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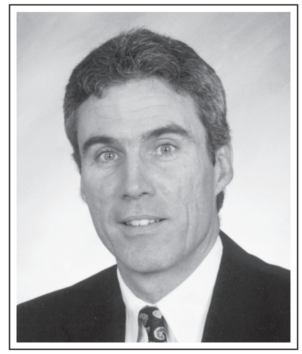
FROM THE EDITOR
RUSS EBBETS

ON THESE FIELDS



One of my solutions to endure modern air travel is to have something to do at the airport. With the drive in, traffic, parking, the shuttle, check-in, security clearance, gate changes and flight delays all presenting their own hurdle, the planning and foresight of a Plan B is all the more worthwhile. One strategy that works well is to have an engaging book. Camped out in my comfy naugahyde chair can make a two, three or four hour layover almost productive. And if the book is good it can make the time fly, even if I am not.

A recent trip presented just this scenario. I lucked out with the book. Tribal Leadership by Dave Logan, John King and Halee Fischer-Wright presented a simple and workable model on effective organizational leadership that readily transfers to track & field.

As I paged through the book I paused to consider ten “leaders” I have had in 20+ years of higher education. One guy did a great job, a few were pretty status quo and the rest were outright scary.

What made the good guy good was that there was a vision and a sensible plan to make it happen. Unfortunately he did not last long, moving on to bigger and better things.

The status quo were proponents of glacial change and fixated on the budget’s bottom line as if it were money out of their pocket. They made time stand still.

The scary group were generally small men and women with the vision of Don Quixote and the personal skills of Genghis Khan. Educated at a weekend Internet university (Wera Reale College) they were an obvious choice for a job nobody else wanted. They used their position to build a resume battling the latest educational dilemmas of grade inflation, millennials and the learning disabled. Their offer to join them on “this journey” was a wild ride one couldn’t refuse. I survived a few and a few I didn’t.

What I found most intriguing about Tribal Leadership is that the authors were not only able to significantly differentiate between leaders and the led but presented a workable plan to get everyone on the same page. The authors found that it is the language one uses, how one verbalizes one’s life that neatly categorizes what contribution one could or would make to an organization.

The five-stage process begins with the pattern less experience of one's first day. Powerless and unfamiliar with what is happening or why it is happening this is clearly seen as the situation of the new recruit. The next two steps are more egocentric developing in the following days and weeks. The repetition of daily practice begins to crystallize the challenges the sport entails. The downside of Stage 2 is one's self-doubt of whether or not one is up to the challenge. "Can I do this?" thought dominates.

Stage 3 is characterized by a degree of success and a feeling that, "I can do this." Real progress has been made and can continue. But of note is that this "I can" attitude is tinged with an undercurrent of one upsmanship, "I can and you can't." This stage fuels a competitive environment that prizes individual effort that may or may not be a benefit to the team.

It is when the "me" morphs into "we" that the team environment will change. "We can do this," entails multiple collaborative efforts directed towards a common goal. These collective efforts produce a gestalt where the result is greater than the sum of the individual parts. Goal achievement, superlative seasons and team championships, and then some are the result.

Stage 5 is an amorphic state akin to Maslow's self-actualization. At this stage there is an intersection of the right people in the right place at the right time whose Herculean efforts combine to make an epic contribution to humankind. Edison's light bulb, the eradication of certain diseases or the computing innovations of the last 20 years would be examples.

"On these fields of friendly strife are sown the seeds that on other days, on other fields will bear the fruits of victory."

— General Douglas MacArthur

The age-old question of whether leaders are made or born was also addressed. Is it the time or is it the person? While it probably is a little of both the take home for the coach is what gets done now? Common values and purpose combined with a team that thinks and lives these values creates an environment of self-leadership and personal example that internally motivates the group toward exceeding expectations, accomplishing the impossible and maybe even conquering a few windmills.

MONLUX PLYOMETRICS STAIR POP-UP TRAINING

Coach Jake explains his system of stair pop-up training for young athletes.

BY JACOB A. MONLUX R.P.T.

INTRODUCTION

I developed a method of plyometric training for younger kids and adolescent athletes over 65 years ago. Now at 85 years old, I would like to share this procedure before I pass on. I named the procedure Monlux Plyometrics Stair Pop-Ups. This training is a simple, safe, affordable, and very effective procedure to develop super-fast, kinetic chain powerreflex reactions to improve running speed, efficient endurance running, vaulting, and jumping.

In 1950, I watched 20 adult Danish gymnasts on tour at George Williams YMCA College as they vaulted over a buck. a small version of a side horse. They ran, leaped and rebounded with both feet from a stuffed mat. (There were no bubble incline boards then.) The gymnasts' feet were approximately 40-50 inches off the ground as they passed gracefully over the buck. It seemed like they floated effortlessly to a very controlled landing (each one five feet apart) in very rapid succession. As a 19-year-old gymnast, I wanted to soar like that.

I asked one of the Danish gymnasts how they trained. He said, "Vault training." Eager to follow their example, but finding no available space in the gym, I realized that a nearby staircase provided the only area for me to practice jumping. I did not think too much about the stair-rebound procedure I arbitrarily chose. I was able to get a fast rebound pop-up after extensive attempts. I did the stair pop-up jumps on cement stairs so often over the next few weeks that I overtrained and developed a dropped metatarsal bruise on my right foot. Even with taping, I had to stop training for several weeks to allow proper healing.

I tried different combinations of "pop-ups" as a State College of

Washington gymnast. Moving toward my teaching/coaching career, in 1956 and 1957, I taught stair pop-ups to my physical education classes. In the 1960s, I coached several hundred gymnasts as a YMCA volunteer. The achievements of the high school athletes and elementary school children I trained over the years formed the basis for my Stair Plyometrics training procedures.

Last year, serving as a volunteer track & field coach for a local high school, I noted some football players training with depth drop-shock plyometrics. I was about to recommend my stair pop-up technique for team training, but decided to wait until I was able to review the literature to determine that it would be safe for today's kids. (As a Certified Physical Therapist, I had treated athletes and testified in court about their injuries and potential for recovery, establishing a basis for injury awards.)

Most of the current methods of rebound training have their origin in the last 50 years. In 1996, I retired from a physical therapy, sports medicine and human performance clinic. I was familiar with the word "plyometrics" in the 1970s, but I did not really understand it until last year's search through the literature. I find that there is still a wide misunderstanding of Plyometrics by many workout centers and sports leaders.

HISTORY OF PLYOMETRICS

N.P. Nielson and Frederic W. Cozen (11) included rebound classifications in their 1934 book. The concept of Plyometrics was developed by Dr. Yuri Verkhoshansky of the USSR (14). He was the first to apply the training and proved it can improve performance greatly. The term Plyometrics (jump-metric) was coined by Fred Wilt, a US track coach and founding editor of this publication. Wilt learned that Dr. Michael Yessis was working with the Russians to introduce this concept to the United States (15) pp 2-7. Yessis and Wilt collaborated to get the information out to American coaches, but it was met with resistance from coaches and the medical profession. The main objective of the Soviet research was to develop practical methods of introducing explosive forces to heighten muscular responses. The athlete would drop down from a height and experience a "shock" reaction upon landing, quickening reflex. For example, the reflex jump response time for athletes was in the range of 0.6 to 0.8 seconds during volitional jump contraction compared to the Russian Plyometncs explosive jump that takes place in 0.1-0.2 seconds. (Yessis. [15] pg. 20.)

Athletic training in the 1930s primarily used multiple static stretches and running to warm up and prepare for events. Yessis brought Plyometrics to the USA and in the following years wrote books and articles describing more ways to improve quickness, speed and explosive power in athletic performance. Drs. Donald A. Chu and Gregory D. Meyers clarified the definition of Plyometrics in U.S. physical education and athletic standards. Chu's definition of Plyometrics has been adopted by the American Academy for Sports Medicine.

BIOMECHANICAL ANALYSIS OF PLYOMETRICS

A loaded jump muscle that elongates is referred to as eccentric. When it contracts on recoil, it is referred to as concentric. The fraction of a second between eccentric loading and the concentric response is called the amortization pause. Most authors will agree that load and recoil responses while doing Plyometric procedures occur in the tri-extension kinetic chain, mostly from the feet to the knees and hips. However, it is my opinion that the antigravity erector spinal muscles, shoulder/arm complex, abdominals, and core make a significant contribution to complete the balanced postural kinetic chain response. These postural links must be in harmony with the tri-extensors and full foot range of motion to summon the entire kinetic chain super-fast reflex/recoil action. How quick the recoil from eccentric to concentric and how powerful the response is dependent on the conditioning, postural balance, and efforts of the athlete.

SUITABILITY OF PLYOMETRICS FOR GROWING CHILDREN

The scientific community recognizes that more running, hopping, skipping and jumping is necessary to stimulate bone structure metabolism for child development, far better than walking and static stretches. Two examples are skipping rope, hopping on one or two feet, and jumping. Adding special rebound movements should be part of the training foundation to develop healthy postural responses for the average child. These trainings stimulate an explosive muscular reaction not usually occurring in walking, running, and static stretches. Yessis lists a variety of plyometric jump procedures in his book *Explosive Running* (15).

Lift Requirements for Advanced Box Drop-Shock Plyometrics Training

"The advanced adolescent athlete should have a lower body plyometrics 1 RM squat that should be at least 1.5 times his or her body weight. The advanced adolescent athlete's upper body plyometric bench press 1 RM should be at least 1.0 times the body weight for athletes over 220 lbs., and 1.5 for athletes whose weight is less than 220 lbs. An alternate measurement of prerequisite upper strength for plyometric is the ability to perform five clap push-ups in a row." Chu and Potach (4b)

Box Drop-Shock Plyometrics training creates a forceful muscular reflex response in the advanced athlete with high bone cellular demands. Box Drop-Shock conditioning may be unsuitable for growing children and adolescents and older seniors when presented from a 30-inch platform. The Box Drop-Shock procedures may have the potential of negative cellular bone metabolism in pre-adolescents and growing adolescents—even though they meet lifting requirements. Jump plyometric training below 30 inches is recommended for the less qualified athlete.

Plyometrics Stair Variations

The standard height of residential and commercial stairs for plyometric pop-ups is within the acceptable movement activities of daily living levels for growing children and younger athletes. The platform heights for all stair pop-ups vary from a drop from 4-7½ inches (residential) to 8½ inches (commercial). The depth may be more or less than 11 inches. A residential home may have different stair configurations. For example, the first stair may start and continue up fourteen steps to the top floor. A first stair may start at the floor to a lower platform turn, progressing to the top level or visa versa. I use a seven-step to a mid-landing and seven stairs progressing to the top landing for this paper example. Adjust your training procedures to the stair configuration allowed by local building codes and measure both the depth and height of your stairs for an accurate jump test measurements. A maximum jump pop-up test is to be given every two weeks to help increase jump power and to determine what step-level response the jumper has achieved.

The stair drop is lower than the 30-inch jump platform drop and is to be done facing the platform rather than away from it. The stair pop-up training period is generally two to three times a week for six weeks per year. The once-summoned reflex response needs to be activated one or more times a month with maintenance during the rest of the season and as needed during the off-season for the beginning athlete. If the athlete does not continue maintenance when the conditioning level drops, he/she risks losing the reflex speed reaction. The athlete must also continue with a maintenance schedule for skills, conditioning and other rebound activities needed for the duration of his/her competitive career. Track athletes may find that doing a short version of portable Plyometric Stair Pop-Ups is beneficial as a part of their warm-up just before racing.

FEASIBILITY STUDY FOR PLYOMETRICS IN PHYSICAL EDUCATION AND SPORTS

Running, hopping, skipping and jumping, general rebounding and special plyometrics activities are needed by growing children to develop healthy cellular bone metabolism. They are building a bony system that will hold up for a lifetime of use including avoiding bone-aging diseases. Coaches, doctors, and parents are interested in what effect cellular metabolism has on growing children.

How much stress activity for children is too much exertion? Young children's bodies crave motion and have inherent physiological drives that cause them to move constantly as they mature into an adult.

The following research report supports the need for rebound and plyometric exercises:

Mark R. Forwood—JBMR (12C), "Importance of Mechanical Loading." "To grow healthy bones, physical activity should not only consist of static or isometric exercise but should incorporate respective bouts of loading that incorporate cyclical loads that include range of strain magnitudes and directions. Since only a few cycles of loading are required to elicit an adaptive response, distribution bouts of loading and incorporated rest periods are more estrogenic than single sessions of long duration. This parameter of loading has been translated into feasible public heath interventions that have achieved improved bone mass and strength in children and adolescents."

A few other researchers verify the value of increased activity loading on growing bone:

- Fredrik Derter and Associates, "A Six Year Exercise Program

Improves Skeletal Traits Without Affecting Fracture Risk" —JBMR.

- Diana Kuh and Associates, "Growth from Birth to Adulthood and Bone Phenotype in Early Old Age"—JBMR, (5),
- Michael Behringer and Associates, "Effect of Weight-Bearing Activities on Bone Mineral Content and Density in Children and Adolescents; a Meta-Analysis" (10).
- Rachel L. Duckham and coauthors, "Does Physical Activity in Adolescents Have Site-Specific and Sex-Specific Benefits on Young Adult Bone Size, Content and Estimated Strength?" JBMR. This study concludes: "Adolescent PA (Physical Activity) will have positive implication on bone structure and strength in young adulthood. Bone benefits, especially in cortical bone size, mineral content, and strength seemed to persist into young adulthood even after accounting for young adults PA."

LAWS GOVERNING PLYOMETRIC JUMPING

What influences does Newton's Third Law have on the body in motion? The loading of muscle resistance during eccentric elongation, the impact of muscle reaction and ligamentous support at the pause or amortization before rebound, and the recoil burst of concentric muscle contracting proportionally to the force are primary effects. The entire rebound reaction is also dependent on varying degrees of general conditioning, coordination, and former degrees of plyometric training.

Law of Function—Movement stimulates function of the body, and function stimulates structure. Therefore, movement is necessary to develop a healthy, functioning body structure.

Wolff's Law—Structure is modified according to the stresses and strains brought to bear upon it.

Rood's Law—One can only develop the component of physical fitness if engaged in activity to develop that component. If increased cellular metabolism is to occur throughout the body, then certain components of physical fitness conditioning developed such as strength, flexibility, agility, balance, coordination and reaction time must be included to produce healthy systems function including the neuromuscular, cardiovascular, bony and other systems.

THE SIGNS OF THIS SUPER-FAST REFLEX POWER RESPONSE ARE

- The pop-up is fast (may be fast but not flat)
- The pop-up is relaxed (may be relaxed but lacks the power to respond with good form)
- The pop-up has good posture upright—slight bend in knee and hip (like athletic jump ball stance.)
- The pop-up is mechanically efficient, smooth (not labored)
- The pop-up is springy (not flat—the pop-up is controlled—frog foot recoil appearance)
- The pop-up looks effortless and is pleasing to the eye. There is no doubt what it is.

I suggest that you take photos of your athletes as they start stair-pop-up training and again in six months and the following year. It will take a while for you, the coach, to recognize the different degrees of pop-up excellence. You will recognize this amazingly fast reflex response when you see your best athletes do stair pop-ups, and you may swear they have already developed the coordination to summon it. Then later, when you see their responses as they perfect the drill, the quality of their performance will shine. But both the athlete and coach should be patient. Sometimes the athlete may not be properly conditioned.

1. Beginners Line Pop-Over Drills

Most elementary school beginners should do the entire horizontal and perpendicular ground line drills every other day one or two round-trips until they are ready for one-step pop-up training five weeks later. Horizontal is defined as a line on the floor the children jump over forward and backward, advancing sideward to the finish ten feet away. The kids pop over sideward to the left, followed by a pop-over to the right and advance forward ten feet to the finish. Then they return with pop-overs backwards jumping to the start. Add doing the drill with one foot hanging. To maintain balance, do not place the one foot in back of the jumping foot.

2. Perpendicular

The same lines as the horizontal pop-over line may be designated as a perpendicular pop-overs line. Stand on the backside of the left or right line, facing forward. Do alternate jumps sideward with both feet over the center line continuously to the opposite side lines to the finish ten feet away. Return backwards to the starting point, doing two-foot pop-overs. Expect children to be uncoordinated as they pop backwards either on two or one foot. To help them understand, you may need to have the athlete or the whole class walk backwards. Then have them hop in place combinations of forward, sideward and backwards. Then finally have them alternate popping across the line backwards continuously with both feet. They may need to jump in place one or two times before each attempt.

The advanced perpendicular pop-over is with one foot. Do pop-overs forward then back for ten feet on one foot or five feet one foot and five feet with opposite foot if ten feet with one foot is too much. Repeat with the opposite foot.

3. Basic One-Stair Pop-Up

Stand on the first stair with your heels raised above the stair's edge. If needed, place hand on the railing or grasp a partner's hand if no railing is available for support. Do a drop down to the ground level with both feet and immediately rebound (pop back up) to the starting position. Repeat twice. Caution the athletes to drop with toes close to the stairs.

Start from an athletic, upright position with the knees and hips slightly bent. Maintain this upright position throughout the jump. Avoid a pop-up from a fiat foot that is not ready to receive weight and rebound. The pop-ups start with the heel raised slightly above the level and return to the starting position. The landing is close to the stairs on the forefoot, full-foot arch and heel briefly. The drop energy is converted to the recoil before the foot has a chance to settle.

If a person has trouble doing the pop-ups correctly, substitute this drill: Standing away from the stairs, have them rebound continuously in place on the floor, three rebounds and a quick high rebound on the fourth.

4. Two-Stair Pop-Ups

There are generally 14 steps to a home's second-floor landing with a turn platform after 7 steps. There is usually ample room for 12 contact-double-stair pop-ups with a six-contact and one-step walk out on the landing. Do first with two-foot pop-up, and then with single-leg pop-ups. Do six contacts with one foot and six contacts with the other. Start on the first step. Drop down to the first floor level, then rebound pop-up to the second step. Repeat the procedure until you are at the top of the 14 stairs. Here is an alternative to jumping the two-stair pop-ups if the 14 steps are not available: Position yourself on the first step and drop to the ground and pop up two stairs. Then, drop one step to the starting point. Drop the second time to the floor and repeat.

5. Diagonal Two-Stair Pop-Ups

With both feet: Stand on the front edge of the step with both heels raised over and above the edge of the stair and rest on the balls of both feet. Drop down one step with both feet and pop-up two steps diagonally to the opposite side of the stairs. Continue the pop-ups diagonally until you reach the second story landing 10-12 pop-ups or 6 contacts each split level and one-step walk-out. Walk down to the bottom of the stairs. With one foot: Do the single-foot one-stair drop, then two-step pop-up diagonal. Beginners land on two feet. This is more difficult and involves coordination, balance and agility, muscle reaction reinforcing power and speed response. Think of leading a shoulder into the pop-up drill. The free leg hangs and makes no contact with the step. Don't put it behind the jump foot.

6. Test for Stairs Height/ Distance Jumper

The coach should stand one step below the jumper (acting as a "spotter") and have a hand near the athlete's lower back without touching, in case the jumper gets off balance and falls back. A four-stair jump level, 8½ inch industrial stairs, is a 34-inches height and four-feet distance. A five-stair jumper is 42½ inches high and five feet in distance. I do believe an advanced adolescent athlete should be able to be a minimal 5-stair jumper. A six- or seven-stair jumper will become a school record holder. Coaches and teachers who wish to have a test for vertical measurement may use this very fine reference: "Achievement Scales in Physical Education" (1934) by N. Neilson and F. Cozen, pg. 55, Jump and Reach for Boys and pg. 119 for Girls. This book has the superb Performance Scales. (11)

7. Jump Landing

Stand and face down the stairs and jump to the floor from one- and two-step levels. Jump from each level twice and land on both feet with arms extended forward, and hold still with slightly bent knees and hips for three seconds. This is a gymnast style landing to teach proper landing control facing out away from the stair as well as facing the stairs. This training may also prepare the athlete for depth jumping off a higher platform.

8. Skills Progression

Children may progress from line

plyometrics training to the one-stair 4/1 drills during the first six-week session. The experienced athlete may start the one-step drop and pop up one step without line plyometrics training. Then progress to two-stair vertical and diagonal stair pop-ups progression. Encourage hop-over line drills for the eager athletes as they lead up to training accommodations to pop-ups. I use a 4/1 for my starting training combination. You may elect to use your own ratio. Be careful not to include too many one-foot pop-ups over four inches for the young and old in the early stages of training. The young may develop some unnecessary soreness. The old may have poor knees and hips and tight ankles that preclude them from progressing into advanced training. When in doubt check with a physician to test if your tri-extensor joints can tolerate rebound activity both for young and senior athletes.

The ratio of one-foot pop-ups to two-foot stair pop-ups is one to four. That is, four two-foot pop-ups followed by a one-foot pop-up. Some basic stair pop-up combinations are 4/1, 8/2, 20/5, 32/8 and 40/10 with the coaches' or teachers' approval. Please note that 20/5 is the work horse training routine for each training session. It is the base training level to refine super-fast reflex response. Do this drill before all other advanced stair pop-up combinations: Gradually train from 4/1, then progress to 8/2. Allow a few days to pass, and then increase gradually to 20/5.

This only takes a few minutes, so have the athlete rest one to two minutes and add 10 contact two-foot, two-stair pop-ups. The next session do a 20/5 basic drill and add vertical one- to three-step pop-up combinations. Try different combinations of stair pop-ups with one or two feet including stair height test when you need more power. The (20/5) speed work horse combination is a training choice to develop the powerful super-fast kinetic-chain reflex reaction needed to be firmly imbedded into your neurological memory engram bank. This basic drill reflex response gets faster and faster and more secure each month until it becomes a super-fast response habit.

9. Warm-Up Drills

I have seen children do a little jogging, or a few jumping jacks as their only warm-up. I have had children walk from a class to the stairs and just start jumping all without incident. But I believe when teaching a class or large number of kids it is prudent to do exercise that clears the joints, increases blood flow and announces to the kinetic chain of the body that rebound training is coming. Rebound and plyometric training should be preceded by some kind of warm-up and stretches both for physical necessities and legal precautions. One may use his own or select from this list:

1. Jumping Jacks—Assure full ROM of the scapulae, arms to the ears—10x

2. Range of Motion, sitting—foot in, foot out, foot up, foot down and foot rotate—4x each foot

3. Standing hop on both feet three times with high pop-up on fourth bounce—4x

4. Extend arms and grasp doorknob or partner's hand, deep squat (Bottom low Asian style), hula hips at bottom—2x

5. Good Morning - Hamstrings—4x

6. Bend over and place hands on your knees. Position the legs forward, side or back so that you stretch the Soleus, Gastrocnemius, Giuteal, Hamstrings, and Adductors. Include shifting the hips doing a hula hip swivel at the end of each stretch to stretch the appropriate muscles—4x

7. Upper Trunk Twist—4x

8. Walk, Run, skip 20 yards

Contra-Indications of Plyometric Stair Pop-Ups

Do not lift weights or practice aerobics before plyometrics training. Under no circumstances do the Plyometrics Stair Pop-Up training immediately at the end of a "hard" turnout, a recipe for developing a *dead reflex.*

Some children may have sore abdominals (counterbalance response), ankle and bottom of the foot pain, sub-occiput headaches, upper back or leg discomfort the next day. This is normal for a new rebound procedure. However, if the complaint is great, omit the stair pop-ups for four days. Such trauma usually lasts for about three days and then goes away. I have never heard athletes complain about prolonged burning calves that ache, torn Achilles tendons, meniscus tears, ankle sprains, or knee strains from stair pop-up training. Athletes have had soreness when they got too enthused, jumping barefoot or overtraining on cement stairs, resulting in stress to the bottom of the feet. The solution was foot soaks in cold water after training and several day-long recovery periods without any plyometrics. A couple of pieces of tape over /under wrap from toe around the heel to the forefoot and anchored at the forefoot will temporarily take pressure off a sore foot's arch.

Conclusion

Properly taught, the Monlux Plyometrics Stair Pop-Up routine is safe, involves a short learning curve, and is effective training to help your athletes achieve peak performance.

Physicians, teachers, or coaches may describe this Plyometrics activity as one of many special rebound training routines to help your child run and jump more efficiently while stimulating healthy growth and development.

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A THEORETICAL BASIS OF MONITORING FATIGUE: A PRACTICAL APPROACH FOR COACHES

This piece is adapted from a research study that first appeared in the *International Journal of Sports Science & Coaching* and was reprinted in *The Coach,* Issue #36, Spring 2007. We think Lambert and Borreson treat the subject with such clarity and thoroughness that it deserves as wide an audience as possible, and particularly to track & field coaches.

BY MIKE LAMBERT AND JILL BORRESEN

ABSTRACT

Training can be described as a process that induces biological adaptations. The basic principle of training is that training (breakdown) is followed by rest (recovery) which results in an improvement in performance. An imbalance in the training load and recovery time can result in symptoms of fatigue. If the imbalance between training and rest persists, the athlete may develop serious symptoms of fatigue that will affect the ability to sustain a high training volume and will have a negative effect on performance. While it is important for a coach to have a training plan, it is also important to be able to adjust the plan based on how the athlete is adapting. A coach needs to be able to answer a series of questions in order to make decisions about training prescription. Information to assist the coach in answering these questions can be acquired from various measurements including perception of effort, session RPE, recovery scales, Profile of Mood States (POMS), Daily Analysis of Life Demands for Athletes (DALDA), assessment of muscle soreness and recovery heart rate. This information can guide decision-making about training and reduce the risk of under or overtraining.

INTRODUCTION

Training used to be mostly instinctive, with training programs evolving through trial and error. About fifty years ago there was an attempt to apply a scientific approach to exercise training with the goal of reaching peak performances [1]. Knowledge has accumulated and it is now known that exercise training can be explained according to the principles of biological adaptation. In accordance with this explanation, each training session imposes a physiological stress [2] that results in transient physiological and metabolic changes [3]. The nature of these changes depends on the type, duration and intensity of exercise [4]. Examples of these transient physiological and metabolic changes are [2]:

- Altered blood flow to the active muscles
- Increased heart rate
- Increased breathing rate
- Increased oxygen consumption
- Increased rate of sweating
- Increased body temperature
- Secretion of stress hormones such as ACTH, cortisol and catecholamines
- Increased glycolytic flux
- Altered recruitment of muscles

These changes, which occur during the bout of exercise, return to their pre-exercise resting levels during the recovery period when the exercise session is over. If these acute bouts of exercise are repeated sufficiently, over time they induce chronic adaptations that are also known as training adaptations [3]. Most of the training adaptations involve remodelling of protein tissue that occurs as a consequence of changes between protein synthesis and degradation [5].

Some of the training adaptations result in changes in muscle morphology, altered metabolism [3] and changes in neuromuscular recruitment patterns during exercise [6]. The nature of the adaptations depends on the type of exercise and the duration, intensity and frequency of the training bouts [4]. These remodelled changes are associated with an improvement in physical performance, are semipermanent and do not disappear after the bout of exercise or training session. However, the remodelled changes do regress if regular exposure to the training ceases as occurs when the athlete stops training [7].

The visible signs of training adaptations include well-defined muscles, low body fat and skilful movements, depending on the type of training stimulus. The unseen training adaptations, particularly after endurance training, are changes such as an increase in plasma volume [8], increased mitochondria in skeletal muscles [9], increased capillarisation [10], cardiac hypertrophy [11] and increased density of bones [12]. High performance athletes adapt at different rates and have different needs for recovery between training sessions [13].

FOR COMPETITORS AT THE ELITE LEVEL THERE IS A FINE LINE BETWEEN DOING TOO LITTLE OR TOO MUCH TRAINING

For recreational athletes there is generally a positive relationship between training load and physiological adaptations resulting in improvements in performance. However, for competitors at the elite level there is a fine line between doing too little or too much training [14-16]. Insufficient training does not induce adequate adaptations and results in suboptimal performance. In contrast, too much training results in maladaptations or the failure to adapt, causing symptoms of chronic fatigue and poor performance [17,18]. The chronic fatigue can be differentiated from acute fatigue as the symptoms of chronic fatigue persist long after the end of the bout of exercise [18].

The terminology describing this condition has not been precise, resulting in a poor understanding of the etiology of the condition [19]. For example, athletes can experience a short term decrement in performance without any other negative symptoms. This has been called "functional overreaching" and generally after recovery the athlete has an improvement in performance. Nonfunctional overreaching can occur after imbalances between training and recovery and may lead to more serious symptoms associated with the overtraining syndrome [19]. These conditions are not productive and should be avoided. However, misinformed coaches can mistake the symptoms associated with nonfunctional overreaching and the overtraining syndrome as being associated with insufficient training. This often results in the coaches prescribing more exercise, which exacerbates the manifestation of chronic fatigue. Other basic errors of training which result in symptoms of chronic fatigue and detract from peak performances include [20];

- Recovery is neglected
- Demands on the athletes are made too quickly
- After a break in training because of illness or injury, the training load is increased too quickly
- High volume of maximal and submaximal training
- Overall volume of intense training is too high when the athlete is training for endurance events
- Excessive time is devoted to technical or mental aspects, without adequate recovery
- Excessive number of competitions—this includes frequent disturbances of the daily routine and insufficient training time which accompanies competition
- Bias of training methodology
- The athlete has a lack of trust in the coach because of inaccurate goal setting.

A common symptom of all these errors in training is the development of fatigue, which persists after the training session. A wise coach/athlete can discriminate the expected fatigue, which is associated with the training session from chronic fatigue, which has a more subtle underlying character and lingers on for longer than expected after the training session. The difference between these types of fatigue are clearly outlined in *Lore of Running* (p.646) [21] which describes the warning sign of impending chronic fatigue as a heavy-legged feeling during exercise, colloquially referred to as the "plods." This condition is also characterized by sore muscles, a sluggish feeling, generalized fatigue and malaise.

If the athlete rests, the symptoms usually disappear within 24 to 48 hours; and when training is resumed, the athlete feels well conditioned. If the athlete does not rest adequately, the condition will progress into the "superplods"— an early stage of the full blown overtraining syndrome [21,22].

Another condition resulting from prolonged exposure to excessive training load is the acquired chronic training intolerance characterized by chronic fatigue [18], changes in muscle morphology [23-25] and psychological disturbances [26]. These conditions are serious and will in all likelihood seriously affect the athlete's career In addition to training errors causing symptoms of staleness, psychological and social stressors also contribute to and worsen these symptoms [27].

Therefore it is logical to assume that if subtle symptoms of chronic fatigue can be monitored and detected before they manifest as serious, persistent symptoms of fatigue, the athlete will have a better chance of sustaining a high volume of training because the errors in training causing the symptoms can be identified and rectified. This paper will discuss practical ways of gathering information to monitor levels of fatigue in an athlete with the goal of using this information to adjust the prescription of training. It is beyond the scope of this paper to discuss the etiology of acute and chronic fatigue. For a discussion on this topic interested readers are referred to other relevant papers [28-33]. While there are expensive, invasive procedures for detecting signs of overtraining [34-37], most of these procedures are of more academic interest than of practical interest to the coach and athlete. These methods will not be discussed; rather the focus of this paper will be on the methods which are non-aversive to the athlete, can be measured on a daily basis and have a practical application. In essence, the information that is gathered needs to assist the coach or physical trainer to answer the following questions on a daily basis:

- How hard did the athlete find the session?
- How hard was the session?
- How did the athlete recover from the session?
- How is the athlete coping with the cumulative stress of training?

While some coaches have intuition and experience which allows them to subjectively answer these questions by observation and discussion with athletes, we propose that a more objective approach of gathering information will provide more sustainable success, as training load can then be adjusted in accordance with how the athlete is feeling and adapting. A practical approach, supported where possible by theory, will be discussed.

HOW HARD DID THE ATHLETE FIND THE SESSION?

RATING OF PERCEIVED EXERTION (RPE)

A rating of perceived exertion (RPE) is based on the understanding that an athlete can inherently monitor the physiological stress his/her body is experiencing during exercise. An athlete's perception of effort is translated into a numerical score between 6 and 20 in the Borg 6-20 RPE Scale [38], Table 1. This table has subsequently been adjusted to a 10 point scale [39] (Table 2).

This principle of monitoring physiological stress was demonstrated in a study by Robinson et al. [40] who found that during steady state exercise the athletes reported RPE correlated well to their average heart rate recorded during the training sessions. They concluded that it may be possible for runners to adjust their training intensity using their own perceptions of effort [40]. Ratings of perceived exertion have been proposed as possible detectors of impending overreaching, with RPE being found to increase during constant exercise load [41].

HOW HARD WAS THE SESSION?

QUANTIFYING TRAINING USING RPE

Several methods have been used to quantify exercise training intensity and have been reviewed by Williams and Eston [42] and Hopkins [43]. One such method, proposed by Banister et al. [44, 45], quantifies a training session into a unit "dose" of physical effort. They suggested that a person's heart rate response to exercise (an indicator of intensity), along with the exercise duration, collectively called a training impulse ("TRIMP"), may be a plausible measure of physical effort as it is based on the extent to which exercise raises heart rate between resting and maximal levels [44,45]. However, the use of this method of quantification is limited by the necessity to use heart rate monitors throughout training. The technique is also restricted to endurance-type exercise that are characterized by steady state workloads and therefore cannot be used with resistance training.

THE SESSION RPE SCALE IS A RATING OF THE OVERALL DIFFICULTY OF THE EXERCISE BOUT, OBTAINED 30 MINUTES AFTER THE COMPLETION OF THE EXERCISE

In an attempt to simplify the quantification of training load, Foster et al. [46] subsequently introduced a Session RPE inventory to measure training load instead of using heart rate data. The Session RPE scale is a rating of the overall difficulty of the exercise bout, obtained 30 minutes after the completion of the exercise [46]. It is based on the Borg Category Ratio (CR-b) RPE Scale, which translates the athlete's perception of effort into a numerical score between 0 and 10. This test is designed to encourage the athlete to respond to a simple question "How was your workout?" with the goal of getting an uncomplicated response that reflects the athlete's global impression of the workout. The Borg scale and the Session RPE adjustments are shown in Table 2.

Table 1: Borg 6-20 RPE Scale [38].

6	
7	Very very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Very very hard
20	

According to Foster [47,48] a daily session load can be calculated by multiplying Session RPE (Borg Category Ratio (CR-b) RPE Scale) by the duration of aerobic exercise in minutes, or the number of repetitions performed in resistance exercise (Equation 1):

Session load = Duration
(or Number of Repetitions) x
Session RPE (1)

This method has been shown to be a valid and reliable measure of exercise intensity in aerobic exercise when compared to heart rate based methods [47]. Session RPE has also been used to measure exercise intensity in resistance training [49,50]. In these studies RPE was influenced more by resistance load than by volume, so that performing more repetitions with a lighter load was perceived as being easier than performing fewer repetitions against a heavier load [49-51].

The use of Session RPE to quantify training load has potential in being a mode- and intensity-independent method that can be used for multiple types of exercise such as high intensity, or non-steady state exercise like resistance training,

Table 2: Borg Category Ratio Scale [39] and Session RPE Scale [46].

Category	Ratio Scale	Session RPE
0	Nothing at all	Rest
1	Very weak	Really easy
2	Weak	Easy
3	Moderate	Moderate
4	Somewhat strong	Sort of hard
5	Strong	Hard
6		
7	Very strong	Really hard
8		
9		Really, really hard
10	Very very strong	Just like my hardest race

high-intensity interval training or plyometric training [47].

However, there still remain questions about the accuracy of its use in both aerobic and resistance training. Impellizzeri et al. [52] found only moderate correlations (r=0.50-0.85) between training loads calculated using Session RPE and a heart rate-based method for members of a soccer team. They suggest that the RPE-based score cannot yet replace the heart rate-based methods as a valid measure of exercise intensity as only 50% of the variation they measured in heart rate could be explained by the session RPE [52].

Sweet et al. [51] and McGuigan et al. [49] found that the RPE varied significantly among different muscle groups used during resistance exercise performed at the same percent of one-repetition maximum. They explained this phenomenon by proposing that perceived exertion increases as muscle mass (and hence metabolic demand), range of motion and the number of joints involved in a movement increase. They further suggested that the order in which the exercises are performed, the fiber type of the muscle used, the mode of exercise for which the athlete is trained (i.e., the level of experience the athlete has in resistance training), as well as the time at which RPE is reported may also affect RPE [51]. For example, a study by Day et al. [50] found no difference between session RPE and mean RPE recorded after 1 set of resistance exercise at equivalent exercise intensities; whereas Sweet et al. [51] who recorded mean RPE after 2 sets, did report differences. It was subsequently found that RPE increased significantly between the first and second sets of resistance exercise [51].

Table 3: The Recovery Scale [27].

6	
7	Very, very poor recovery
8	
9	Very poor recovery
10	
11	Poor recovery
12	
13	Reasonable recovery
14	
15	Good recovery
16	
17	Very good recovery
18	
19	Very, very good recovery
20	

The complex interaction of the many factors that contribute to the personal perception of physical effort, including hormone concentrations (e.g., catecholamines), substrate concentrations (e.g., glucose, glycogen, lactate), personality traits, ventilation rate, neurotransmitter levels, environmental conditions or psychological states, may limit the use of RPE in accurately quantifying or prescribing exercise intensity [42]. However, although using objective physiological measurements like heart rate may be a more accurate way of calculating training load (for steady state endurance training), the subjective measure of RPE remains useful for various types of exercise. Thus if heart rate monitors are not available, or an easier, more practical means of reporting and calculating training load is required, the RPE method measures the "difficulty of the training session" with sufficient accuracy. The research on the RPE method and resistance training shows that the timing of the measurement is important and should be kept constant.

HOW DID THE ATHLETE RECOVER FROM THE SESSION?

The basic principle of training is that breakdown (training) is followed by recovery (rest) which results in an "overshoot" in performance and adaptation [27]. It follows that the greater the training load, the more recovery is needed. A sequence of these training load/recovery units stimulates adaptations, which are associated with physical performance. Imbalances (too much training/insufficient recovery) over time will result in symptoms of chronic fatigue.

A scale for monitoring recovery, analogous to the Borg 6-20 point scale [38] has been proposed [27]. This is shown in Table 3.

THE GREATER THE TRAINING LOAD, THE MORE RECOVERY IS NEEDED

According to Kenttä and Hassmén [27] there are two versions of this test: (i) perceived recovery; and (ii) action recovery. For the perceived recovery the athlete is asked before bedtime to rate his/her recovery for the previous 24 hours, including the previous night's sleep using the scale described in Table 3. There is only one study which has reported using the perceived recovery scale [53]. In this study an elite Japanese sprinter was studied for one year, during which time his session RPE and recovery scores [27]—amongst other variables—were monitored on a daily basis. The authors applied the data to a mathematical model and were able to predict

Table 4: An Example of the Scoring for Action Recovery [27,54].

		Points
Nutrition		
Breakfast	1	
Lunch	2	
Supper	2	
Snacks between meals	1	
Carbohydrate reloading after practice (assuming healthy, quality balanced meals)	2	
Adequate hydration through the day	1	
Adequate hydration during/after training	1	
Maximal subtotal		***10***
Sleep and rest		
Good night of quality* sleep	3	
Daily nap (20-60 mm)	1	
Maximal subtotal		***4***
Relaxation and Emotional Support		
Full mental and muscular relaxation after training	2	
Maintaining a relaxed state throughout the day**	1	
Maximal subtotal		***4***
Stretching and active rest		
Proper cool-down after each training period	2	
Stretching all the exercised muscle groups	1	
Maximal subtotal		***3***
TOTAL		**20**

*Individual perception **The goal is to use a variety of relaxation techniques (breathing, massage, etc.)

performance with a high degree of accuracy. Although there is a lack of published research data on this technique, the method has excellent practical value as it is easy to administer, can be done on a daily basis and educates the athletes about the nuances of recovery.

For the action recovery, the athletes score themselves for each of the four main categories: (i) nutrition and hydration; (ii) sleep and rest; (iii) relaxation and emotional support; and (iv) stretching and active rest (see Table 4) [27]. These four categories summarize factors that can affect recovery and need to be considered when information is gathered about recovery status [27].

There are no published data using the action recovery method, but there is a practical description on the test described on a website [54]. As with the perceived recovery test, the action recovery is measured over the previous 24 hours. The score is measured for each of the four categories. A total of 20 points are available for this test and a score of less than 13 points indicates that recovery from training is incomplete [27]. An example of the scoring is shown in Table 4 [54].

This test draws attention to the psychosocial cues which are associated with poor recovery. The application of this method allows the coach to monitor recovery and match this to the training load. While more research is needed to determine how to interpret the scoring system, the concept of monitoring recovery using this test system is practical, easy to use and should be of practical benefit.

MUSCLE SORENESS

It is inevitable that after a hard training session the muscles will be stiff and painful [55]. The pain is usually delayed and peaks 24 to 48 hours after the activity that causes the pain. The etiology of this pain has been well studied and seems to have its origins in inflammation [56,57]. The pain can range from a mild stiffness to a more serious pain which affects muscle function [58]. It has been shown that when exercising with stiff muscles there is a higher exercise stress during submaximal exercise [59]. Trying to sustain a high training load with sore muscles will lead to symptoms of overreaching [19]. For this reason it is important to monitor any symptoms of muscle soreness which may result from training. Training load can then be adjusted in accordance with the symptoms of pain. There are no clear guidelines about what level of muscle soreness should be reached before training load is reduced. Decisions about muscle soreness and training should be made based on the type of sport, length of season and phase of training.

This pain can be measured objectively with a specially designed pressure probe. However, we have found that a subjective pain assessment is just as accurate and as quick and easy to administer as the objective assessment [60,61].

For this assessment the subjective scale ranges from 0 to 10, where 0 represents no pain, and 10 represents maximal, unbearable pain. Specific muscles should be identified for this assessment, based on the type of training. For example, the coach of a long distance runner would be interested in the muscle soreness of the quadriceps femoris and gastrocnemius muscles, whereas a gymnastics coach might be more interested in the muscles of the upper body. This assessment should be done at the same time of day, every day and following a standardized movement (e.g., knee bend).

HOW IS THE ATHLETE COPING WITH THE CUMULATIVE STRESS OF TRAINING?

PROFILE OF MOOD STATES

The Profile of Mood States (POMS) questionnaire was published in 1971 as a self-report test designed to measure the psychology of mood state, mood changes and emotion [62]. The POMS test has 65 items that measure six identifiable moods or feelings: Tension-Anxiety, Depression-Dejection, Anger-Hostility, Vigor-Activity, Fatigue-Inertia, and Confusion-Bewilderment. The respondents answer according to a scale (0 = not at all, 1 = a little, 2 = moderately, 3 = quite a bit, 4 = extremely). The test was initially designed for patients undergoing counselling or therapy, but has evolved to be used in sport.

Changes in mood states, assessed with POMS have been shown in studies in which performance decrements occurred, supporting the use of the POMS scores as an early indicator of overreaching [41,63]. Filaire et al. [64] found that soccer player's moods improved with an increase in winning performances despite an increase in the intensity of training. They also observed an increase in depression and tension during a period of poor performance, where relationships between players and coach, financial and family problems, and levels of fatigue appeared to be unchanged. They therefore suggested that the changes in POMS during this period may have been affected by factors other than those relating exclusively to training or external personal influences [64].

THE POMS TEST HAS 65 ITEMS THAT MEASURE SIX IDENTIFIABLE MOODS OR FEELINGS

Rietjens et al. [65] studied various physiological, biochemical and psychological markers in an attempt to find whether strenuous training induced fatigue (possibly leading to an overreached state) could be diagnosed early. Training load was increased by 100% and maintained for 2 weeks in an attempt to induce overreaching. However, the intensified cycling training resulted in no change in performance and only a trend towards an increased average mood score, reflecting a decline in mood on the POMS questionnaire. After finding significant differences in cognitive speed tests they suggested that central fatigue may be the first and most sensitive parameter with which to detect overreaching, with an increase in the shortened POMS score and an increase in RPE being secondary markers of this state [65]. Collectively these studies show that the POMS test can be informative, providing other information about the athlete is collected simultaneously.

DAILY ANALYSIS OF LIFE DEMANDS FOR ATHLETES

The Daily Analysis of Life Demands for Athletes (DALDA) was developed as a sport specific test to monitor an athlete's specific stress of training [66]. This test monitors the physiological stress of training in addition to the stresses that may exist outside the training environment (but which may contribute significantly to the total stress exposure). The test has evolved after having had the content validated, the readability checked and the reliability established [66]. The DALDA can be administered throughout a training season, can easily be incorporated into a training logbook and can be scored by the athlete or coach.

The first part of the test (Part A) involves the general sources of stress that occur in daily living (Table 5). The second part of the test (Part B) involves symptoms of stress (Table 6). The definition for each question occurs adjacent to each variable.

Each question is scored with either a "worse than normal", "normal' or "better than normal" response. This test is not designed for comparisons between athletes, but rather for comparisons or changes within an athlete over a season. Therefore a profile has to be established for each athlete and the changes or trends in the scores provide information about the exposure to stress of the athlete. The test is widely used by coaches and is also sufficiently robust to be used in research [63].

RESTING HEART RATE

Resting heart rate has been a popular marker of training status for many years. Resting heart rate decreases slightly after endurance training [67-72]. However, other researchers have found no significant difference in resting heart rate in trained individuals [73,74]. Many studies reporting a difference in resting heart rates between trained and untrained individuals are cross-sectional in nature, thus limiting the ability to discern whether the difference is due to training or due to inherent variation between the two populations [72,75]. The longitudinal studies have also produced varying results. For example, longitudinal studies have found heart rate during sleep to be reduced [76] or unchanged [77] after several weeks of exercise training. There is no change in the resting heart rate of highly trained athletes who reduce their training load during a taper as they prepare for a peak athletic event [7].

The changes in resting heart rate after exposure to periods of high volume training/competition are also varied. Morning heart rate of runners decreased in the first week of a 20-day race and then increased by about 10 beats.min-1 towards the end of the race [78]. In a study of ten athletes, who increased their training volume by 38% over a 3-week period, there were no changes in resting heart rate (despite six of the athletes showing early signs of overreaching with changes in their POMS scores).

A study of twelve swimmers, who increased their training from 4266 ± 264 m.day-1 to 8970 ± 161 m.day-1 for 10 days, showed that the swimmers also developed signs of overreaching without any change in resting heart rate [79]. However in a study of seven competitive cyclists, who increased their training load for 2 weeks with the intention of inducing symptoms of fatigue, the heart rate measured during sleep increased from an average of 50 to 54 beats.min-1 [80]. This study suggested that measuring heart rate during sleep, rather than resting heart rate upon waking, may be a marker for training status and monitoring cumulative fatigue [80].

One of the reasons for the varied data may be that resting heart rate may be influenced by many environmental factors [81] and if these are not controlled properly the heart rate data will be influenced. With this as background, and based on the assumption that during sleep these factors will have less of an effect on heart rate, a study was designed to determine the precision of measuring heart rate during sleep

Table 5: Sources of Life Stress for the DALDA Including Their Definitions [66].

Variable	Definition
Diet	Consider whether you are eating regularly and in adequate amounts. Are you missing meals? Do you like your meals?
Home-life	Have you had any arguments with your parents, brothers or sisters? Are you being asked to do too much around the house? How is your relationship with your wife/husband? Have there been any unusual happenings at home concerning your family? How are you getting on with your roommates?
School/College/Work	Consider the amount of work that you are doing there. Are you required to do more or less at home or in your own time? How are your grades or evaluations? Think of how you are interacting with administrators, teachers or bosses.
Friends	Have you lost or gained any friends? Have there been any arguments or problems with your friends? Are they complimenting you more or less? Do you spend more or less time with them?
Training and Exercise	How much and how often are you training? Are the levels of effort that are required easy or hard? Are you able to recover adequately between efforts? Are you enjoying your sport?
Climate	Is it too hot, cold, wet or dry?
Sleep	Are you getting enough sleep? Are you getting too much? Can you sleep when you want to?
Recreation	Consider the activities that you do outside of your sport for enjoyable relaxation. Are they taking too much time? Do they compete with your application to your sport?
Health	Do you have any infections, a cold, or other temporary health problems?

Table 6: Symptoms of Stress for the DALDA Including Their Definitions [66].

Variable	Definition
Muscle Soreness	Do you have any sore joints and/or pains in your muscles?
Techniques	How do your techniques seem/feel to you? Have your technical skills changed?
Tiredness	What is your general state of tiredness?
Need for Rest	Do you feel that you need a rest between training sessions?
Supplementary Work	How strong do you feel when you do supplementary training (e.g., weights, resistance work, stretching)?
Boredom	How boring is your training?
Recovery Time	Do the recovery times between each training effort need to be longer?
Irritability	Are you irritable? Do things get on your nerves?
Weight	How is your weight?
Throat	Have you noticed your throat being sore or irritated?
Internal	How do you feel internally? Have you had constipation, upset stomachs, etc.?
Unexplained Aches	Do you have any unexplained aches or pain?
Technique Power	How do you rate the level of power you develop in your techniques?
Enough Sleep	Are you getting enough sleep?
Between-Sessions Recovery	Are you tired before you start your second training session of the day?
General Weakness	Do you feel weak all over?
Interest	Do you feel that you are maintaining your interest in your sport?
Arguments	Are you having squabbles and arguments with people?
Skin Rashes	Do you have any unexplained skin rashes or irritations?
Congestion	Are you experiencing congestion in the nose and/or sinuses?
Training Effort	Do you feel that you can give your best effort at training?
Temper	Do you lose your temper?
Swellings	Do you have any lymph gland swellings under your arms, below your ears, in your groin, etc?
Likeability	Do people seem to like you?
Running Nose	Do you have a running nose?

in a group of subjects who maintained their training. Ten females who maintained a constant training load over 3 weeks were studied [82]. Although the average heart rate was similar over the 3 weeks (65 ± 9; 63 ± 6; and 67 ± 7 beats.min-1), on an individual basis the minimum heart rate during sleep varied by up to 8 beats.min-1 during the study. With this amount of variation, it is unlikely that changes in heart rate measured during sleep will have any practical prognostic value in identifying fatigue in athletes.

In summary, although it may be concluded that resting heart generally decreases with increased training status, this relationship is probably stronger when the person goes from a sedentary to a trained state. In athletes the results are much more variable, reducing the value of this test as a useful tool for monitoring training status.

HEART RATE VARIABILITY

The development of heart rate monitors [83] has allowed further research into the mechanisms behind heart rate responses during exercise and adaptations to training. Particular attention has been focused on heart rate variability, largely as a means with which to evaluate cardiac autonomic control. While there are potentially aspects of heart rate variability which will have practical use for monitoring autonomic control in athletes undergoing training, it is premature at this stage to use it in a diagnostic way [84]. A review of the literature revealed that prospective, randomized, controlled, long-term studies using validated measurements are needed before heart rate variability can be used with confidence in monitoring training status [84].

HEART RATE RECOVERY

Heart rate recovery may be defined as the rate at which heart rate decreases, usually in the first minute or two, after moderate to heavy exercise. The heart rate response to the cessation of exercise is governed by the autonomic nervous system, specifically parasympathetic reactivation and sympathetic withdrawal [85-88]. Changes in autonomic nervous system activity during recovery after exercise is affected by exercise training [70] and overtraining [37]. Therefore, it may also be a practical and reliable marker of chronic fatigue and provide information about how the athlete is coping with the cumulative stress of training.

Some cross-sectional studies have shown that there may be potential in the use of heart rate recovery to distinguish trained from untrained individuals. A study by Bunc et al. [89] showed that trained athletes reached steady state sooner and had a faster recovery than untrained subjects, for the same absolute intensity of exercise. They concluded that endurance-trained athletes have faster heart rate responses at the start and cessation of exercise and therefore suggest that an athlete's state of training can be established by assessing the changes in heart rate after exercise [89].

Short and Sedlock [90] analyzed heart rate recovery following two 30-minute bouts of cycle ergometer exercise in trained versus untrained subjects. Baseline and recovery heart rate was lower in the trained group compared to the untrained group, so subsequent results were adjusted for this baseline difference. After exercise of the same relative intensity (70% VO_2peak) heart rate recovery was not different between the groups. However, after exercise of the same absolute intensity (1.5 1mm-i VO_2) heart rate recovery in the trained subjects was lower during the entire 8-minute recovery period [90].

THE OUTCOME OF TRAINING (I.E., PREDICTABLE PERFORMANCE) IS DEPENDENT ON A BALANCE BETWEEN THE TRAINING LOAD AND RECOVERY

A longitudinal study by Sugawara et al. [91] showed that post-exercise heart rate decreased significantly faster after only 4 weeks of an 8-week moderate intensity training period and returned to baseline levels after 4 weeks of subsequent detraining. They suggest that exercise training may enhance post-exercise vagal re-activation, but that a relatively short period of detraining may reverse this effect [91]. The effects of 5 months of detraining were studied by Michael et al. [92] in 10 female middle distance or sprint runners who had been participating in a 3.5-month interval training program. They found that heart rate recovery after a standardized step-test and treadmill run became slower as detraining time increased.

It has been suggested that overtraining causes a disturbance in autonomic control [93] which will be reflected in recovery heart rate. In accordance with this, we have designed a submaximal shuttle test comprising 4 stages of increasing intensity interspersed with recovery periods [94]. In this test the subjects are asked to run between two lines, drawn 20 meters apart on a rubberized indoor floor. The pace of running within each of the four stages (8.4 km h-i, 9.6 <m-h-1, 10.8 km-h-1 and 12.0 kmh-1, respectively) is set by a pre-recorded auditory signal recorded onto a compact disk. Each stage lasts two minutes followed by rest for one minute after each of the first three stages and two minutes after the fourth stage. Therefore, the total duration of the test is 13 minutes. This test was designed to be submaximal and non-aversive for the athletes so that it can be administered frequently during different phases of training. Furthermore, the test is easy to administer and about 20 athletes can do the test simultaneously. The test has a high reliability and low standard error of measurement (1.1%) [94]. For the information to be useful, the test needs to be done on a weekly basis, so that a profile for each player can be established. On its own, the heart rate recovery test may not be diagnostic. If the data are interpreted in context with other data gathered, however, it will provide useful information and contribute to decisions about training prescription.

SUMMARY

It may be concluded that the outcome of training (i.e., predictable

ALTHOUGH A COACH MAY HAVE A BROAD PLAN OF TRAINING FOR AN ATHLETE, IT IS IMPORTANT TO MAKE MINOR ADJUSTMENTS TO THE TRAINING LOAD BASED ON HOW THE ATHLETE IS RESPONDING AND ADAPTING

performance) is dependent on a balance between the training load and recovery. Although a coach may have a broad plan of training for an athlete, it is important to make minor adjustments to the training load based on how the athlete is responding and adapting. Coaches need to carefully adjust the training load according to the symptoms that manifest in response to the training. The chance of the athletes adapting and reaching a competitive peak in a predicable way will be increased if the coach adopts a systematic approach by gathering information after each training session. Future research needs to refine the relationships between variables that can be monitored; in particular how variables can predict imminent fatigue before it occurs. As there is limited time to gather information at each session, it is important that research identifies those tests that provide the most accurate information with the least amount of time and effort. Until that information is available, it is recommended that the questions that need to be answered, and the tests that can be used to provide information, are:

- How hard did the athlete find the session? Solution:
  – RPE (every session)
- How hard was the session? Solution:
  – Session RPE (every session)
- How did the athlete recover from the session? Solution:
  – Perceived and action recovery (daily basis)
  – Muscle soreness (daily basis)
- How is the athlete coping with the cumulative stress of training Solution:
  – POMS (every week)
  – Recovery heart rate test (every week)
  – DALDA (daily basis)

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FUNCTIONAL TRAINING FOR RUNNING SPORTS

This is an excerpt from the new book *Functional Training* (Human Kinetics, 2016), written by Juan Carlos "JC" Santana, founder and director of the Institute of Human Performance (IHP) in Boca Raton, Florida. IHP has been recognized as one of the top training facilities in the world and the best core-training facility in the United States.

BY JUAN CARLOS "JC" SANTANA

Sports that require high power or sustained running, such as track and field and endurance running, are rarely grouped together. However, all running is a variation of a sprint. This approach is substantiated by the increased amount of forefoot running in long races (e.g., mile, 5K, marathons). Long distances that used to be covered using a heel-to-toe (full foot) plant are now being raced on the forefoot and finished in sprint times. Therefore, this program increases the power output of the body's locomotive system and then lets the athlete adapt the power gained to his specific race and distance covered.

Warm-Up for Conditioning and Strength

Fabulous Five[1]: 2 sets
Runner's reach[2]: 2 x 10 to 20
Slide running[3]: 2 x 10 per side

CONDITIONING

Perform each quadplex in order and then start the sequence again. Complete for as many sets as indicated. Rest adequately between each exercise to maintain good form and quality of movement, eventually targeting a 30- to 60-second rest period after each exercise. Use enough load to make the assigned repetitions challenging while maintaining good form. Unless otherwise specified, use the progression in table 9.10.

The How

If your fitness level is high, you can start with any week that feels comfortable and repeat the week as many times as necessary to create a strong base of training.

Core 1

Triple Threat[4] (weeks 1-5)
Running curl[5]: 2 or 3 x 10 to 20 per arm

STRENGTH

Perform each triplex in order for the number of sets indicated. Rest adequately between each exercise to maintain good form and quality of movement, eventually targeting a 30- to 60-second rest period after each exercise. Use enough load to make the assigned repetitions challenging while keeping good form. Unless otherwise specified, use the progression in table 9.11.

[1] **JC Santana's Fabulous Five** consists of SB (stability balls) hands-on-ball push-ups; SB hyperextension; SB reverse hyperextension; SB knee tuck (double leg to single leg); and SB skier—a program designed for building total-body stability and strength.

SB hands-on-ball push-up

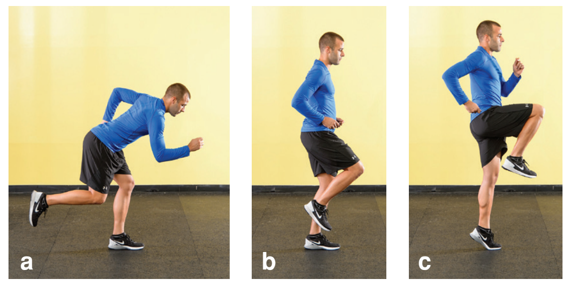
SB hyperextension

SB reverse hyperextension

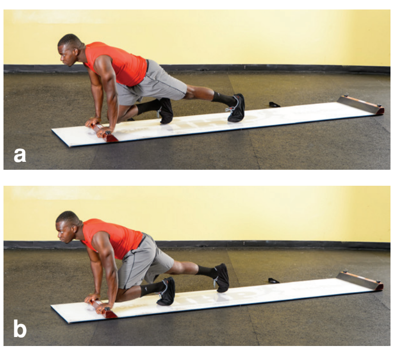
SB knee tuck (double leg to single leg).

SB skier

[2] **Runner's Reach:** Stand on left leg (knees bent about 20 degrees, as in running). Right leg moves back as shoulders lean forward. Place arms in running position (right arm forward, left arm back, elbows at 90 degrees). Extend body while bringing left arm forward and right arm back. At the same time bring right knee forward and right foot up. At top of the movement, be on the ball of the left foot with left knee fully extended. Return to starting position and repeat. This exercise develops 7-frame hip stability, running speed, and helps to prevent hamstring injuries.



Running reach: (a) starting position; (b) middle position; (c) top of movement.



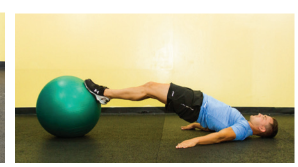
[3] **Slide Running:** Use on a commercial slide apparatus (see illustration). Place slide on a nonslip surface and put on the booties suggested by the manufacturer over your shoes. Plank position with hands on the floor, as shown. Flex right hip about 90 degrees to slight right foot forward toward the chest. Left leg is extended. Keep core and shoulders stable and tight throughout. Explosively switch position of the legs/knees, as shown. Continue this running motion for the number of repetitions indicated.

Slide Runing: (a) starting position;
(b) extend right leg and flex left hip and knee.

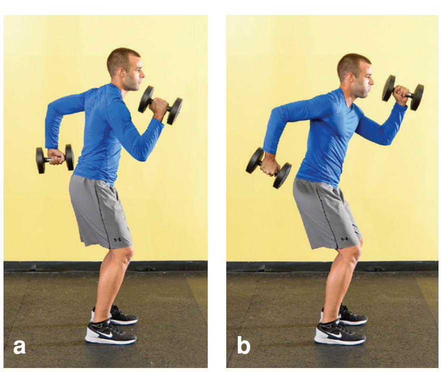
[4] **JC Santana's Triple Threat** includes SB bridge, SB leg curl, and SB hip lift (all double leg to single leg). These exercises improve hamstring strength and are effective in hamstring rehabilitation.

SB birdge

SB leg curl



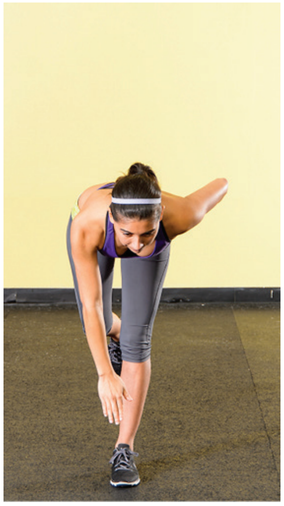
SB hip lift



[5] **Running Curl.** Should be performed with a kind of running action. Stand with knees slightly flexed. Core tight, arms at side with palms facing the body. Flex right arm to 90 degrees, with dumbbell in front of you, while left arm goes back to counterbalance. Perform a running motion with your arms without allowing core or lower body to move.

Running curl: (a) right-arm flex; (b) left-arm flex.

The Exercises (Conditioning)


Single-leg CLA anterior reach

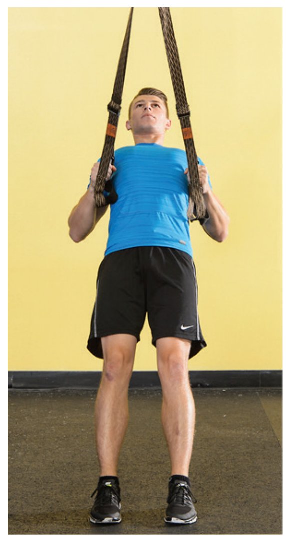

DB or KB cross overhead press


SB hands-on-ball push-up


45-degree calf pump


Single-leg squat

BP push–pull


Recline pull (row)


45-degree wall run

Additional Warm-Up

45-degree calf pump: 2 x 30 sec.
45-degree wall run: 2 x 30 sec.

The How

If your fitness level is high, you can start with any week that feels comfortable and repeat the week as many times as necessary to create a strong base of training.

Core 2

Triple Threat (weeks 6-10)
Running Curl: 2 or 3 x 10 to 20 per arm
Ropes alternating up and down: 2 or 3 x 10 to 20 per arm

POWER AND POWER ENDURANCE

Perform each quadplex in order and then start the sequence again. Complete for as many sets as indicated. For power, rest 1 minute between exercises and then 1 to 2 minutes between the second and first exercises. For power endurance, do not rest between exercises and then rest 0 to 30 seconds between circuits. Use enough load to make the assigned repetitions challenging while maintaining good form. Unless otherwise specified, use the progression in table 9.12.

TABLE 9.10: Running Sports: Conditioning Quadplexes

The single-leg CLA anterior reach and single-leg squat should be performed on each leg.

Exercise	Week 1	Week 2	Week 3	Week 4
Quadplex 1 1. Single-leg CLA anterior reach 2. DB or KB cross overhead press 3. SB hands on ball push-up 4. 45 degree calf pump (15 sec.)	2 x 10	3 x 10	3 x 15	4 x 10 to 15
Quadplex 2 1. Single-leg squat 2. BP push-pull 3. Recline pull (row) 4. 45 degree wall run (15 sec.)	2 x 10	3 x 10	3 x 15	4 x 10 to 15

The Exercises (Strength)

DB or KB single-leg RDL

BP staggered-stance CLA decline press

MB short diagonal chop

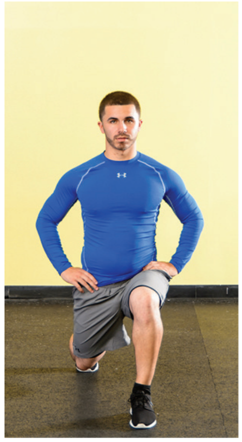
BP staggered-stance CLA compound row

DB horizontal fly rotation

BP staggered-stance alternating row

The Exercises (Power and Power Endurance)

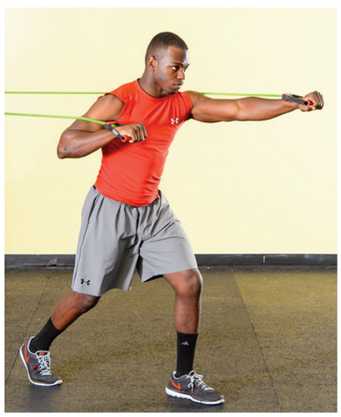

Bodyweight double-leg squat


Bodyweight alternating lunge


Alternating split jump


Squat jump


Bodyweight push-up


BP staggered-stance alternating press


BP staggered-stance fly


Explosive push-up


BP row


BP staggered-stance bent-over alternating row


BP swim


MB overhead slam

TABLE 9.11: Running Sports: Strength Triplexes

The DB or KB single-leg RDL should be performed on each leg.

Exercise	Week 1	Week 2	Week 3	Week 4
Triplex 1 1. DB or KB single-leg RDL 2. BP staggered-stance CLA decline press 3. MB short diagonal chop	2 x 6	3 x 6	3 x 4	4 x 4
Triplex 2 1. BP staggered-stance CLA compound row 2. DB horizontal fly rotation 4. BP staggered-stance alternating row	2 x 6	3 x 6	3 x 4	4 x 4

Warm-Up

45-degree calf pump: 2 or 3 x 45 to 60 sec.
45-degree wall run: 2 or 3 x 45 to 60 sec.
Runner's reach: 2 x 10 to 20
Slide running: 2 x 10 per side

The How

If your fitness level is high, you can start with any week that feels comfortable and repeat the week as many times as necessary to create a strong base of training.

SUPPLEMENTAL CORE

Triple Threat (weeks 11-15) for power
Triple Threat (weeks 16-20) for power endurance
Running Curl: 2 or 3 x 10 to 20 per arm
Ropes alternating up and down: 2 or 3 x 10 to 20 per arm

Offering strength, endurance, power, and sport-specific exercises and programming, ***Functional Training*** is a comprehensive resource for every athlete, coach, and athletic trainer. It's now available in bookstores everywhere, as well as online at HumanKinetics.com.

TABLE 9.12: Running Sports: Power and Power-Endurance Complexes

Exercise	Week 1	Week 2	Week 3	Week 4
POWER*				
Meta complex 1 (JC Leg Crank)	2 sets	2 sets	3 sets	3 sets
Bodyweight double-leg squat	x 24	x 24	x 24	x 24
Bodyweight alternating lunge	x 12 per leg	x 12 per leg	x 12 per leg	x 12 per leg
Alternating split jump	x 12 per leg	x 12 per leg	x 12 per leg	x 12 per leg
Squat jump	x 12	x 12	x 12	x 12
Meta complex 2 (JC Meta Chest 1.0)	2 sets	2 sets	3 sets	3 sets
Bodyweight push-up	x 20	x 20	x 20	x 20
BP staggered-stance alternating press	x 20 per leg	x 20 per leg	x 20 per leg	x 20 per leg
BP staggered-stance fly	x 10 per side	x 10 per side	x 10 per side	x 10 per side
Explosive push-up	x 10	x 10	x 10	x 10
Meta complex 3 (JC Meta Back)	2 sets	2 sets	3 sets	3 sets
BP row	x 20	x 20	x 20	x 20
BP staggered-stance bent-over alternating row	x 20 per arm and leg	x 20 per arm and leg	x 20 per arm and leg	x 20 per arm and leg
BP swim	x 20	x 20	x 20	x 20
MB overhead slam	x 10	x 10	x 10	x 10
POWER ENDURANCE**				
Meta complex 1 (JC Leg Crank)	2 sets	2 sets	3 sets	3 sets
Bodyweight double-leg squat	x 24	x 24	x 24	x 24
Bodyweight alternating lunge	x 12 per leg	x 12 per leg	x 12 per leg	x 12 per leg
Alternating split jump	x 12 per leg	x 12 per leg	x 12 per leg	x 12 per leg
Squat jump	x 12	x 12	x 12	x 12
Meta complex 2 (JC Meta Chest 1.0)	1 to 2 sets	1 to 2 sets	2 sets	2 sets
Bodyweight push-up	x 20	x 20	x 20	x 20
BP staggered-stance alternating press	x 20 per leg	x 20 per leg	x 20 per leg	x 20 per leg
BP staggered-stance fly	x 10 per side	x 10 per side	x 10 per side	x 10 per side
Explosive push-up	x 10	x 10	x 10	x 10
Meta complex 3 (JC Meta Back)	1 to 2 sets	1 to 2 sets	3 sets	3 sets
BP row	x 20	x 20	x 20	x 20
BP staggered-stance bent-over alternating row	x 20 per arm and leg	x 20 per arm and leg	x 20 per arm and leg	x 20 per arm and leg
BP swim	x 20	x 20	x 20	x 20
MB overhead slam	x 10	x 10	x 10	x 10

*During the power phase, rest 30-60 seconds between each exercise and 1-2 minutes between each circuit. Concentrate on high intensity with each repetition.

**During the power endurance phase, do not rest between each exercise. During weeks 1 and 2, rest 1 minute between each circuit. During week 3, rest only 30 seconds between each circuit. Week 4, try not to rest between exercises or sets.

USATF COACHING EDUCATION

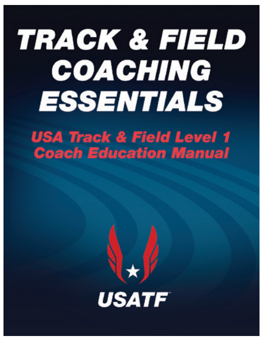
LEVEL 1 SCHOOLS

2016

Feb. 6-7	Alhambra High School – Phoenix, AZ
Feb. 19-21	University of Portland – Portland, OR
Feb. 19-21	Christian Brothers College High School – St. Louis, MO
Feb. 19-21	Benedictine University – Lisle, IL
Feb. 20-21	San Diego State University – San Diego, CA
Mar. 4-6	Public School 9 – New York, NY
Mar. 5-6	Brown & Dorsett Foundation – New Orleans, LA
Mar. 18-20	Villanova University - Villanova, PA
May 21-22	Allen High School – Dallas, TX
May 28-29	Cerritos College – Norwalk, CA
June 4-5	Sylvan Hills High School – Little Rock, AR
June 10-12	Atlantic Sports Health – Morristown, NJ
June 11-12	Thomas Carr High School – Indianapolis, IN
June 17-19	Benedictine University – Lisle, IL
June 18-19	Crossfit/Personal Sport Performance – Longwood, FL
June 18-19	Renaissance High School – Detroit, MI
June 19-21	UNC Greensboro – Greensboro, NC
June 25-26	Edmond Memorial High School – Oklahoma City, OK
June 27-28	Stillwater Senior High School – Stillwater, MN
July 15-17	Nassau Community College – Garden City, NY
July 15-17	Ironwood Throws Facility – Rathdrum, ID
July 16-17	Christopher Newport University – Newport News, VA
July 22-24	Savannah State University – Savannah, GA
July 22-24	Johns Hopkins University – Baltimore, MD
Aug. 6-7	Highline Community College - Seattle, WA
Aug. 13-14	Roosevelt High School – Des Moines, IA
Sept. 30-Oct. 2	Community College of Philadelphia – Philadelphia, PA
Oct. 14-16	Benedictine University – Lisle, IL
Nov. 12-13	Allen High School – Dallas, TX
Nov. 12-13	Cardinal Stritch University – Milwaukee, WI
Nov. 18-20	Eastern Michigan University – Ypsilanti, MI
Nov. 18-20	Johnson & Wales University – Denver, CO
Nov. 19-20	Tennessee State University – Nashville, TN
Nov. 26-27	UNLV – Las Vegas, NV
Nov. 26-27	TBA – Kansas City, MO
Dec. 9-11	Westerville South High School – Westerville, OH
Dec. 16-18	Public School 9 – New York, NY

COACHING EDUCATION

USATF



NEW RECERTIFICATION GUIDELINES FOR USATF LEVEL 1 COACHES

As of January 1, 2015, the Coaching Education Committee has implemented a recertification component for the Level 1 curriculum. Recertification for Level 1 coaches will now be required on a 4-year cycle.

PURPOSE

To introduce new training techniques, and provide the latest materials to enhance the knowledge of Level 1 coaches. As of January 1, 2015, a new textbook and updated curriculum was introduced into all Level 1 schools.

QUALIFYING PERIOD

Certification will be renewable every four years to match the Olympic cycle. To open the new recertification, a "grandfather clause" will be offered from January 1, 2013 through December 31, 2020. This is a special offer to open the recertification guidelines. A Level 1 coach who fails to recertify through the 2020 Olympic quadrennium as of December 31, 2016 will be removed from the USATF coach certification database.

RECERTIFICATION GUIDELINES

To retain a Level 1 certification that is recognized by various educational organizations, including NCACE, USOC, a coach who received their Level 1 certification prior to January 1, 2013, and has not obtained an USATF Level 2 Certification must meet the new recertification guidelines. There are two options for coaches to renew his/her status as a USATF Certified Coach. **Click here** for full explanation of guidelines and how to begin your Recertification.

WHAT THE NEW RECERTIFICATION PROVIDES:

- Second Edition Level 1 textbook (updated content that includes graphics, skill pictures, updates from USATF master coaches)
- Updated school curriculum content, delivered by certified instructors
- USADA modules to provide coaches with best practices for Anti-doping information
- New online exam
- Recertification through December 31, 2020.

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