are urgently needed.

**MARKERS OF OVERTRAINING**

Overtraining is often characterized as excessive frequency, volume, or intensity of training, resulting in fatigue, illness, or injury. It is often due to a lack of sufficient rest, recovery, or nutrient intake. For optimal training-induced adaptation, overtraining, as opposed to overreaching (i.e., excessive training on a short-term basis), should be avoided. The objective of training should be to elicit a response that specifically targets a physiological determinant of endurance performance (e.g., VO2max). Any training stimulus too high (or too low) will not target the desired physiological parameter.

Some of the key immunological, biochemical and physiological markers of overtraining are leukocyte responses to antigens, salivary IgA, neutrophil/lymphocyte ratio, plasma cortisol or cortisol/testosterone ratio, urinary steroids or catecholamines. Some other markers are plasma glutamine, plasma urea, plasma cytokines, blood lactate response to incremental or high intensity exercise, and plasma or salivary cortisol response to high intensity exercise. Some of the common changes are underperformance, muscle weakness, chronic fatigue, sore muscles, increased perceived exertion during exercise, reduced motiva-
tion, and sleep disturbance. Others include increased early morning or sleeping heart rate, altered mood states, loss of appetite, gastrointestinal disturbance, and recurrent infection. Although it likely is not feasible for the coach to obtain blood samples to assess biologically-determined training status, key behavioral variables, such as reduced motivation and mood, as well as other easily obtained variables, such as morning heart rate, may be used as an evaluative tool for coaches.

**EXPEDITING RECOVERY AND INJURY PREVENTION**

To achieve optimal performance and reduce the effects of detraining, training should be programmed and implemented to minimize injury. In addition to effective training, other methods can be employed to minimize the likelihood of developing an injury and expedite the recovery process between training sessions. Common methods include the use of post-exercise water immersion and contrast temperature water immersion therapy. For water immersion, common practice includes soaking in an ice-bath for 15-20 minutes at 12-15 degrees Celsius. For contrast temperature water immersion, common practice includes alternating immersion in cold and warm water, each lasting up to 5-minutes. The hypothesized mechanisms through which cold water immersion may assist in tissue recovery includes: flushing of waste products (e.g., lactic acid) out of affected tissues by constriction of blood vessels, reduced rate of physiological processes via a reduction of metabolism, reduction in edema (swelling), and intracellular-intravascular fluid shift. With respect to edema and soft tissue inflammation, and similar to the mechanisms through which active recovery may reduce exercise-induced edema, post-exercise water immersion may reduce soft tissue inflammation by shifting fluid from the extravascular space into the vascular compartment.

Providing support for these assertions, Vaile and colleagues showed that contrast water therapy, compared to passive recovery, was associated with a smaller reduction, and faster restoration, of strength and power measured by isometric force and squat jump production following exercises that induced delayed onset muscle soreness. De Nardi et al. compared the effects of cold-water immersion and contrast water therapy on the performance of adolescent soccer players during a week of training. With respect to a variety of physiological parameters (e.g., leukocytes, hemoglobin, creatine kinase), no differences emerged between the two methods and these two methods did not negatively influence the performance of the athletes (i.e., countermovement jump, sprint ability and 5-foot shuttle run), which is similar to other studies showing that water immersion does not negatively influence soccer-related performance. Importantly, De Nardi et al. showed that contrast water therapy resulted in a reduced perception of fatigue after the training session. Furthermore, Pournot et al. compared to effectiveness of temperate water immersion (36 degrees Celsius), cold water immersion (10 degrees Celsius), contrast water temperature (10-42 degrees Celsius) and passive recovery on maximal strength, power and post-exercise inflammatory responses in 41 highly trained elite athletes (Football, Rugby and Volleyball players). Results showed that, at 1-hour post exercise, a significant improvement in maximal isometric voluntary contraction of the knee extensor muscles was observed in the cold water immersion and contrast water therapy groups compared to pre-exercise. Further, for the contrast water immersion group, this result was associated with attenuation in the rise in leukocytes, suggesting a reduced passive leakage from disrupted skeletal muscle. Demonstrating an indirect influence on tissue restoration, Halse et al. showed that post-exercise water immersion is associated with higher energy intake in the subsequent meal. Although evidence does support the use of water immersion, some studies have failed to demonstrate its effectiveness, which may be explained by the protocol employed, i.e., not waiting long enough to take assessments after the immersion.
With respect to injury prevention, and as previously mentioned in the last paragraph of the “Training Methodology in the Off-Season” section, core strength plays a pivotal role in injury prevention. When there is insufficient core strength, an individual is at an increased likelihood of developing a distally-related pathology. On the other hand, when the kinetic chain is working efficiently, injury may be minimized as, in addition to and/or a result of proper kinetic chain alignment, there are more appropriate force distributions across the chain, optimal shock absorption and reduced compressive forces at the joints. Additionally, strengthening weak proximal muscles may also enhance control and efficiency of movement through coordinated muscle contraction patterns.

Alignment factors such as arch type and leg-length differences are also associated with running injuries. There are three common foot arch types, “normal” arch, pes cavus (high-arched or supinated feet), and pes planus (flat-footed or pronated feet). When there is excessive pronation or supination, compensatory rotation occurs at the tibia and stress is transmitted proximally through the leg. The result of this stress contributes to foot, ankle, knee, hip or lower back pain in pronated or supinated runners.

Selecting the proper running shoes based on foot type is the initial step in proper running biomechanics. Running shoes vary from other shoes because they have specific combinations of support and stability designed for a high-impact heel-toe gait. Running in faulty or improper shoes can adversely affect the lower extremity alignment, making runners more susceptible to injury. Along with choosing the rights shoes, runners should also replace their shoes after 500 to 700 km because they lose their shock-absorbing abilities.

NUTRITION

It is not within the scope of this paper to describe the specific dietary guidelines for athletes, as this information can be found elsewhere. However, we would like to briefly discuss some emerging evidence related to carbohydrate intake and subsequent performance. It is widely established that enhancing glycogen content through carbohydrate intake is important in sustaining endurance activities. Thus, coaches often recommend that their runners consume sufficient carbohydrates prior to their workouts. Importantly, “carbohydrate loading” will likely not enhance performance in shorter distances (i.e., 3km-10-km), as fatigue in such distances is likely a result of other factors, such as limitations in aerobic metabolism, rather than glycogen depletion. Additionally, emerging evidence indicates that training with low glycogen stores, every once in a while, may enhance performance. Hansen et al. conducted a study that examined the adaptations of training with low glycogen stores or training with high glycogen stores. Prior to a 10-week training program, participants maximal power and time to exhaustion were assessed using a dynamic knee extensor exercise. After these pre-training assessments, 7 participants underwent a 10-week program. Throughout the program, one of their legs trained more with low glycogen compared to the other leg. For example, one leg trained twice, every other day. For the leg training twice every other day, they trained the leg for an hour and then two hours later, the leg underwent another training session with the second training session having low contents of glycogen. The second leg trained once a day, and the 24 hour recovery allowed for optimal glycogen re-synthesis to occur. Results showed that only the “low” training leg had significantly higher resting glycogen concentration during and after the training, suggesting that training with low levels of glycogen increases genetic expression and ultimately increases the muscle’s glycogen storing capacity. Additionally, compared to the “high” leg, the “low” leg had significantly higher increases in citrate synthase, a
SUMMARY AND CONCLUSION

Based on our review of the literature and experience pertaining to adolescent distance running training, we suggest that, when feasible, coaches individualize and employ periodization into their runner’s training regimen. Additionally, it may be beneficial to limit the intensity and frequency of training in the off-season and, to assess for overtraining, evaluate the runner’s motivation and mood levels, as well as morning heart rate. To reduce the likelihood of injury, coaches should employ a systematic training regimen and runners are encouraged to develop their core strength and use appropriate running shoes. Further, to expedite recovery between workouts, runners may wish to undertake cold water immersion or contrast water immersion post training. To increase enzymes associated with aerobic metabolism, runners, every once in a while, may want to train with low glycogen stores. And, nearing the end of the season, coaches may want to employ an exponential decay taper of 2-weeks in duration with the training volume decreasing by 41-60% without any changes in intensity or frequency. Lastly, the coach and runner needs to carefully plan their training during the transition from high school to collegiate distance running.

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Paul D. Loprinzi, PhD, is an assistant professor in the Department of Exercise Science at Bellarmine University in Louisville, KY. He competed as a distance runner in cross-country and track at the division 1 level and has several years of coaching high school distance runners. His research focuses on promoting physical activity across the lifespan and examining the effects of different training methods on endurance performance in distance runners. His research model is that the promotion of positive health behaviors (i.e., physical activity) during early childhood may lead into lifelong engagement in physical activity, as well as the development of athletic excellence during late childhood and adulthood.

Timothy R. Greenwood is a senior undergraduate exercise student at Bellarmine University. He currently competes on the cross-country and track teams as a distance runner at Bellarmine University, and previously competed for Butler Traditional High School. After graduating, he is interested in pursuing a career in physical therapy and teaching.

Ryan Cornwell is a cross-country and track coach at Sandy High School in Sandy, OR. He has been coaching distance runners for seven years, and has coached multiple state qualifiers including several top finishers and one state champion. He currently trains and competes as a competitive distance runner and has since 1997. Before coaching, he completed formal educational training as an exercise science student at Portland State University. He also has a USATF level one certification for track and field.
ESSENTIAL ABSTRACTS

Commonalities of Winning Coaches

RESEARCH QUESTION

With the impact that coaches can have on student-athlete’s lives, it is imperative to maintain quality individuals to serve in this challenging profession. To help aspiring coaches to avoid common pitfalls and reenergize coaches who may be frustrated with certain aspects of their career, Miller, Lutz and Fredenburg (2012) examined the coaching philosophies, views and practices of outstanding high school coaches.

METHOD

Eighty coaches were identified in 10 states as “Outstanding.” This distinction was based on a number of criteria such as performance (win-loss records, championships, etc.) and positive character development. These coaches had coached their respective sports an average of 27.4 years and reported being a head coach for an average of 22.6 years. Collectively, these coaches won a total of 175 state championships and five coaches won 10 or more state titles each. They also had won many district, conference, regional, and other titles, and many of their team shad been ranked nationally (e.g., USA Today ranking). Additionally, they reported winning numerous “coach of the year” awards at the state level, as well as other awards such as National High School Coach of the Year, Nike Coach of the Year, AP Coach of the Year, etc. The coaches were asked to complete an online survey with open-ended questions.

RESULTS

How do outstanding coaches avoid discipline problems with athletes? The coaches admitted that problems are inevitable, but 63 percent strongly suggested that the best way to minimize discipline problems is to establish and enforce “clear and high expectations,” indicating that “You get what you expect most of the time.”

When discipline is necessary, what specific techniques do you apply? The coaches emphasized a need for fair and consistent enforcement of rules and expectations. It is best to “develop a history of making strong decisions and sticking to them…trust is important.” While every coach had specific ways of addressing discipline problems, one coach employed John Wooden’s (1997) adage, “Don’t treat everyone the same, treat them the way they deserve to be treated.”

What is the most challenging ethical dilemma you have faced in your coaching career? How did you handle it? In hindsight, would you have handled it differently and how? Ethical challenges included a vast array of situations from which two general themes emerged: decisions regarding appropriate punishment for athletes who violate team rules, and actions involving personal coaching integrity.

List any book(s) that you would recommend to a head coach. Expert coaches have extensive libraries and read a great deal on a variety of topics. Most coaches recommended books written by or about individuals who have been successful coaches in their sport. Respondents overwhelmingly recommended
books by John Wooden, such as They Call Me Coach, Coach Wooden’s Pyramid of Success, Beyond Success, and Wooden: A Lifetime of Reflections and Observations.

What advice would you have to notice coaches? Much of the advice centered on being a student of the sport. For example, one coach stated, “Go to clinics, work camps, pick the brain of seasoned coaches, be patient [and] do not rush your learning, decide as early as you can if you want to get to the next level and work toward that goal.” One common theme centered on achieving a balance between faith and family with coaching. Some coaches suggested bringing family to practice, and others pointed out the importance of setting limits on the time spent at work.

What Does This Study Mean for Coaches? Most of the expert coaches reported following commonly accepted practices, and they display traditional leadership characteristics—effective organizer and planner, hard worker, knowledge seeker, compassionate mentor, and reflective practitioner. They are clear about their expectations for themselves, their assistants, and their athletes. Overall, outstanding coaches want to help young people reach their potential on and off the “playing field.” As one coach stated, “Take care of your athletes, not just as athletes, but as people.”

REFERENCE

-Abstracted by Matthew T. Buns, Editor, Track and Cross Country Journal
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