NSCA
COACH
VOLUME 1
ISSUE 4

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NSCA COACH

VOLUME 1
ISSUE 4

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SLIDING TOWARD SOCHI—PART II: A REVIEW OF PROGRAMMING TACTICS USED DURING THE 2010 – 2014 QUADRENNIAL

BRAD DEWEESE, EDD, CSCS, MATT SAMS, MA, CSCS, AND AMBROSE SERRANO, MA, CSCS

INTRODUCTION

Part I of this two-part series on athletic development for bobsled athletes highlighted the theoretical constructs used during the creation of practice agendas. Our programming model, termed Seamless Sequential Integration (SSI), describes the combination of previously separate training theories and components including conjugate sequential training, phase potentiation, and vertical integration. This mode of programming was used to ensure that the development of individual fitness qualities occurred in a logical and complementary manner. In addition, this model allowed the coaches to address the tenants of periodization through the inclusion of an objective athlete-monitoring program that provided unique insight into each athlete's physiological adaptations to the training stimuli (1).

Part II continues the discussion on bobsled training with an overview of how information collected through a performance-monitoring program can be used to assist in the development of a sliding sport talent identification program and the fine-tuning of training blocks throughout each annual plan. The monitoring program should treat each athlete as an individual case with intra-individual longitudinal monitoring being the primary focus.

IDENTIFICATION OF BOBSLED-SPECIFIC PHYSICAL CHARACTERISTICS

With little to no information regarding the physical characteristics of elite bobsled athletes in existence, coaches will first need to get a handle on what physical characteristics are needed to excel in the sport. With no information to start, baseline data needs to be compiled. Based on the sport requirements, some suggested variables that should be tested include morphological and anthropometric measures, reactive and isometric strength, and power. Some tests may require specific equipment. For example, isometric mid-thigh pulls (IMTP) can be assessed using PASCO force plates and analyzed using LabVIEW data analysis software (2). Reactive strength is another variable that can be monitored through a series of maximal jumps on a force plate. It is valuable to test these jumps using a variety of loads (an example load progression for these jumps could be unweighted, 10 kg, 20 kg, 40 kg for both the men and women, and then an additional weighted jump of 60 kg for the men).

This compilation of data can provide the strength and conditioning coach a better understanding of the physical attributes needed for the sport and current standing of their athletes. For example, as bobsledders sprint for the initial part of their races, this time period may be an important variable to examine when testing an incoming athlete. Since this time period is so crucial, the rate of force development would be a valuable measure to test.

Another aspect that may be noteworthy is the anthropometric profile of the athletes. Bobsled is unique in that it is a sport that requires an athlete to find balance between maintaining a weight that will create and sustain momentum when traveling down the track, and avoiding a body composition that is so high that it deleteriously affects sprint performance.

Mentioned previously, the SSI model is built to ensure potentiation of one phase into another, with each block of training having a particular training focus and expectations for which adaptation

in performance measures should occur. The use of testing for performance monitoring can help determine if the intended results are indeed occurring, and if not, the coaches can then make the proper program adjustments moving forward. For instance, Table 1 is a theoretical representation of what may result from exposing an athlete to varying block foci, as revealed by the iMTP performance test. Data analysis and interpretation can provide the attending coach an opportunity to determine whether or not those results in performance adaptations are being achieved.

PRACTICAL CONSIDERATIONS IN PROGRAM DESIGN

A successful start in bobsled requires the athlete to overcome the sled's inertia and displace it with high forces. Since the time available to produce force is limited by the duration of the stance phase (ground contact time) of the sprint, rate of force development is an important training priority when optimizing competitive readiness.

Through the utilization of blocks of concentrated loads, rate of force development (RFD) can be trained successfully. This approach can be carried out through the prescription of a range of relative intensities for each set-rep scenario. These differing intensities will expose the athletes to a large spectrum of movement speeds during a training block, which may assist in shifting the athlete's entire force-velocity curve to the right, as theorized in Figure 1. Recall from part I, relative intensities are used to bridge the gap between an athlete's calculated load (based on a set-rep maximum) and the residual effects of summated fatigue that the athlete may "bring" into that training session. Furthermore, set-rep best systems differ from a one-set maximum system in that the percentage prescribed for a training session is based on what the athlete can hypothetically perform for that given set-rep scenario (for instance a 3 x 5) instead of a 1 or 3 repetition maximum. It should be noted that this method of prescribing intensity can account for varying levels of training status and physiological differences exhibited by athletes.

Figure 2 illustrates how a bobsled athlete may progress through sequential phases of training through the implementation of concentrated loads and varying intensities. Coaches should select exercises for each block based on the training emphasis. For instance, in Figure 2, back squats stayed a staple for most, if not all, of the training year in order to mature and optimize force production. In conjunction, weightlifting movements increased in complexity (e.g., movement skill, range of motion, etc.) so that RFD could be fully matured once the season began. The weightlifting movements are also broken down into derivatives (e.g., clean grip shoulder shrug and clean grip pull to knee) in order to stabilize movement efficiency and force output before commencing with more complete lifts such as the mid-thigh clean or power clean. Lastly, auxiliary exercises such as unilateral squats, upper body presses, and posterior chain can be prescribed to compliment individual athlete needs as well as to maintain an adequate volume-load.

CONCLUSION

This training model, which attempts to cohesively blend strength and speed development through strategic exercise selection and loading paradigms, guided the process of program planning for these bobsled athletes. Given the nature of most bobsled training programs, a quadrennial plan is most logical. This longer period of time allows for the maturity of required fitness qualities in a successive manner. Prioritizing each year of the quadrennial toward a specific training agenda (e.g., maximal strength) may allow subsequent years to build toward a more narrow and specific focus (e.g., rate of force development and explosive speed). In order to ensure the proper development of an athlete within each stage of training, a performance-monitoring program can also be implemented.

While any sport can be largely chaotic, effective training can maximize preparedness and the chances for competitive success. At no other level of sport is this more apparent than the Olympic Games, where fractions of a second separate a podium-performance from fourth place. The authors hope that providing insight into the training model used by a select group of elite-level bobsled athletes over the past quadrennial will further bolster the successful development of future bobsled training programs.

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FIGURE 1. THEORETICAL REPRESENTATION OF THE SHIFT IN FORCE-VELOCITY CURVE AS RESULT OF EXPOSURE TO VARYING LOADS AND MOVEMENT SPEEDS

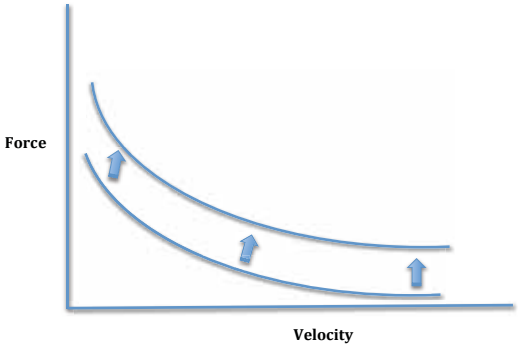

FIGURE 2. EXAMPLE OF STRENGTH DEVELOPMENT PROGRAMMING WITH PHASE POTENTIATION AND RELATIVE INTENSITIES

WEEK:	OBJECTIVE	VOLUME	DAY 1	DAY 2	DAY 3
1	RTF	3 x 5	80%	80%	75%
2	RTF	3 x 5	80 – 82.5%	80 – 82.5%	75 – 77.5%
3	SE	3 x 10	82.5 – 85%	82.5 – 85%	75 – 77.5%
4	SE	3 x 10	87.5%	87.5%	80%
5	SE	3 x 10	90%	90%	80 – 82.5%
DAY 1 (PUSH EMPHASIS)		**DAY 2 (PULL EMPHASIS)**		**DAY 3 (PUSH-PULL COMBO)**	
Back squat		Pull to knee		Snatch grip shoulder shrug	
Overhead press		Clean grip shoulder shrug		Back squat	
Lunges		Stiff-legged deadlift		Incline bench press	
Bench press		Pull-ups		Step-ups	
6	MS	3 x 5	85%	85%	75%
7	MS	3 x 5	90%	90%	77.5 – 80%
8	MS	3 x 5	95%	95%	80 – 82.5%
9	MS	3 x 5	82.5%	82.5%	75 – 77.5%
DAY 1 (PUSH EMPHASIS)		**DAY 2 (PULL EMPHASIS)**		**DAY 3 (PUSH-PULL COMBO)**	
Front squat		Mid-thigh pull		Mid-thigh pull	
Overhead press		Clean pull		Back squat	
Split squat		Glute ham		Bench press	
Incline bench press		Bent-over row		Reverse hyper	

FIGURE 2. EXAMPLE OF STRENGTH DEVELOPMENT PROGRAMMING WITH PHASE POTENTIATION AND RELATIVE INTENSITIES *(continued)*

WEEK:	OBJECTIVE	VOLUME	DAY 1	DAY 2	DAY 3
10	MS	5 x 5	87.5%	87.5%	75 – 77.5%
11	MS	3 x 5	92.5%	92.5%	80%
12	MS	3 x 5	95 – 97.5%	95 – 97.5%	82.5%
13	MS-AS	3 x 3	80 – 82.5%	80 – 82.5%	75%
DAY 1 (PUSH EMPHASIS) Push press Back squat Bench press Squat to press			**DAY 2 (PULL EMPHASIS)** Mid-thigh clean Clean pull Stiff-legged deadlift Pull-ups		**DAY 3 (PUSH-PULL COMBO)** Countermovement shrug Back squat Incline bench press Split squat
14	AS	5 x 3	85 – 87.5%	85 – 87.5%	75%
15	AS	3 x 3	92.5%	92.5%	75 – 77.5%
16	AS	3 x 3	95%	95%	80 – 82.5%
17	CV	3 x 3	80 – 82.5%	80 – 82.5%	75%
18	CV	3 x 2	85%	85%	75%
DAY 1 (PUSH EMPHASIS) Push jerk Back squat Bench press Squat jumps			**DAY 2 (PULL EMPHASIS)** Power clean Mid-thigh pull Bent-over row		**DAY 3 (PUSH-PULL COMBO)** Countermovement shrug Back squat Incline bench press

Key:
RTF=Return to fitness
SE=Strength endurance
MS=Maximal strength
AS=Absolute strength
CV=Convergence

TABLE 1. REPRESENTATION OF TRAINING BLOCK FOCUS WITH THEORETICAL CHANGES IN IMTP PERFORMANCE POST-BLOCK AND RELATIVE INTENSITIES

VARIABLE	STRENGTH ENDURANCE BLOCK	STRENGTH BLOCK	ABSOLUTE STRENGTH BLOCK	CONVERGENCE BLOCK	EXPLOSIVE SPEED BLOCK
Peak Force (PF)	→, ↑	↑	↑	→, ↑	→, ↑)
Force at 90ms	→, ↑	↑	↑	→, ↑	→, ↑
Force at 250ms	→, ↑	↑	↑	→, ↑	→, ↑
RFD at 90ms	↓	→, ↑	→, ↑	↑	↑)
RFD at 250ms	↓	→, ↑	→, ↑	↑	↑

Indicates an expected increase (↑), decrease (↓), or no significant change (→) in specific performance measures.

ENHANCING MOTOR LEARNING WITH SLED TRAINING

JOEL BERGERON, MS, CSCS,*D, USATF-2

Strength and conditioning programs for athletic performance can be broken into two main components—physiologic improvement and motor learning. While physiologic enhancement to strength, power, and endurance play a role in athletic success, they are relatively easy things to improve with consistent training. Sport-specific skill acquisition such as swinging a bat or shooting a basketball, however, takes thousands of quality repetitions in order to master and generally progress at a slower rate. Most coaches do not realize that strength training, plyometrics, and core conditioning all contribute to motor learning, when used appropriately.

When analyzing movement patterns, the human body moves through three planes of movement; sagittal (flexion/extension motions), frontal (ab/adduction motions), and transverse (rotary) (1). All movements take place in one of these three planes no matter how simple or complex, or utilize a combination of them simultaneously. Most strength and conditioning programs are made up primarily of exercises taking place in the sagittal plane against the vertical pull of gravity. Teaching athletes how to move more efficiently is more than just adding frontal, transverse, unilateral, or bilateral exercises into a program. It also has to do with the progression of movement patterns athletes learn, the combinations of movements participated in when exercising, and what is most commonly overlooked—the line of pull. This enhances neurological learning, but even more importantly, brain plasticity, or the ability of the brain to synthesize new movement patterns at a faster rate (2). Brain plasticity is promoted by teaching the nervous system a greater number of ways to create motor pathways, which send signals out to the muscular system (2).

Motor learning as a principle is analogous to trails created in a forest by animal traffic. The less a path is traveled, the more difficult it is to traverse the course due to forest overgrowth. The more a path is traveled, the greater the ground is worn, and if more routes from point A to point B are created, the animal can find a path to the destination in a shorter period of time. The nervous system works in a similar manner. The challenge is figuring out an efficient way of teaching athletes how to create plasticity through the training prescribed. Exposing athletes to a variety of movement patterns that simulate actual sport mechanics can enhance and shorten this learning process.

IDENTIFYING FUNDAMENTAL SPORT MOVEMENT PATTERNS

Most sports involve three common sport movements; swinging an implement, throwing an object, and a form of locomotion seen as linear, lateral, or a combination (agility) of the two. The difficulty is breaking these movements into simpler patterns that can be taught using conventional strength training and muscular conditioning. But even beyond this, the greatest challenge is finding exercises and routines that actually translate back to sport moves.

Performing a squat, bench press, jump, or simple medicine ball throw are all good ways to begin teaching gross movement patterns, however they fall well short of reproducing the actual

sport move in most instances. These exercises are dissimilar in both range of motion, tempo, rhythm, and execution when compared to full athletic movements. Even Olympic-style lifts are deficient in reproducing the movement patterns seen in most sports, as these exercises primarily take place in the sagittal plane against vertical resistance.

Most coaches waste a lot of time training their athletes in these areas because it is easy to see immediate improvements in absolute strength and power, which for a common athlete, can have a significant, initial positive influence on their sport performance. However, if the goal is to place the athlete in the best position for long-term success, a revised approach toward motor learning should be considered. In order to promote translation of power application into a sport movement, it is important to develop absolute power using these gross exercises but still perform a portion of the actual sport movement (i.e., swinging a bat).

The three common sport movements can be further broken into three movement patterns; hip flexion/extension, trunk rotation (torque), and a combination of lower body to upper body summation of force in a rhythmic manner.

Hip flexion and extension are critical to enhance hip displacement for jumping, stride length, and stride frequency. When trying to improve an athlete's speed, every movement of the body is about hip displacement across space. The faster the hips move for a given distance, the faster the body travels which is manifested as higher speed. Quicker velocities of movement translate to higher levels of competition in nearly every major sport.

Trunk rotation provides a mandatory translation of lower body power traveling through the spinal column and delivering this inertia into the trunk, leaving the arms and hands through either a throwing or swinging motion of an implement. Referred to as the serape effect, the velocity of throwing an implement or swinging a club (such as a bat, stick, or racket) is directly correlated to the amount of force transferred from lower body to upper body about the spine (3). By rotating the hips ahead of shoulders, an athlete is effectively "pulling" their shoulders behind their hips in a whipping motion. This creates a summation of forces, and when timed correctly, develops much higher velocities than if the trunk and upper body were used independently.

Finally, developing a slow to fast rhythm promotes maximum velocity for throwing and striking/swinging of an implement. This is achieved by initiating movements with the prime movers of the body (large muscles such as the gluteus maximus, hamstrings, quadriceps, latissimus dorsi, and pectoralis) followed by assisting or secondary movers (smaller muscles of the arms, legs, feet, and hands). Athletes must understand the timing of a movement to excel.

Recall that in order to create speed of an implement (bat or ball), maximum velocity must be achieved during the point in time of release or striking of the implement (i.e., throwing a ball or making contact with a bat). This happens because the athlete knows how to coordinate the kinematic chain of their body and times all of their body movements to achieve max power at the very moment they are needed. The question to coaches is what are you prescribing to your athletes to help them learn this outside of practice? Sled training can provide an invaluable tool that combines both sport movements with relatively unrestricted external, horizontal resistance.

PROMOTING ATHLETICISM THROUGH SLED TRAINING

As already mentioned, most strength and conditioning programs are dominated by sagittal plane exercises. Adding more frontal and transverse plane exercises, while helpful in promoting general motor learning, still may fall short of teaching advanced sport moves. In the context of developing absolute strength and rudimentary power enhancement, Table 1 provides an example of common learning progressions for lower and upper body strength development. While these exercises provide a solid base of strength, they still do not teach actual sport moves efficiently.

The sled is generally misunderstood as a limited training tool, or simply not used, primarily because many coaches consider training in the sagittal plane for straight line, such as with sprinting drills. This is a very limited application of this training tool and minimizes the true value. Sled workouts provide a training stimulus that more closely mimics real-world physical demands of life and sport because they can create horizontal resistance. Sport demands call for a combination of both vertical and horizontal requirements, with the majority being horizontal. Normal weight room exercises predominantly simulate vertical weight displacement; therefore it is necessary to develop strength in a horizontal plane.

Sled training also allows for frontal and transverse plane activities while in locomotion, something not readily available in the weight room. Injuries in these two planes generally occur due to lack of physical preparation at the tempos and intensities seen in competition. Using the sled helps train athletes for these types of physical stressors. It is in this way that sleds can help decrease the likelihood of injuries, and help develop strength, power, and speed that are transferable to performance. Refer to Table 2 for key coaching points related to sled training.

When utilizing sled exercises, coaches should use a modular system composed of three parts:

1. The sled where weight is loaded.
2. A length of rope between the harness/handles and sled, this should be around 6 – 8 ft long.
3. A set of handles tethered to the mid-piece to facilitate most moves. These can be purchased or constructed using simple rope and PVC pipe available at any hardware store. The handles should be at least 10 ft in length to accommodate most wingspans and arm lengths. A harness may be used for basic exercises such as sled sprints and are readily available through most sport equipment suppliers.

Table 3 provides examples of how to incorporate sled training into an overall weekly microcycle. Table 4 provides guidelines for prescribing individual sled workouts. Below are example sled exercises which help take the absolute strength developed with basic strength, plyometric, and medicine ball exercises, and applies them in the context of the three major sport moves. Doing 3 – 5 of these exercises for three sets of 100 yards each can easily occupy a 45-min workout when done with appropriate loading. It should be noted that all exercises could be increased in difficulty by beginning with bilateral execution of the movement and progressing to unilateral execution, and ultimately unilateral alternating execution after a few weeks of each step in the progression.

1. **Walking Bench Press** – Walk, performing a bench press. Take long, exaggerated steps almost like a lunge step. (Figures 1 and 2)
2. **Walking Lat Pull** – Same as a lat pull however walking backwards (Figures 3 and 4)
3. **Squat to Press** – Squat, lean forward against weight, stand explosively, and finish with an overhead press. (Figures 5 and 6)
4. **Walking Batter Ups** – Perform a swinging motion similar to throwing or swinging a bat. This exercise can be performed with a "crow's hop" movement similar to a baseball outfielder making a long throw. (Figures 7 – 10)
5. **Bear Crawl** – Use a harness and perform a forward bear crawl, similar to pushing a sled in football but with the load being dragged. (Figures 11 – 13)
6. **Squat to Pull** – Perform the squat to pull moving backwards. Perform a squat with arms extended, stand, execute a lat pull, then take backward steps while extending the arms back out until fully extended. (Figures 14 and 15)
7. **Crossover Step Jump** – Perform a crossover step and flex the lead leg, keeping the trail leg extended. Push off the lead leg and perform a jump. (Figures 16 – 18)
8. **Lateral Walk with Arms Extended** – Make a "triangle" by extending both arms holding the handles in front of the chest. This greatly works the trunk and other stabilizers. (Figures 19 – 21)
9. **Single-Joint Movements** – Any typical single-joint exercise, such as a biceps curl or triceps extension, can be simulated. Make sure to keep the sled moving at all times by constantly keeping the feet in motion.

When setting up a comprehensive strength and conditioning program, it is important to choose a variety of exercises that set up foundational strength yet still link the exercises back to the three common sport moves. While development of absolute strength and power with conventional strength training and conditioning is an integral component to performance enhancement, it is even more important to be able to convert this into usable athletic strength. Using sleds on a regular basis provides coaches with an avenue to complete this challenge.

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TABLE 1. COMMON EXERCISES TO ENHANCE ABSOLUTE STRENGTH AND RUDIMENTARY MUSCULAR POWER

TARGETED BODY SECTION	INTRODUCTORY EXERCISES	NOVICE EXERCISES	VETERAN EXERCISES	ADVANCED EXERCISES
Lower Body Strength	Bodyweight squat	Dumbbell or barbell squat or deadlift	Olympic-style lifts, rack squats or deadlifts	Deadlifts or squats using resistance bands or chains
Upper Body Strength	Push-up (modified/ regular), inverted row	Dumbbell or barbell bench press, pull-ups	Pressing exercises executed with unilateral movement, or partial ROM with lockouts or board presses, weighted pulling exercises	Pressing or pulling exercises using resistance bands or chains
Trunk Strength	Crunch, plank, sit-up, prone trunk extension (superman)	Lateral bends off raised platform, any variety of bodyweight abdominal work with external resistance	Modified deadlifts and squats to create low-leverage scenarios for trunk stability (e.g., good mornings)	Tire flips, medicine ball throws
Lower Body Power	Double-leg hurdle hop with soft landing, box jump with step down	Continuous double-leg hurdle or box hops	Single-leg hurdle or box hops	Depth jumps off a platform
Upper Body Power	Medicine ball chest thrust	Plyometric push-ups	Heavy weighted throws using a barbell, clapping push-ups	Depth drop off a platform into a push-up
Trunk Power	Medicine ball rotational throw or overhead throw with follow-through	Single-arm medicine ball throws	Medicine ball throws with a partner, or throws off a rebounding surface such as a wall	Medicine ball throws in reaction to striking an implement (use of a sling)

TABLE 2. KEY COACHING POINTS FOR SLED TRAINING

1. For the majority of exercises, there should be no 'slack' in the line connecting the sled, to the athlete.
2. The athlete should almost always have their feet moving with an upright trunk posture. If they are constantly walking, there should be almost no slack on the line as a result.
3. Execute most moves with an explosive, high velocity acceleration phase, and a controlled, 2-3 second long deceleration phase.
4. While momentum can be used, there should be a balance between control and speed to promote motor learning and overall quality of execution.
5. Start with basic moves and build to more complex ones.
6. Always control the movement. Some exercises call for aggressive pushing/pulling to facilitate body mechanics. However, all exercises should have a controlled deceleration phase to the lift.
7. Doing multiple sets substantially increases intensity, particularly for exercises late in the workout.
8. When form is bad, switch to something easier or stop the workout. Quality is more important than quantity.
9. Always emphasize correct body mechanics. While form/technique may breakdown, it should not be done completely wrong (i.e., rounded back, overuse of the rotator cuffs, etc.)
10. Don't train haphazardly. Write down distances, reps, and weights and progress. This will make athletes very strong when done regularly.

TABLE 3. EXAMPLE MICROCYCLE SCHEDULING

MONDAY	Heavy lower body lift, core conditioning with medicine ball, plyometrics
TUESDAY	Heavy upper body lift, total body sled training
WEDNESDAY	Conditioning with sprints, cardio, aerobic training with sleds as a recovery activity
THURSDAY	Total body strength training with dynamic effort/speed/hypertrophy
FRIDAY	Total body sled work with rotary and frontal plane work; not linear/sagittal exclusive, conditioning with the sled

TABLE 4. RECOMMENDATIONS FOR INDIVIDUAL SLED WORKOUT PRESCRIPTIONS

1. Use a straightaway that is at least 25 yards long.
2. Each exercise should be for a total of at least 100 yards (two 25-yard trips up and back).
3. The number of exercises and sets prescribed is dependent on time available.
4. Generally, doing 5-8 exercises for 100 yards each takes about 30 minutes. This takes into account explaining, demonstrating, coaching, and swapping weights or reconfiguring apparatus between exercises if necessary. This is the equivalent of ½ mile of externally resisted work involving total body sports mechanics. When was the last time you did this as part of your workout?
5. Rest for 1-2 minutes between sets, and emphasize, control, accuracy, high-intensity, and explosive movements.
6. This will be very challenging and taxing for the novice athlete. Remember that if form breaks down, choose a simpler exercise or provide recovery to promote overall quality.
7. Make sure athletes record the weights they are able to use for each exercise in the same manner they would a normal strength training routine. This is important to promote progression, consistent challenge, and increase self-confidence by seeing personal improvement.

FIGURE 1. WALKING BENCH PRESS

FIGURE 2. WALKING BENCH PRESS

FIGURE 3. WALKING LAT PULL

FIGURE 4. WALKING LAT PULL

FIGURE 5. SQUAT TO PRESS

FIGURE 6. SQUAT TO PRESS

FIGURE 7. WALKING BATTER UP

FIGURE 8. WALKING BATTER UP

FIGURE 9. WALKING BATTER UP

FIGURE 10. WALKING BATTER UP

FIGURE 11. BEAR CRAWL

FIGURE 12. BEAR CRAWL

FIGURE 13. BEAR CRAWL

FIGURE 14. SQUAT TO PULL

FIGURE 15. SQUAT TO PULL

FIGURE 16. CROSSOVER STEP JUMP

FIGURE 17. CROSSOVER STEP JUMP

FIGURE 18. CROSSOVER STEP JUMP

FIGURE 19. LATERAL WALK WITH ARMS EXTENDED

FIGURE 20. LATERAL WALK WITH ARMS EXTENDED

FIGURE 21. LATERAL WALK WITH ARMS EXTENDED

TRAINING CONSIDERATIONS FOR A SOCCER GOALKEEPER

JASON METZ, MS, CSCS, TSAC-F, AND JULIA MCCRACKEN

On June 16, 2014, the United States National Soccer Team played against Ghana in the first stage of the 2014 Fédération Internationale de Football Association (FIFA) World Cup. Despite a previous upset in 2010 that eliminated the United States from the tournament, they were able to beat Ghana by a score of 2 – 1. Clint Dempsey scored the quickest goal in the history of the FIFA World Cup (only 29 s into the game), while teammate and goalkeeper Tim Howard defended their goal from strikes against their opposition. As the tournament advanced, Howard's skills were evident as he denied numerous shots against Portugal and Germany in later matches. His new found title as the "Secretary of Defense" during the tournament perfectly captured how Howard caught, punched, blocked, and dove to prevent goals from the opposing team.

Goalkeepers are the last defender on the field, and the only ones allowed use of their hands to prevent a goal scoring opportunity. With the unique skill requirements of this position, the training requirements also differ from other positions in the sport of soccer.

FIELD POSITIONING OF A GOALKEEPER

The main area of concern to a goalkeeper during a soccer match is the goal, goal area, and penalty box. A regulation goal in FIFA sits centered directly atop the goal line and is 8 ft tall by 24 ft wide (between goal posts). Goals must have goalposts and crossbars that are equal in size and do not exceed 5 in. The goal area consists of two lines drawn at right angles to the goal line 18 ft in length from the goal posts, and are joined by an 18 ft line drawn parallel to the goal line. The penalty box is measured at 54 ft outside of the goal post with two lines drawn at right angles to the goal line extending out 54 ft and joined together by a line parallel to the goal line. This area of the field has the quickest play occurring as game situations continually change (5).

POTENTIAL GOAL SCORING OPPORTUNITIES

During the course of play, numerous scoring situations can arise that lead to a shot on goal. Corner kicks are taken from within the corner arc (3 ft) between the goal and the touch line. During this restart, the goalkeeper must be aware of their positioning and utilize teammates to prevent a goal. Multiple attackers and teammates will be involved, reinforcing the need of communication and specific roles between players.

A penalty kick will occur if a foul occurs for the attacking team within the penalty box of the opposing team or in the case of a shootout. The penalty mark is 38 ft from the midpoint of the goal line and requires an arc of a circle to be drawn outside the penalty box allowing 30 ft from the center of the mark. During a penalty kick, the goalkeeper must keep their feet on the goal line until the kicker has made contact with the ball. This type of kick is solely between the kicker and the goalkeeper (5).

Breakaways can also occur during a soccer match, where the goalkeeper may be one-on-one with an attacker. The goalkeeper must read the play and react accordingly in order to successfully deny a goal. When there is only one attacker, the goalie can focus solely on one opponent; however, multiple attackers versus the goalkeeper is a situation that happens frequently as well. These plays force the goalkeeper to be aware of their position on the

field. Long or short passes between attacking players stresses the need for the goalkeeper to have fast reaction ability, with swift and purposeful movements.

POSITION REQUIREMENTS AND TRAINING

A soccer goalkeeper needs a unique set of physical abilities for the various situations they may face during a game, a few of which were listed previously. Physical conditioning may not be enough for a goalkeeper needing to respond quickly. For this reason, reaction training should be a staple in a well-rounded conditioning program for soccer goalkeepers. As in other sports requiring a high degree of reactive skill, soccer goalkeepers can benefit from training to improve mental processing speed by training both auditory and visual components (1,3,6,10).

Since soccer goalkeepers are responsible for processing a lot of information in a very short amount of time, it is important to challenge all forms of stimulus response. The auditory component can be something as simple as listening to the sound of the thud on the ball as it leaves an attacker's foot (9). If it is coming from something like a corner kick or a penalty kick, understanding the amount of time the ball will be in the air can affect how the goalkeeper defends the play. One sport that is very dependent on auditory reaction training is track and field sprinters. Tonnessen et al. showed a sprinter's 100-m time was significantly associated with reaction time ($p < 0.01$) (9). A sprinter is trained to respond to the sound of a starting pistol, so is it a far stretch to assume a goalkeeper can be trained to respond to the sound of a kicked ball?

Visual training improves their ability to recognize player movements and understand what it means for the defense. A visual reaction/agility test performed by Zemkova et al. assessed the difference between a non-competitive atmosphere and a competitive atmosphere (11). The results showed there was a significant improvement in ability during a competitive atmosphere. This would lead one to believe the effort put into the drill is just as important as the drill itself (11).

Another aspect of conditioning that is of extreme importance is power. Power by definition is a function of weight moved by unit of time. The Olympic-style lifts, clean and jerks, and snatches may improve power which can affect everything from vertical jump to being able to dive for a ball (2,4,8). Because of the technical aspects of these movements, it is very important to seek coaching from a qualified professional. Olympic-style movements can be very beneficial, but also very dangerous if taught incorrectly or prescribed improperly.

One final aspect of a soccer goalkeeper's physical requirements is multidirectional speed and agility. Like most sports, soccer is not uniplanar—moving straight forward, backward, or side to side—and involves change of direction abilities. Because soccer does not have a preprogrammed task, mental processing speed must translate to a correct muscular movement as quickly as possible (6). The motor control component of speed and agility drills is a response for the mental decision making process (2). Salonikidis et al. cited work stating plyometric training has been shown to improve motor control (8). Training to improve both speed and agility as well as motor control can be done by incorporating drills as well as plyometrics into a goalkeeper's training program (4,8).

PROGRAM DESIGN

As with all sports, a program should always begin with designing an appropriate periodization model to address training needs throughout the training year. Table 1 shows a sample 12-month training schedule for high school soccer players. After a periodization model is designed, figuring out energy system requirements for each season will direct a coach to the appropriate intensity and set of program guidelines. Once the energy system is factored in and guidelines are established, exercises can be added to achieve the desired level of specificity of training. Table 2 outlines a sample in-season training schedule factoring in for games and practices and Table 3 lays out a basic training template excluding team practice time.

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TABLE 1. HIGH SCHOOL SOCCER SAMPLE TRAINING SCHEDULE

OFF-SEASON					PRE-SEASON		IN-SEASON			POST-SEASON	
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

TABLE 2. SAMPLE IN-SEASON SOCCER SCHEDULE

AUGUST	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1	2	3
	4	5	6	7	8	9	10
Pre-season	11	12	13	14	15	16	17
Begin in-season	18 Scrimmage	19 Practice	20 Train practice	21 Practice	22 Practice	23 Game	24 Off
	25 Train	26 Practice	27 Train practice	28 Practice	29 Game	30 Practice	31 Off

SEPTEMBER	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	1 Off	2 Game	3 Off	4 Game	5 Off	6 Game	7 Off
	8 Off	9 Game	10 Practice	11 Game	12 Practice	13 Train practice	14 Off
	15 Off	16 Game	17 Practice	18 Game	19 Practice	20 Train practice	21 Off
	22 Off	23 Game	24 Practice	25 Game	26 Practice	27 Game	28 Off
	29 Off	30 Game					

TABLE 2. SAMPLE IN-SEASON SOCCER SCHEDULE *(continued)*

OCTOBER	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			1 Train practice	2 Practice	3 Game	4 Practice	5 Off
	6 Train	7 Practice	8 Game	9 Practice	10 Game	11 Practice	12 Off
	13 Train	14 Practice	15 Game	16 Practice	17 Train	18 Practice	19 Off
	20 Train	21 Practice	22 Train practice	23 Practice	24 Practice	25 Districts	26 Districts
	27 Off	28 Train practice	29 Practice	30 Practice	31 Travel		

NOVEMBER	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
						1 Regionals	2 Regionals
	3 Practice	4 Practice	5 States	6 States	7 States	8 States	9 States
	10 States	11 States	12 States	13 States	14 States	15 States	16 States
Begin post-season	17	18	19	20	21	22	23
	24	25	26	27	28	29	30

TABLE 3. SAMPLE IN-SEASON GOALKEEPER CONDITIONING EXERCISES

DYNAMIC WARM-UP	Side shuffle High knee pull Walking quad High kick High skip
EXPLOSIVE TRAINING	Medicine ball drop jump Medicine ball snatch throw Lunge jump
SPEED AND AGILITY	Diagonal side shuffle 4-cone shuffle Pro-agility with burpee
REACTION TRAINING	Mirror drill Turn around defense Color touch drill
COOL-DOWN	5-min walk Static stretches Band stretches

A PROACTIVE APPROACH TO HEALTH AND PERFORMANCE—NUTRIENT AND BLOOD TESTING

DAWN WEATHERWAX, RD, CSSD, ATC, CSCS

It is improbable to always know if physical condition and performance is at an optimal state as some issues have unspoken outcomes. However, the body's system can be observed by blood testing to help achieve desired results whether training for a competition, pursuing an individual goal, or improving general health.

Besides looking at a lipid profile, another important step to monitoring health is by establishing a baseline of values for fasting glucose, ferritin, vitamin B-12, and vitamin D. For the purposes of this article, these are the four blood profiles that will be emphasized. Next comes knowing what the standard values are and then aiming for peak levels, if appropriate.

GENERAL BLOOD MARKERS

Fasting Glucose: The body uses glucose for energy. The body must keep blood glucose in a tight range. Approximately 25% of those who have an ideal bodyweight and composition still show pre-diabetic numbers (7). Chronic stress or poor sleeping practices can also impact blood sugar levels in a detrimental way (6). If fasting glucose numbers are too high or too low there are negative consequences including eye, heart, kidney, and neurological damage (19). According to the American Diabetes Association, a fasting blood glucose level between 70 and 100 milligrams per deciliter is considered normal (1).

Ferritin: Ferratin is a protein found mostly in the liver, skeletal muscles, spleen, and bones. It stores iron in these areas so the body can use it in the future. The preponderance of iron stored in the body is found in ferritin. Because of this, the ferritin test is often the preferred measurement to determine the amount of iron in the body (4,20). At least 25% of any group of athletes can be expected to exhibit low ferritin levels without being anemic (18). Athletes who are most susceptible are ones with a low dietary iron intake, menstrual losses, and high training levels. Low ferritin levels may lead to anemia, extreme fatigue, impaired cognitive performance, suboptimal metabolism, susceptibility to infection, and compromised immune system and brain development (3,8). The range of ferritin levels that is considered "healthy" remains a controversial topic since recent studies have suggested that even non-athletes may need more than previously thought (12).

Many authorities recommend iron supplementation for hypoferritinemic individuals (16,23). Besides supplementation, 8 – 32 mg of iron per day through dietary intake is suggested pending on dietary practices. Too much iron intake can also be harmful to individuals, so caution is advised to maintain healthy levels. Good food sources of iron include liver, beef, chicken, salmon, lentils, beans, potatoes, quinoa, spinach, broccoli, apricots, potatoes, pumpkin seeds, thyme, 80% dark chocolate, molasses, tofu, and tempeh.

Vitamin B12: Vitamin B12 is a water-soluble vitamin that plays an important role in the body. It helps with the formation of red and white blood cells, the metabolism, and oxygen delivery to the tissues (9). It also impacts the function of the brain and central nervous system. Signs of constipation, fatigue, loss of appetite, memory loss, shortness of breath, and weakness are all side effects of vitamin B12 deficiency. Declining vitamin B12 numbers can be linked to low stomach acid, excess alcohol intake, gut inflammation, medications, pernicious anemia, post-surgical malabsorption, and vegetarianism (10,22). A study showed that 40% of people between the ages of 26 and 83 had B12 levels in a range at which many experienced neurological symptoms, and another 25% had low or outright deficiency (11). The most unpredicted outcome was the similarly low levels found in younger people when compared with mature adults (11). Animal products, including meat, poultry, fish, seafood, eggs, and dairy products are excellent sources for vitamin B12 (24).

Vitamin D: Vitamin D is a secosteroid, which is a derivative of a steroid with a broken ring. It functions as a modulator for as many as 1,000 genes; is involved in calcium homeostasis, bone health, immunity, inflammatory intonation, and skeletal muscle function; and has a potential impact on training and performance of athletes (5,14,17). The best indicator of vitamin D levels is to measure serum 25(OH)D, which is commonly done with a 25-Dihydroxyvitamin D test . Generally, vitamin D levels range from 32 – 100 ng/dl on most lab reports.

One research study found that 72 out of 89 National Football League (NFL) players (with an average age of 25 years old) exhibited inadequate levels of Vitamin D (2). Deficiency may be linked to an increase in muscle injuries (2). Out of these 89 NFL football players, 27 players had deficient levels (<20 ng/dl) and 45 had insufficient vitamin D levels (20 – 31.9 ng/dl). Sixteen out of the 27 players suffered a muscle injury with a mean vitamin D level of 19.9 ng/dl. Possible signs of low vitamin D levels are fatigue, achiness, and compromised immune system. The goal is to strive for 200 international units (IU) of vitamin D a day from food and the rest from ideal sun exposure (15). Additional supplementation may be needed if an inadequate amount of sun exposure is not obtained. Fatty fish (e.g., mackerel, salmon, sardines, oysters, catfish, and tuna), fortified milk, egg yolks, fortified mushrooms, and certain brands of margarine, yogurt, and cereal are reputable sources for this vitamin (21).

VALUE OUTCOMES

All individuals with desirable values should continue to monitor their numbers over the years. Always get a copy of lab results and file them away for comparison. If any numbers seem irregular or suboptimal, it is highly suggested to seek out help from a sports dietitian, qualified nutritionist, or other health professionals.

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TABLE 1. NORMAL VALUES FOR BLOOD PARAMETERS

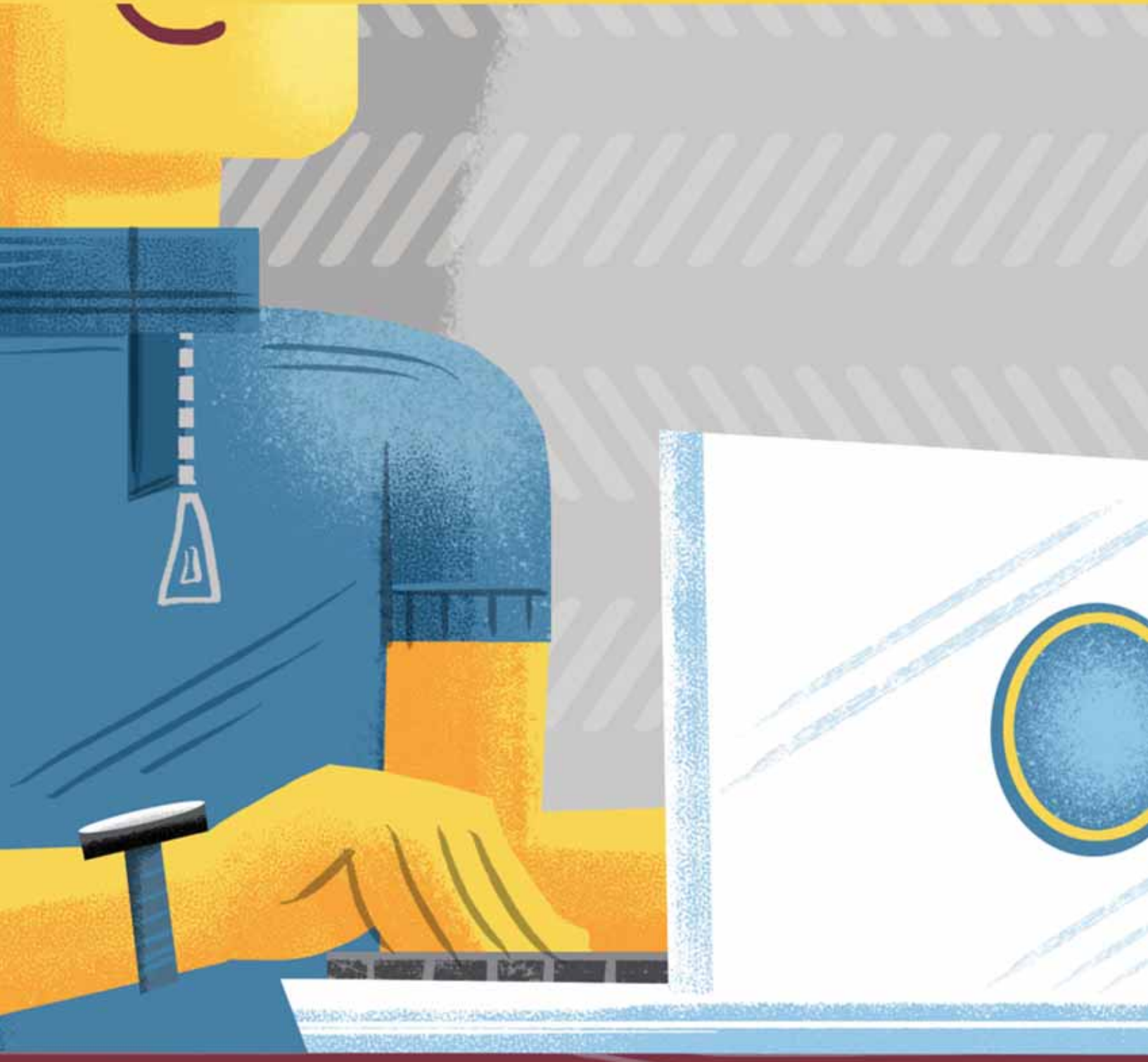
ITEM	OPTIMAL RANGES MALES	OPTIMAL RANGES FEMALES
Fasting Glucose (mg/dl)	70 – 100	70 – 100
Vitamin B12 (pg/mL)	300 – 1000*	300 – 1000*
Vitamin D; serum 25(OH)D (ng/dl)	40 – 70	40 – 70
Ferritin (ng/mL)	20 – 100	40 – 100

* Some believe that vitamin B12 should be at least above 500 pg/mL (24)

STEP THREE

CHECK IN FOR YOUR RECERTIFICATION TRIP

RECERTIFICATION DEADLINE: DECEMBER 31, 2014



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PROPRIOCEPTION TRAINING FOR OFFENSIVE LINEMEN

ANDY FORTUNA AND MICHAEL GONZALEZ

The most common injuries that may occur among offensive linemen are knee and ankle injuries (2,6). In a study conducted at the 2005 National Football League Combine, approximately 57% of the 61 offensive linemen evaluated had suffered from a knee injury at some point during their collegiate career (3). A study of offensive linemen at the 2006 National Football League Combine reported that approximately 80% of the 50 offensive linemen evaluated had suffered a foot or ankle injury (6). Understanding the most common injuries among offensive linemen helps to show why strengthening the ankles and knees can be very important. Most of the workouts for offensive linemen primarily focus on power, explosiveness, and agility training. A lack of focus exists regarding balance, stability, and proprioception. The contributing factors to these injuries are instability and insufficient body control in dynamic movements (8). Through proprioception training, an athlete's balance and stability may be trained to improve athletic performance and minimize the risk of injury in offensive linemen.

WHAT IS PROPRIOCEPTION?

Proprioception can be thought of as the sense of knowing the position of body parts and limbs in relation to space. The human body contains certain receptors that send signals to the central nervous system (CNS) about their location (5). Mechanoreceptors are the receptors responsible for the detection of joint movement and position, which are located in the joint capsules, ligaments, muscles, and skin (2). After the CNS receives the input from these receptors, it signals the rest of the body so that it is able to respond to the external stimulus accordingly (1).

BENEFITS OF PROPRIOCEPTION TRAINING FOR OFFENSIVE LINEMEN

For offensive linemen, balance and stability are very important attributes. It is common in game situations to have a 200-lb (or more) athlete pushing against them, trying as hard as they can to knock them down or aside. So, the ability to stay on their feet is crucial for success at their position. A great way to train for this common scenario is through proprioception training. Proprioception training may give the offensive lineman better mobility, which may lead to increased efficiency in their performance. It may also lead to increases in strength and agility (1). An athlete who is more stable and balanced in their movements is able to perform faster, more powerfully, and with less risk of injury (1).

TRAINING METHOD

Implementing wobble board, balance trainer, balance disc, and star excursion training may help target these important factors. Designing a program of balance and stability exercises with movement-specific training may improve stability and body control while reducing the risk of injury.

Wobble board training may improve stability, proprioception, and coordination of the ankle joint. The firing of mechanoreceptors

through the wobble board demands the visual, vestibular, and somatosensory systems to act to keep the body in the center of gravity. Training the athlete through these systems heightens their body awareness by improving their functional instability (2).

Incorporating the balance trainer into a program may enhance lower extremity neuromuscular strengthening and control. Isometric contraction of the quadriceps and hamstrings while stabilizing on the balance trainer improves dynamic balance and may help reduce the incidence of anterior cruciate ligament (ACL) injuries (7). Similar to the balance trainer, the balance disc utilizes dynamic balance for lower extremity strengthening and control while isolating both legs by using two discs.

The star excursion training emphasizes stabilization, proprioception, and strengthening in the lower leg and knee. The contraction of the anterior tibialis and gastrocnemius works the balance and stability of the ankle joint with the weight of the body. At the same time, the eccentric contraction of the quadriceps and hamstrings increases strength, and ultimately may help to prevent ACL injuries (4).

WOBBLE BOARD PLANTAR FLEXION (FIGURE 1)

The athlete should stand on one leg on the front end of the wobble board with the other leg lifted in the air. The athlete must maintain balance while in plantar flexion without touching the floor. Repeat for two sets of 15 s holds. Perform the first set with eyes open and the second set with eyes closed. The athlete should alternate legs after each 30-s interval.

FIGURE 1. WOBBLE BOARD PLANTAR FLEXION

WOBBLE BOARD DORSIFLEXION (FIGURE 2)

The athlete should stand on the back of the wobble board with one leg and maintain balance while in dorsiflexion. Repeat for two sets of 15 s holds. Perform the first set with eyes open and the second set with eyes closed. The athlete should alternate legs after each 30-s interval.

FIGURE 2. WOBBLE BOARD DORSIFLEXION

WOBBLE BOARD INVERSION (FIGURE 3)

The athlete should stand on one leg on the side of the wobble board and lift the other leg in the air. The athlete must maintain balance and repeat for two sets of 15 s holds with the ankle inverted. Perform the first set with eyes open and the second set with eyes closed. The athlete should alternate legs after each 30-s interval.

FIGURE 3. WOBBLE BOARD INVERSION

WOBBLE BOARD EVERSION (FIGURE 4)

The athlete should stand on one leg on the side of the wobble board (right leg/left side) and hold their opposite leg in the air while maintaining balance. Repeat for two sets of 15 s holds with the ankle everted. Perform the first set with eyes open and the second set with eyes closed. The athlete should alternate legs after each 30-s interval.

FIGURE 4. WOBBLE BOARD EVERSION

BALANCE TRAINER MEDICINE BALL CHEST PASS (FIGURE 5)

The athlete should stand on a balance trainer and maintain balance while holding a medicine ball (weight of medicine ball can vary). The athlete should perform a semi-squat and hold the ball at chest level. Then the athlete should push the medicine ball forward away from their chest to fully extend their arms and pass the medicine ball to a partner. Repeat for two sets of 12.

FIGURE 5. BALANCE TRAINER MEDICINE BALL CHEST PASS

STAR EXCURSION BALANCE DRILL (FIGURE 6)

The athlete should place the arch of his right foot in the middle of the taped lines with the other leg lifted in front. The athlete should then proceed to move his elevated leg in the air in the direction of the taped lines without touching the floor; after each direction, return to the starting position. Repeat for two sets. The athlete should alternate legs after completing the entire sequence. Difficulty can be increased by performing the exercise barefoot.

FIGURE 6. STAR EXCURSION BALANCE DRILL

BALANCE TRAINER PUNCH DRILL (FIGURE 7)

The athlete should stand and maintain balance on a balance trainer while a partner holds a pad up directly in front of them. The athlete then bends at the knees and assumes a semi-squat position with the hands at chest level. When ready, the athlete should extend their arms forward rapidly with hands open and push the pad while maintaining balance. Repeat for two sets of 12.

FIGURE 7. BALANCE TRAINER PUNCH DRILL

QUICK DROP STEP DRILL (FIGURE 8)

The athlete should assume a proper offensive lineman stance. Then, on command, the athlete will step backwards to a marked area with the trail leg rapidly for 15 s. After each drop step, the athlete should return to the starting stance. Repeat for two sets of 15. Perform the first set with the eyes open and then the second with the eyes closed. The athlete should complete both sets then alternate the trail leg. Progression can also be added (e.g., two steps, three steps, etc.).

FIGURE 8. QUICK DROP STEP DRILL

BALANCE DISC STANCE HOLDS (FIGURE 9)

The athlete should stand on two balance discs in an offensive lineman stance for 15 s. The athlete should alternate the lead leg after each interval. Repeat for two sets of 15-s holds. Perform the first set with the eyes open and second set with the eyes closed.

FIGURE 9. BALANCE DISC STANCE HOLDS

CONCLUSION

The most common training programs for offensive linemen include power and strength training routines such as hang cleans, power cleans, snatches, and bench presses. The most common injuries found in offensive linemen are those to the lower extremities, which may be due to instability in the joints. Proprioception training has many benefits; it may increase stability, balance, increase joint movement and efficiency, and help to enhance power and speed. Incorporating proprioception training into an offensive lineman's routine may improve dynamic balance, stability, and increase their athletic performance and help prevent injuries. Implementing these proprioceptive training exercises may help improve the effectiveness of training programs for offensive linemen.

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CONSIDERATIONS FOR MAINTAINING IN-SEASON STRENGTH AND POWER

TRAVIS BROWN, MS, CSCS,*D

There are several key components in maintaining an athlete's strength and power throughout the long season, regardless of sport. In addition, there are several factors that affect fluctuations in strength and power throughout a season that can make maintenance of these levels difficult. Many would agree that nutrition, hydration, sleep, and training are important components. This article will focus on considerations for maintaining strength and power during the season for explosive ground-based sports in regards to training and the utilizing certain training tools.

EFFICIENT WORKOUTS

During the season in all levels of sports, from high school, college, amateur to professional, time is of the essence. The coaches and athletes only have a small amount of time to prepare for their next opponent. The ability to get more done in less time is extremely valuable. Workout efficiency is something that the performance coach should focus on during in-season workouts. The coach should focus on movement patterns that are optimal in regards to how the body moves on the field for the specific sport. Workouts should focus on horizontal, vertical, and diagonal vector lines working in the frontal, sagittal, and transverse planes. Everything should be done on their feet, using the entire body to perform a task. Getting the athletes in and out quickly, while efficiently building strength in a short period of time is vital to maintaining in-season strength and power.

SIMPLE VERSATILE TOOLS

Traveling is another source of wear and tear on the athlete over the course of the season. Many athletes suffer from the countless days of traveling on the road and having limited training options. Finding tools that can be packed easily and transported to and from various locations in other locations will help save time for set up and provide a shorter breaking down time than if a wide range of implements were brought. Suspension trainers, anchored land-based apparatuses, harnesses, and resistance bands with various attachments can all be transported fairly easily and provide numerous options for training in all planes of motion with bilateral and unilateral loads while limiting time spent on setting up and tearing down. This type of training can closely resemble the athletic movements seen on the field of play and help to maintain strength and power while traveling during the season.

LOADED LOCOMOTION EXERCISES

Many athletes experience a mid-season feeling of a stiff body and some may even be nursing a muscle strain or similar injury. The last thing these athletes may want to do during the season and towards the end of the season is go into the weight room when they are still expected to perform on game day. The traditional weight room workouts often focus on sagittal plane movements, like the squat, bench press, and traditional Olympic-style lifts. Even though these lifts are good for building strength, these traditional lifts may not be specific to how the athletes move on the field (with some exceptions). Rather than focus on these traditional lifts for in-season workouts, it may be more effective to incorporate sport-specific movements to maintain strength. One example might be using a harness that allows freedom of movement in all directions, while pulling a load attached to the harness. This would allow the coach to train strength and power using movements that may resemble the movements on the field more closely. All athletes have a different build and gait, so the use of a harness allows for freedom of movement in all directions while providing a load that can be manipulated easily. For the example of using a harness, the focus should not be so much on speed of movement; the focus should be more on having a heavy enough load that requires the athlete to apply force into the ground to move/drag it. This encourages power development that can carry over directly to the field and potentially help improve performance while helping to maintain strength and power during the long season.

In summary, adding these types of tools and focus to an in-season training program may benefit the athletes by providing them with quick, efficient workouts, with versatile tools that offer many options that may carry over directly to the field of play.

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GNC LIVE WELL

STRENGTH AND CONDITIONING FOR THE MIDDLE SCHOOL AND HIGH SCHOOL RUNNING LONG JUMPER

RYAN MCCLURE, CSCS, NSCA-CPT

The role of strength and conditioning in the development of middle school and high school running long jumpers is often overlooked by coaches, parents, and athletes. There are many ways a strength and conditioning coach can influence a young athlete competing in the running long jump positively. For the purposes of this article, the long jump will be broken down into three phases so that the strength and conditioning coach can focus on improving each through strength and power training. The three phases of the long jump are:

1. The acceleration phase
2. The maximal speed phase
3. The single leg take-off (Figures 1 and 2)

DEVELOPING STRENGTH AND POWER

To be successful, long jumpers must produce high levels of force quickly. It is crucial for these athletes to develop total body strength and power with an emphasis on the lower body including the hips. Strength can be described as slow speed muscular force. Power can be described as fast speed muscular force, or the rapid application of strength.

Because of ambiguity in the amount of strength a running long jumper needs to get the most out of power training, it may be best to incorporate a mix of strength and power training into their workout programs (13). This is referred to as a mixed methods approach. A focus only on strength training or only on power training would not lead to maximal results (16). The combination of strength and power training may lead to improvements in the three phases of the long jump. By improving these areas, athletes may improve their jumping distance as long as the technical aspects of the jump are performed correctly.

There is a relationship between training for strength and training for power. Strength should be considered the foundation required for the development of power since stronger athletes are reported to express higher power outputs (9,12,13,15). Therefore, it appears lower body strength is critical for the development of long jumpers of all ages and ability levels. This can be true of younger jumpers who may have low strength levels. Various lower body lifts can be beneficial for the improvement of strength in long jumpers including barbell back and front squats, kettlebell front squats, leg presses, weighted lunges, weighted step-ups, and deadlifts. Younger athletes may improve their long jump distance simply by improving their overall lower body strength levels.

Oftentimes, athletes can experience a plateau in their strength improvements and action must be taken to cause further improvement. At this point, it would be beneficial for the strength and conditioning coach to incorporate power training into the training program (8). Power expression is critical for success during the performance of athletic events like sprinting and jumping (7,11,15). This is where various types of loaded and unloaded power exercises can be incorporated into the training program. Loaded power can be defined as a quick, explosive movement that involves the use of an external load such as sled

pushes (Figure 3) and resisted broad jumps (Figures 4 and 5). Unloaded power can be considered fast movements of the body using only the athlete's bodyweight such as box jumps (Figures 6 and 7) and power skips (Figures 8 and 9). All three phases of the long jump require the triple extension of the ankles, knees, and hips. Power exercises that focus on triple extension should be used over other types of power training for long jumpers. For example, a loaded power exercise like the landmine squat press (Figures 10 and 11) would be preferred over a loaded power exercise like the kettlebell swing because it involves the triple extension of the ankles, knees, and hips, while the kettlebell swing involves only the double extension of the knees and hips. The landmine squat press is a diagonal power exercise, meaning that it contains both vertical and horizontal components. This is specific to the long jump because the jumper is required to jump both vertically and horizontally for best results.

As mentioned, once adequate strength levels are reached, then power training can be incorporated. It is important to note for safety considerations that while Olympic-style lifts may provide many of the benefits of power training mentioned here, it may not be advisable to implement Olympic-style lifting into the training of youth athletes if they have no previous experience, or if the coach is not qualified to instruct the lifts properly. That is not to say Olympic-style lifts cannot be utilized by experienced coaches training an appropriately trained athlete.

The rate of force development, or explosive muscle strength, is critical for all phases of the long jump (1). It is important that force is applied rapidly during all phases of the long jump. Strength training alone may cause significant improvements in the long jump due to increased power outputs, and power training alone may cause significant improvements in the long jump (9,12,13,15). The combination of strength and power training will likely cause the greatest improvements in the rate of force development leading to better jumps if technique remains good (4,13). Strength and power training increases power output, and power output is critical for acceleration, sprinting, and the single leg take-off of the long jumper. Therefore, workout programs for youth long jumpers should include not only strength exercises like squats and lunges but also power exercises like box jumps and sled pushes. When included in a well-designed, periodized plan, this mixed methods approach may lead to improvements in the performance of middle school and high school running long jumpers.

ACCELERATION

Acceleration is the process of going from a static, or near static, starting position and reaching maximal speed as soon as possible (3). This is the beginning phase of the long jump and is critical because the athlete needs to reach maximal speed as quickly as possible. As mentioned previously, quick force application off the ground is important for optimal acceleration, and ultimately a successful performance. Plyometric exercises have been shown to improve speed, especially the ability to accelerate (17). The plyometric exercises used should be specific to the long jump and involve horizontal power movements (2). Some examples of exercises that utilize horizontal power movements to improve acceleration include resistance band and bodyweight broad jumps, bounding and hopping drills (Figures 12 and 13), sled pushes, and depth broad jumps (Figures 14, 15, and 16). Plyometrics should be appropriately combined with strength training for improving acceleration (17).

MAXIMAL SPEED

Development of maximal speed in jumpers is essential in order to compete at a high level. Sprinting speed (i.e., stride frequency multiplied by stride length) is the ability to achieve high velocity (14). Some common methods to improve stride length include resisted sprinting with a harness (Figure 17), parachute, or sled (5). To improve stride frequency, many athletes perform assistance exercises like downhill sprinting or towing (6). An important aspect to remember when performing these exercises to improve maximal speed is to make sure that the athlete's running form is not altered. This is especially important with middle school and high school jumpers. In addition to resisted and assisted sprinting, programs should incorporate strength and power training in order to develop maximal force. The more force that a jumper can apply into the ground, the faster they will sprint.

SINGLE-LEG TAKE-OFF

The development of single-leg (SL) strength and power can be valuable to long jumpers because their power is derived from a single leg take-off to jump. Both legs should be targeted equally and individually in training because the improvement of SL strength and power for the jump phase of the long jump may lead to increases in acceleration and maximal velocity. When an athlete is accelerating or sprinting at top speed, the ability to produce powerful ground reaction forces with one leg is paramount.

Some examples of SL strength exercises to improve all three phases of the long jump include suspended SL squats (Figure 18), SL leg press, lunges, and step-ups. Some examples of SL power exercises to improve long jump distance are power skips, sled push hops (Figures 19 and 20), SL depth broad jumps, SL medicine ball horizontal jump tosses (Figures 21 and 22), SL resisted broad jumps, SL jumps from a box (Figures 23, 24, and 25) and SL continuous hops.

CONCLUSION

The running long jump is a unique blend of acceleration, maximal speed, and a single leg take-off. In order to improve in these phases, athletes must become stronger and more powerful. Ideally, this will occur through a mixture of upper body, core, and lower body strength and power exercises in a well-designed strength and conditioning program. Strength training should be the initial emphasis for middle school and high school jumpers, but power training should be incorporated as well. In combination with technique training with the sport coach, a mixed methods strength and power training program with appropriate progressions may improve the performance of running long jumpers.

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TABLE 1. SAMPLE 12-WEEK PRE-SEASON LONG JUMP PROGRAM

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
WEEK 1:	UB and LB Hypertrophy	UB, LB, and Core Power	Rest	UB and LB Strength	UB, LB, and Core Power	Acceleration and Maximal Speed Day	Rest
WEEK 2:	UB and LB Hypertrophy	Acceleration and Maximal Speed Day	Rest	UB and LB Hypertrophy	UB, LB, and Core Power	Acceleration and Maximal Speed Day	Rest
WEEK 3:	UB and LB Strength	UB, LB, and Core Power	Rest	UB and LB Hypertrophy	UB, LB, and Core Power	Acceleration and Maximal Speed Day	Rest
WEEK 4:	UB and LB Hypertrophy	Acceleration and Maximal Speed Day	Rest	UB and LB Hypertrophy	UB, LB, and Core Power	Acceleration and Maximal Speed Day	Rest
WEEK 5:	UB and LB Strength	UB, LB, and Core Power	Rest	UB and LB Hypertrophy	UB, LB, and Core Power	Acceleration and Maximal Speed Day	Rest
WEEK 6:	UB and LB Hypertrophy	Acceleration and Maximal Speed Day	Rest	UB and LB Hypertrophy	UB, LB, and Core Power	Acceleration and Maximal Speed Day	Rest
WEEK 7:	UB and LB Strength	UB, LB, and Core Power	Rest	UB and LB Hypertrophy	UB, LB, and Core Power	Acceleration and Maximal Speed Day	Rest
WEEK 8:	UB and LB Hypertrophy	Acceleration and Maximal Speed Day	Rest	UB and LB Hypertrophy	UB, LB, and Core Power	Acceleration and Maximal Speed Day	Rest
WEEK 9:	UB and LB Strength	UB, LB, and Core Power	Rest	UB and LB Strength	UB, LB, and Core Power	Acceleration and Maximal Speed Day	Rest
WEEK 10:	UB and LB Hypertrophy	Acceleration and Maximal Speed Day	Rest	UB and LB Strength	UB, LB, and Core Power	Acceleration and Maximal Speed Day	Rest
WEEK 11:	UB and LB Strength	UB, LB, and Core Power	Rest	UB and LB Hypertrophy	UB, LB, and Core Power	Acceleration and Maximal Speed Day	Rest
WEEK 12:	UB and LB Strength	Acceleration and Maximal Speed Day	Rest	UB and LB Strength	UB, LB, and Core Power	Acceleration and Maximal Speed Day	Rest

Key: UB=upper body; LB=lower body

TABLE 2. SAMPLE ACCELERATION AND MAXIMAL SPEED WORKOUT

ACCELERATION AND MAXIMAL SPEED SAMPLE WORKOUT	SETS X REPS	REST PERIOD	PURPOSE
Accelerators (10 yards or to maximal speed)	5x10 yds	1:00	Acceleration
Maximal velocity sprints	5x25 yds	2:30	Acceleration and maximal speed
Resisted sprints (harness or parachute)	5x15 yds	2:30	Stride length
Assisted sprints (downhill or towing)	5x20 yds	3:00	Stride frequency
Run-throughs (starting point through the board)	5x long jump distance	3:00	Acceleration and maximal speed
Full routine including the single-leg take-off	5x	3:00	Acceleration, maximal speed, and SL take-off

TABLE 3. SAMPLE LONG JUMP HYPERTROPHY WORKOUTS

SAMPLE HYPERTROPHY LOW VOLUME WORKOUT	SETS X REPS	REST PERIOD	INTENSITY	PURPOSE
SL leg press	3x8	1:00	8-10RM	SL LB hypertrophy
Dumbbell bench press	3x8	1:00	8-10RM	UB horizontal push hypertrophy
		2:30		
Barbell squats	3x8	1:00	8-10RM	DL LB hypertrophy
Machine high pull	3x8	1:00	8-10RM	UB vertical pull hypertrophy
		2:30		
Dumbell shoulder press	3x8	1:00	8-10RM	UB vertical push hypertrophy
Machine horizontal pull	3x8	1:00	8-10RM	UB horizontal pull hypertrophy
		2:30		
Dumbbell lunges	3x8 each leg	1:00	8-10RM	SL LB hypertrophy
Kettlebell single-leg Romanian deadlift	3x8 each leg	1:00	8-10RM	SL LB hypertrophy
	24 Sets			
SAMPLE HYPERTROPHY MODERATE VOLUME WORKOUT	**SETS X REPS**	**REST PERIOD**	**INTENSITY**	**PURPOSE**
Dumbbell step-ups	4x10 each leg	1:00	10-12RM	SL LB hypertrophy
Bench press	4x10	1:00	10-12RM	UB horizontal push hypertrophy
		2:30		
Deadlift	4x10	1:00	10-12RM	LB hypertrophy
Pull-ups (assisted, bodyweight, or resisted)	4x10	1:00	10-12RM	UB vertical pull hypertrophy
		2:30		
Incline machine chest press	4x10	1:00	10-12RM	UB vertical push hypertrophy
Dumbbell single-arm row	4x10 each arm	1:00	10-12RM	UB horizontal pull hypertrophy
		2:30		
Suspended single-leg squats (bodyweight or resisted)	4x10 each leg	1:00	10-12RM	SL LB hypertrophy
Double-leg leg press	4x10	1:00	10-12RM	DL LB hypertrophy
	32 Sets			

TABLE 3. SAMPLE LONG JUMP HYPERTROPHY WORKOUTS *(continued)*

SAMPLE HYPERTROPHY HIGH VOLUME WORKOUT	SETS X REPS	REST PERIOD	INTENSITY	PURPOSE
Barbell squats	5x12	1:00	12-15RM	DL LB hypertrophy
Dumbbell lunges	5x12 each leg	1:00	12-15RM	SL LB hypertrophy
		2:30		
Machine horizontal chest press	5x12	1:00	12-15RM	UB horizontal push hypertrophy
Dips	5x12	1:00	12-15RM	UB vertical push hypertrophy
		2:30		
SL leg press	5x12 each leg	1:00	12-15RM	SL LB hypertrophy
Dumbbell step-ups	5x12 each leg	1:00	12-15RM	SL LB hypertrophy
		2:30		
Machine high pull	5x12	1:00	12-15RM	UB vertical pull hypertrophy
Machine horizontal pull	5x12	1:00	12-15RM	UB horizontal pull hypertrophy
	40 Sets			

SL=single leg; DL=double leg; UB=upper body; LB=lower body

TABLE 4. SAMPLE LONG JUMP POWER WORKOUTS

SAMPLE POWER WORKOUT #1	SETS X REPS	REST PERIOD	PURPOSE
Single-leg to double-leg box jumps	4x2 each leg	2:30	SL LB vertical power
Alternating battle ropes	4x8	2:30	UB power
Single-leg to double-leg resisted broad jumps	4x2 each leg	2:30	SL LB horizontal power
Medicine ball core toss	4x12	2:30	Core and UB power
Landmine squat press	4x2	2:30	LB Diagonal, UB, and core power
Lying medicine ball drop pass	4x5	2:30	UB power
Single-leg continuous high hurdle hops	4x5 each leg	2:30	SL LB power
Power skips	4x5 each leg	2:30	SL LB vertical and horizontal power

SAMPLE POWER WORKOUT #2	SETS X REPS	REST PERIOD	PURPOSE
Single-leg or double-leg depth broad jump	4x4 each leg	3:30	SL LB horizontal power
Power push-up onto medicine ball	4x5	3:30	UB power
Single-leg horizontal medicine ball jump toss	4x4 each leg	3:30	SL LB horizontal power
Knee drive medicine ball toss	4x6	3:30	Core and UB power
Sled push	4x15 yards	3:30	LB horizontal power
Single-leg jump from box	4x4 each leg	3:30	SL LB vertical power
Reverse medicine ball core toss	4x8	3:30	Core power
Single-leg sled push hops	4x15 yards each leg	3:30	SL LB horizontal power

SL=single leg; DL=double leg; UB=upper body; LB=lower body

TABLE 5. SAMPLE LONG JUMP STRENGTH WORKOUTS

SAMPLE STRENGTH WORKOUT 1	SETS X REPS	REST PERIOD	INTENSITY	PURPOSE
Barbell back squat	3x5	3:00	5RM	LB strength
Bench press	3x5	3:00	5RM	UB horizontal push strength
		4:00		
SL leg press	3x5 each leg	3:00	5RM	SL LB strength
Overhand wide grip pull-ups (assisted or resisted)	3x5	3:00	5RM	UB vertical pull strength
		4:00		
Barbell step-ups	3x5 each leg	3:00	5RM	SL LB strength
Incline bench press	3x5	3:00	5RM	UB vertical push strength
		4:00		
Dumbbell single-arm row	3x5 each arm	3:00	5RM	UB horizontal pull strength
Deadlift	3x5	3:00	5RM	LB strength
	24 Sets			

SAMPLE STRENGTH WORKOUT 2	SETS X REPS	REST PERIOD	INTENSITY	PURPOSE
Dumbbell lunges	5x5 each leg	3:00	5RM	SL LB strength
Dumbbell bench press	5x5	3:00	5RM	UB horizontal push strength
		4:00		
Double-leg leg press	5x5	3:00	5RM	LB strength
Machine high row	5x5	3:00	5RM	UB vertical pull strength
		4:00		
Kettlebell front squat	5x5	3:00	5RM	LB strength
Barbell shoulder press	5x5	3:00	5RM	UB vertical push strength
		4:00		
Kettlebell sideways step-ups	5x5 each leg	3:00	5RM	SL LB strength
Kettlebell single-leg Romanian deadlift	5x5 each leg	3:00	5RM	SL LB strength
	40 Sets			

SL=single leg; DL=double leg; UB=upper body; LB=lower body

FIGURE 1. SL TRIPLE FLEXION BEFORE TAKE-OFF IN THE LONG JUMP

FIGURE 2. SL TRIPLE EXTENSION AND KNEE DRIVE AT TAKE-OFF OF THE LONG JUMP

FIGURE 3. SLED PUSH

FIGURE 4. SL TRIPLE FLEXION TAKE-OFF ON RESISTED BROAD JUMPS

FIGURE 5. TRIPLE EXTENSION IN THE AIR ON SL RESISTED BROAD JUMPS

FIGURE 6. TRIPLE FLEXION BEFORE SL BOX JUMP

FIGURE 7. LANDING AFTER SL BOX JUMP

FIGURE 8. SL TRIPLE FLEXION DURING POWER SKIP

FIGURE 9. SL TRIPLE EXTENSION DURING POWER SKIP

FIGURE 10. TRIPLE FLEXION DURING THE SQUAT PHASE OF THE LANDMINE SQUAT PRESS

FIGURE 11. TRIPLE EXTENSION ON THE LANDMINE SQUAT PRESS

FIGURE 12. TRIPLE FLEXION AT START OF SL CONTINUOUS HURDLE HOPS

FIGURE 13. TRIPLE EXTENSION AT TAKE-OFF DURING SL CONTINUOUS HURDLE HOPS

FIGURE 14. START OF SL DEPTH BROAD JUMP

FIGURE 15. SL TRIPLE FLEXION LANDING AFTER DROPPING OFF BOX FOR DEPTH BROAD JUMP

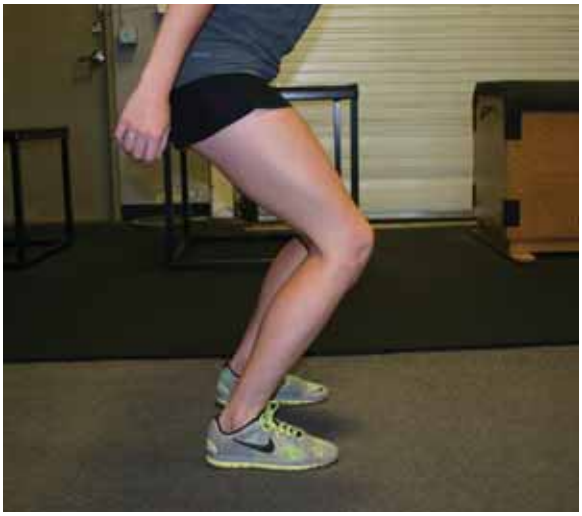

FIGURE 16. DL FINAL LANDING AFTER SL DEPTH BROAD JUMP

FIGURE 17. PARTNER-RESISTED SPRINTS WITH A HARNESS

FIGURE 18. SUSPENDED SL SQUAT

FIGURE 19. STARTING TRIPLE FLEXION POSITION ON SL SLED PUSH HOPS

FIGURE 20. TRIPLE EXTENSION POSITION ON SL SLED PUSH HOPS

FIGURE 21. TRIPLE FLEXION START OF SL MEDICINE BALL HORIZONTAL JUMP TOSS

FIGURE 22. TRIPLE EXTENSION POSITION RIGHT BEFORE JUMP AND RELEASE OF THE BALL

FIGURE 23. STARTING POSITION OF SL JUMP FROM BOX

FIGURE 24. TRIPLE FLEXION TRANSITION PHASE OF SL JUMP FROM BOX

FIGURE 25. TRIPLE EXTENSION DURING SL JUMP FROM BOX

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ANALYZING HITTING, KICKING, AND THROWING SPEED

JOSE PALAO, PHD, CSCS, AND DAVID VALADES, PHD

In sports, the higher the level of competition, the higher speed of execution and subsequently, the less time there is for the players to execute. In sports where athletes have to hit, kick, or throw a ball, one of the keys for success involves the players' ability to accelerate the game and reduce the opponent's response time (e.g., kicking toward the goal, pitching, etc.). Improving the hitting, kicking, and throwing ability usually involves an increase in the athlete's strength and/or an improvement in the movement mechanics (3).

To monitor the ball speed in practice and in competition, it is possible to use radar (immediate feedback) or video analysis (indirect feedback). This monitoring can be done in isolated situations or in integrated situations. The use of these instruments allows coaches and strength and conditioning professionals to assess how the athletes are executing their movements objectively. Specific literature about strength training indicates that a speed reduction of more than 10% means that practice is not adequate for training the strength application (1).

The measurement protocol must be established and followed for all the measurements in order to monitor the speed execution reliably (2). The goals for monitoring, level of the athletes, the instruments, and resources available must be considered in order to establish this protocol and the conditions of the measurement (generic or specific situation). Ideally, the monitoring should be done in real and simplified situations. The number of measurements per session, per week, etc. will vary in relation to the number of athletes to be evaluated, resources that are available, time spent per athlete to perform the measurement, and level of integration with the practice.

Once the data are obtained, they should be analyzed at least three ways. First, there should be an analysis of the data from each measurement; the data should be analyzed each time. This gives information about how the athlete is executing and his/her shape in this specific moment of the season. Secondly, the data accumulated throughout the season gives information about the evolution of the athlete and the effect of the training. Third, which is more general, involves comparing the values with reference values of the population and/or team. This allows for the needs and goals to be established for the athlete in the short-term as well as the long-term.

1. First level of analysis: qualitative analysis of the practice/execution. During the season, the data are accumulated and a mean and/or speed peak can be established. From this reference value, the execution of the athlete must not descend more than 10% of the peak speed (1). This calculation can be done easily with a spreadsheet. Executions done in training under this value do not necessarily ensure that the training is valuable. If the data are obtained with radar, the data will allow for immediate feedback to the athlete; which, in turn, allows strength and conditioning professionals and coaches to monitor the quality of the practice in order to help keep athletes involved in practices.

Note: data for bad execution or error in the measurement should not be recorded. The speed generated in the hits, kicks, and throws involve a combination of technique and ability to apply strength by the players. This type of monitoring can provide information about both aspects of the execution. In this case, collaboration between the strength and conditioning coaches and sport coaches is required.

2. Second level of analysis: analyzing the evolution throughout the season. The accumulation of data allows for a perspective of the tendency of the athlete throughout the season and to assess the effect of the training done by the athlete. An easy way to look at the tendency of the data is to make a graph using a spreadsheet and add the tendency line (linear regression line) to the graph. The tendency can be calculated for the different parts of the season or for the whole season.

3. Third level of analysis: analyzing the data in relation to reference values. The team's values and/or team-specific normative profiles should be used (general or by game position). These values allow coaches to know whether the players' measurements are good, normal, or poor in relation to the rest of the team, or the reference values used. The reference helps sport coaches and strength and conditioning coaches assess the state and level of the players in order to plan their training.

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TABLE 1. SAMPLE OF SITUATIONS WHERE THE BALL SPEED CAN BE MONITORED IN DIFFERENT SPORTS

SPORTS	DESCRIPTION OF THE MEASUREMENT SITUATION
Tennis, badminton, squash, and padel	Five serves after the specific warm-up or at the end of the practice; Exercise in practice where the athlete has to do a sequence of hitting a target (e.g., serves, drives, etc.)
Team handball, waterpolo, lacrosse, baseball, and softball	Five throws after the specific warm-up or at the end of the practice; Simplified task in the practice where the athlete has to execute a sequence of throws to a target (e.g., serve, drive, etc.)
Soccer, indoor soccer, rugby, and football	Five kicks after the specific warm-up or at the end of the practice; Simplified task in the practice where the athlete has to execute a sequence of kicks to a target (e.g., kicks, passes, etc.)
Volleyball and beach volleyball	Five serves after the specific warm-up or at the end of the practice; Task in the practice where the athlete has to execute a sequence of hitting a target (e.g., serves, spikes, etc.)
Golf	Five swings after the specific warm-up at the driving range; Task where the athlete has to execute a sequence of swings aiming at a target

TRAINING AND CONDITIONING FOR SKEET SHOOTING

SILVESTRE MARTINEZ AND LLOYD LOYA

Skeet shooting is a very popular and competitive sport (5). As with every sport, everyone wants to have an edge on their competition. Everyone wants to be the best, but in order to be the best you must train every aspect of the sport to have the competitive advantage over your competition. Many people who participate in skeet shooting spend hours practicing their shooting which is considered the best way to improve in this sport. However, what if the shooter could add something else to their training that may help improve their shooting along with the usual shooting practice? Supplementing skeet shooting with a sport-specific and functional movement resistance training program may help to elevate skeet shooting performance. The purpose of this article is to illustrate how a resistance training program specific to the movements of the sport may provide that added advantage in skeet shooting.

DEMANDS OF SKEET SHOOTING

Skeet shooting is a sport that can really take a toll on the body. A typical skeet shooting session may take up to two hours. Skeet shooting events can last up to a week and may consist of walking in the sun while absorbing the recoil of each shot. All these factors can cause mental and physical stress on the body that can become a negative factor when it comes to shooting performance. The duration of skeet shooting can hinder the performance of even those who are greatly skilled at shooting (7). The primary upper body muscles in the body that allow skeet shooters to perform the shooting motion (i.e., aim and torso rotation) are the trapezius, deltoids, arms, lower back, and abdominals (core). The primary lower body muscles that supply the body with a firm stable base are the quadriceps and the calves (2,6). Strengthening these muscles, along with improving cardiovascular stamina for longer events, may boast improvements in skeet shooting skills. Any cardiovascular training will need to be sport-specific to keep the athlete in a game situation. The training program provided is designed specifically to focus on improving the shooting motions (i.e., shooting stance, torso rotations, and arm/shoulder placement with gun) of the sport by enhancing the athlete's strength and conditioning through functional movements of the sport. Every training concept will be utilized through the sport (7).

INJURY PREVENTION (FIGURES 1 – 11)

When it comes to any sport, no athlete wants to get injured. It is important to always consider the health of the athlete before anything else. Repetitive blows to the shoulder, which is where most of the impact is taken from the recoil, can seriously injure a competitive shooter (4). Although there is no guarantee of preventing injuries, coaches and athletes should do everything possible to minimize injuries (4). After firing thousands of rounds a year, it can be common for a competitive shooter to injure their rotator cuff or develop tendonitis of the shoulder, neck, elbow, or wrist, for example. Such injuries often start as mild discomfort but can quickly turn into something much more serious and can even lead to surgery (4). This is why a proper warm-up/cool-down should be done before and after any training or shooting session to reduce the chances of injury (Tables 1 and 2) (1,2).

FIGURE 1. ARM CIRCLES – FORWARD

FIGURE 2. ARM CIRCLES – BACKWARD

FIGURE 3. ROTATOR CUFF – INTERNAL ROTATION

FIGURE 4. ROTATOR CUFF – EXTERNAL ROTATION

FIGURE 5. TRICEPS EXTENSION

FIGURE 6. FOREARM AND WRIST – SUPINATED

FIGURE 7. FOREARM AND WRIST – PRONATED

FIGURE 8. TRAPEZIUS STRETCH

FIGURE 9. CROSS ARM STRETCH

FIGURE 10. FOREARM STRETCH

FIGURE 11. FOREARM STRETCH

EVALUATION

Before administering any type of training program, a health screening evaluation and fitness assessment should be conducted by a qualified professional. This will also aid in placing the athlete in the best stage of the training program that suits their level of conditioning. Once the health screening and fitness assessment are completed, then the training may begin. The training program provided is scheduled for three days out of the week (Table 3). This is only the recommended duration and frequency for the training program; days of the week can be changed according to one's schedule. This training program also requires a training assistant as a safety precaution.

SPORT-SPECIFIC TRAINING EXERCISES

TRUNK ROTATION WITH RESISTANCE IN SKEET SHOOTING STANCE (FIGURES 12 – 16)

Explosively pull the cable as if preparing to shoot. Focus on using the core while rotating and returning to the starting postion in a controlled manner. Exhale during the pull and inhale while returning to the starting position.

FIGURE 12. TRUNK ROTATION WITH RESISTANCE – START

FIGURE 13. TRUNK ROTATION WITH RESISTANCE – FINISH

FIGURE 14. TRUNK ROTATION WITH RESISTANCE WITH BALANCE TRAINER

FIGURE 15. TRUNK ROTATION FROM SHOOTING MOTION – START

FIGURE 16. TRUNK ROTATION FROM SHOOTING MOTION – FINISH

DUMBBELL RAISES IN SHOOTING STANCE (FIGURES 17 – 20)
Raise the dumbbells explosively while contracting the shoulder muscles. Front and lateral raises are meant to strengthen the shoulder while remaining in a shooting stance. Raising the dumbbells in this position allows for training in the functional motion of shooting. Standing on a balance trainer is a progression of this exercise which forces engagement of the core, quadriceps, and calves all at the same time, which are primary muscles used for shooting. Exhale while raising the dumbbells and inhale while slowly returning to the starting position in a controlled manner.

FIGURE 17. DUMBBELL ANTERIOR RAISES

FIGURE 18. DUMBBELL LATERAL RAISES

FIGURE 19. FRONT LATERAL DUMBBELL RAISES FROM SHOOTING POSITION

FIGURE 20. SHOOTING RAISES

STANDING SHRUGS IN SKEET SHOOTING STANCE (FIGURES 21 – 23)

While preparing to shoot, the trapezius and posterior deltoid muscles should be engaged to provide support while holding the gun in a shooting position. While focused on maintaining proper shooting form, this exercise may strengthen the trapezius and posterior deltoid. Adding the balance trainer will also engage the core, quadriceps, and calves.

FIGURE 21. SHOULDER SHRUGS - START

FIGURE 22. SHOULDER SHRUGS - FINISH

FIGURE 23. SHOULDER SHRUGS WITH BALANCE TRAINER

RESISTANCE BAND RECOIL IN SHOOTING POSITION (FIGURES 24 – 26)

In order to mimic the recoil from shooting, a resistance band can be wrapped around the shoulder for this exercise. A partner can safely pull the resistance band while the athlete's core and primary lower body muscles are used to remain stabilized.

FIGURE 24. RESISTANCE BAND RECOIL

FIGURE 25. RESISTANCE BAND RECOIL WITH BALANCE TRAINER

FIGURE 26. RESISTANCE BAND RECOIL WITH DUMBBELLS

FARMER WALKS/SHOOTING POSITION (CARDIO)

Professional shooters fire in between heart beats when they are aiming at their target. The better the shooter's cardiovascular endurance, the slower their heart rate will be during competition. Therefore, an athlete may improve their shooting performance by incorporating a cardiovascular aspect into their training regimen so that their heart rate will be slower and they will have longer gaps in between each heart beat in which to shoot (7). For this exercise, keep the trapezius, posterior deltoids, and core engaged during intervals to mimic proper shooting form (Table 4).

CONCLUSION

Many times athletes ask how and why the exercises they are performing are related to their specific sport. Competitive skeet shooting is a competitive sport. What is lacking in many competitive skeet shooters is a sport-specific resistance training program designed to provide a competitive advantage that will enhance their overall performance. There are cardiovascular, muscular strength, and endurance components to skeet shooting. Developing such a sport-specific training program may keep the skeet shooter engaged and motivated in attaining better performance while minimizing the risk of injury. By implementing the training program illustrated in this paper, the skeet shooter may see marked improvement in their shooting performance.

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TABLE 1. WARM-UP/MOBILITY EXERCISES BEFORE TRAINING

EXERCISES	SETS/REPS
Arm circles - forward (full ROM for shoulders)	2 of 15
Arm circles - backward (full ROM for shoulders)	2 of 15
Rotator cuff - internal rotation	2 of 15
Rotator cuff - external rotation	2 of 15
Triceps extension (warm-up elbows)	2 of 15
Forearm/wrist (supinated/pronated)	2 of 15

* Since it is not likely to have gym equipment before you practice or participate in a competition, the exact warm-up can be done with a mobile resistance band

TABLE 2. COOL-DOWN/STATIC STRETCHING

EXERCISES	SETS/REPS
Arm circles - forward (full ROM for shoulders)	2 of 15
Arm circles - backward (full ROM for shoulders)	2 of 15
Cross arm stretch	Hold for 10 s on each arm
Overhead shoulder stretch	Hold for 10 s on each arm
Forearm stretch	Hold for 10 s on each arm

TABLE 3. PROGRESSION TRAINING FOR SKEET SHOOTING

EXERCISES	PROGRESSION 2	PROGRESSION 3	SETS AND REPS
Trunk rotation with cable resistance in shooting stance	Include balance trainer	Balance trainer and increase resistance	3 sets of 8 – 10 reps
Dumbbell raises in shooting stance frontal, lateral, and shooting motion	Include balance trainer	Increase weight of dumbbells	3 sets of 8 – 10 reps
Standing shrugs in shooting stance	Include balance trainer	Balance trainer and increase weight	3 sets of 8 – 10 reps
Resistance band recoil in shooting stance	Include balance trainer	Include 5 lb dumbbells	3 sets of 8 – 10 reps

*Recommendation: For best results, workout should be performed at least three times a week

TABLE 4. CARDIO BRISK WALK INTERVAL TRAINING

EXERCISES	PROGRESSION 2	PROGRESSION 3
Farmer walks - brisk dumbbell walk with shrugging Duration: 30 s Recovery: 60 s	Duration: 30 s Recovery: 45 s	Duration: 30 s Recovery: 30 s
Brisk dumbbell walk in shooting position Duration: 30 s Recovery: 60 s	Duration: 30 s Recovery: 45 s	Duration: 30 s Recovery: 30 s

*Recommendation: For best results, workout should be performed at least three times a week

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