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Endurance Sports

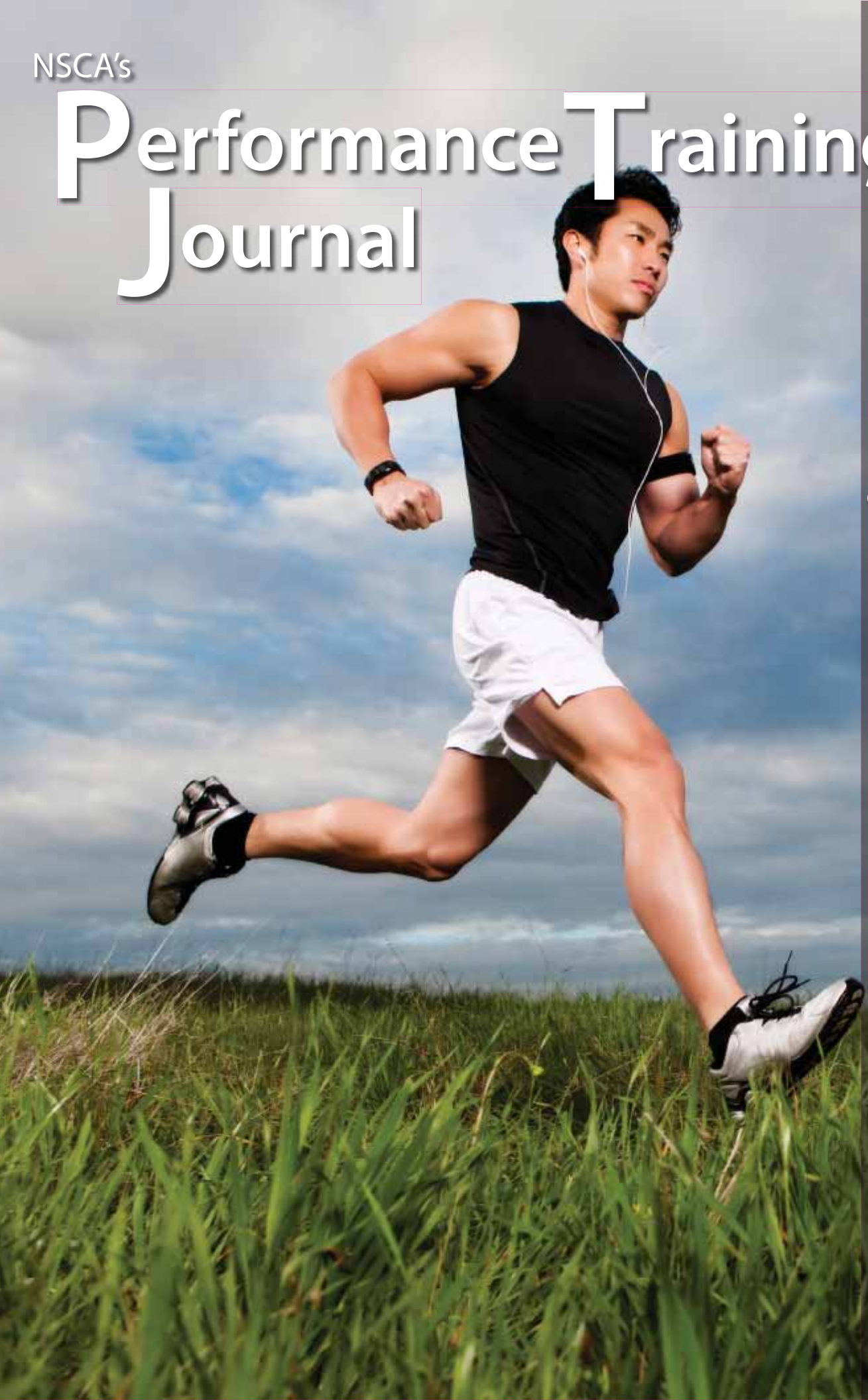
Features

The Evaluation and Prevention of Sudden Cardiac Death among Endurance Athletes: The RACE for LIFE Initiative

*Matt Rhea, PhD, CSCS,*D and Craig Phelps, DO, FAOASM*

Heart Rate Monitoring as a Supplemental Tool for Soccer Player Training Programs

Katie Sell, PhD, CSCS and Marcelo Aller, NSCA-CPT, CSCS



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G. Gregory Haff, PhD, CSCS, FNSCA

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Block Periodization Optimizes Endurance Performance in World-Class Kayakers.

Much debate exists about the optimal method for planning training to induce optimal performance gains in athletic populations. While periodization is accepted as a core concept in this process, debate exists about which models of periodization are the most beneficial. Specifically, the idea that traditional periodization models are not as effective as others has been suggested by several authors. Since there appears to be limitations in the traditional model, a modern trend is toward block modeling. Traditional periodization requires the development of many fitness characteristics simultaneously, while block modeling utilizes concentrated loadings which are applied in a sequential manner. While block periodization is commonly discussed by coaches and sport scientists, very little scientific inquiry has directly investigated the effectiveness of this model in athletes. Recently, researchers from Spain examined the effects of a traditional and block model of periodization. Ten world-class paddlers were utilized in this cross-over design. Assessments were performed at four time points across each annual training plan. Results of the study demonstrated that both models of periodization result in significant increases in maximal aerobic capacity even though the traditional periodization model required 120 more training hours than the block model. Additionally, the block model resulted in increases in paddling speed at peak VO2 peak, paddling power at peak VO2 peak, stroke rate at VO2peak. Overall, these findings suggest the ability of block periodization to optimize performance to a greater extent than more traditional periodization models in advanced athletes. Additionally, the block model was able to optimize performance with significantly less time being dedicated to endurance training as a result of a better ability to maintain training residuals. Therefore, with advanced athletes it has been suggested that block periodization is a more effective model of periodization and additional scientific inquiry is warranted to see if block periodization is a superior model for other sports.

Garcia-Pallares J, Garcia-Fernandez M, Sanchez-Medina L, et al. Performance changes in world-class kayakers following two different training periodization models. *Eur J Appl Physiol*. (in press)

Combining Resistance and Endurance Training Improves Tactical Operational Performance.

When looking at tactical operators, such as soldiers and police officers, there is a large requirement placed upon manual performance tasks such as lifting and carrying tasks. Recently, more women have begun to work in these areas and physical performance may occur in response to their specific strength levels. Because muscular strength has been suggested to impact tactical performance it may be warranted to include strength training in the preparation of tactical operators. Recent researchers from the US Army Research Institute, in conjunction with the University of Connecticut, examined the effects of resistance training, endurance training, and combined resistance training and endurance training on performance. Fifty-six women were randomly assigned one of four training interventions each of which lasted eight weeks: 1) endurance training, 2) resistance training, 3) combined training, and 4) control training. Each of the training interventions (endurance, resistance and combined training groups) exercised on three non-consecutive days. Specifically, the endurance group performed a combination of steady state aerobic exercise and high-intensity interval training. The resistance training group performed a daily undulating resistance training program in which Mondays required 3 x 12RM, Wednesday required 3 x 8 – 10RM, and Friday required 3 x 6 – 7RM. The combined group performed both training interventions on the same day of the week, while the control group performed no exercise training. Results indicated that the highest gains in strength were noted for the resistance training group while the endurance group produced the least gains in strength. Strength gains demonstrated the following pattern: strength training > combined > endurance > control. While the following pattern was noted for improvement sin maximal aerobic capacity: combined > endurance > resistance > control. Additionally, the obstacle course and drag test demonstrated the following pattern of improvement: combined > resistance > endurance > control. Ultimately, it was determined based upon this data that tactical operators were best prepared for their jobs through the use of a combined resistance and endurance training program. While the data generated by this study is interesting, more studies are necessary in order to determine the optimal integration of training factors for tactical operators.

Hendrickson NR, Sharp MA, Alemany JA, et al. Combined resistance and endurance training improves physical capacity and performance on tactical occupational tasks. *Eur J Appl Physiol.*(in press)

High-Intensity Interval Training Improves Performance and Maximal Aerobic Power in Alpine Skiers.

Alpine skiing is a sport which requires high levels of technical skill, aerobic and anaerobic power and capacity, as well as leg strength. There are numerous methods that can be used to address these issues. Recently, the use of high-intensity intervals has been suggested as a method for stimulating significant performance improvements. Recently, researchers from Switzerland examined the effects of 15 high-intensity interval session performed in an 11-day period. Sessions consisted of four 4-minute high-intensity intervals performed on a cycle ergometer or a ski-specific obstacle course. Participants exercised to 90 – 95% of maximal heart rate separated by 3-minute recovery periods. Training sessions were blocked into three 3-day periods in which ergometer training was undertaken four times, while an obstacle course was performed once. The interval training intervention resulted in a significant 6% increase in maximal aerobic power, a 5.5% increase in relative peak power output, and 9.6% increase in power output at the ventilator threshold. The results of this study suggest that short term blocks of intensified interval training result in increased markers of endurance performance which may be useful if applied appropriately in a periodized training plan.

Breil FA, Weber SN, Koller S, et al. Block training periodization in alpine skiing: effects of 11-day HIT on VO_2max) and performance. *Eur J Appl Physiol*. (in press)

High-Intensity Interval Training Induces Improvements in Endurance Performance.

Recent evidence suggests that high-intensity interval training results in significant metabolic and performance adaptations that are similar to those seen in classic endurance training modalities. Many of the studies that support this contention have used all-out or maximal effort activities to induce these benefits. While this model appears to be efficient and effective, the intensities employed may not be well tolerated by most individuals. Therefore, recent research from McMaster University in Canada examined the effects of two weeks of interval training performed at the power output achieved at maximal aerobic power. A total of 8 – 12 60-second intervals each separated by 75 seconds of recovery were performed every other day for two weeks. A total of six training sessions were completed for a total time commitment of 2 – 2.5 hours or ~20 – 29 minutes per session during the 2-week training period. This training intervention resulted in a significant improvement in time to complete 50kj and 750kj of cycling performance. Additionally, biopsy data revealed significant increases in mitochondrial enzyme activities. Specifically, cytochrome c oxidase increased by 29% and citrate synthase increased by 16%. Additionally, there was an increase in muscle glycogen stores and GLUT 4 transport protein concentrations. There was also an increase in mitochondrial biogenesis regulators which suggests that improvement in mitochondrial function has occurred. As a whole, this study demonstrated remarkable improvements in endurance performance as well as changes to the mitochondrial capacity with a minimal amount of training time. Therefore, it appears that high-intensity intervals offer a reasonable method for inducing significant endurance performance gains. ■

Little JP, Safdar A, Wilkin GP, et al. A practical model of low-volume high-intensity interval training induces mitochondrial biogenesis in human skeletal muscle: potential mechanisms. *J Physiol*. 2010;588(Pt 6):1011 – 1022.

Kyle Brown, CSCS

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Kyle Brown is a health and fitness expert whose portfolio includes everything from leading workshops for Fortune 500 companies and publishing nutrition articles in top-ranked fitness journals, to training celebrity clientele—from pro athletes to CEOs to multiplatinum recording artists. Kyle's unique approach to health and fitness emphasizes nutrition and supplementation as the foundation for optimal wellness. After playing water polo for Indiana University, as well as in London, Kyle became involved in bodybuilding and fitness for sport-specific training. Kyle is the creator and Chief Operating Officer for FIT 365—Complete Nutritional Shake (www.fit365.com).

The Benefits of Walking Lunges for Endurance Athletes

Now that resistance training is becoming standard protocol for nearly all athletes, it's time to evolve into sport-specific resistance training programs. Endurance athletes should not train like bodybuilders, as a plan focused on gaining muscle mass can actually be counterproductive. Instead, dynamic, sport-specific exercises that involve multiple muscle groups and core stability, like the walking lunge, should be a fundamental component of any successful lower-body workout.

The walking lunge is one of the most beneficial exercises for endurance athletes as it stresses joint mobility, strength, flexibility, core, and challenges the cardiovascular system. Mobility of the ankle, hip, and knee joints are required to maintain perfect alignment as well as to maintain stability. Flexibility is involved as the walking lunge creates a strong hip flexor stretch while working the quads, glutes, hamstrings, calves, and tibialis anterior. Walking lunges can be used for improving hamstring strength and running speed in athletes including young soccer players (1). This exercise can create more hip flexibility and mobility. Moreover, unlike traditional stable resistance training movements, walking lunges challenge your balance while engaging small muscles that are used while performing bilateral lower limb exercises like running or cycling.

How to do Walking Lunges

Begin by standing up straight, and take a large step forward with your right leg, striking with your heel first, bending both knees so that your front knee is aligned over your ankle and the back knee comes close to the floor. Your back heel is lifted off the floor. As your back knee is heading down to and almost touches the floor, push yourself up with your back left leg, forcing the weight of your body through your right heel, simultaneously bringing your left foot together with your right foot. Continue alternating legs for 20 steps without pausing.

As you become more advanced, you can transform the walking lunge into an even more dynamic movement. Variation includes the walking lunge with a twist. To add resistance, you can hold a medicine ball or dumbbells. There are also walking lunges into a medicine ball press, walking lunges into a dumbbell bicep curl, and walking lunges into a squat jump to name a few. Overall, the most important factors are maintaining a strong core while focusing on joint mobility, strength, and flexibility. ■

1. *Journal of Strength and Conditioning Research*: May 2009 - Volume 23 - Issue 3 - pp 972 – 978 doi: 10.1519/JSC.0b013e3181a00d98

The Evaluation and Prevention of Sudden Cardiac Death Among Endurance Athletes: The RACE for LIFE Initiative

Matthew R. Rhea, PhD, CSCS,*D and Craig Phelps, DO, FAOASM

In the fall of 2007, during the US Olympic Men's Marathon Trials in New York City, Ryan Shay collapsed and died without warning. Apparently healthy and one of the most highly trained and conditioned endurance athletes on the planet, there was little warning or reasoning to explain his death. It was later determined his death was caused by a heart abnormality but little additional information was discovered that might help us understand why the fatal cardiac event happened or how we might have been able to prevent it. In October 2009, three men, ages 26, 36, and 65, died during or shortly after running the Detroit marathon (5). These deaths represent a rare, but tragic and devastating, occurrence among endurance sport participants. Research, education, and personal review are needed in an effort to prevent as many deaths as possible.

Sudden cardiac death among endurance athletes, or during endurance exercise/events, is quite uncommon. One investigation (1) showed that .006% of endurance athletes experienced adverse cardiac events during, or shortly after, endurance sport participation. While occurrences are rare, and the benefits of regular cardiovascular exercise generally outweigh the risks of cardiac complication (2) successful intervention of even one preventable death is well worth our investment in educational and prevention efforts. Endurance athletes can take added precautions to reduce their risk of sudden cardiac death by conducting regular personal health inventories, and do their part in preventing some adverse reactions to endurance training and/or performance, ensuring safe and enjoyable participation in their chosen sports.

There may be no substitute for a regular, thorough history and exam by a physician, preferably one familiar with sudden cardiac death among athletes, to ensure any identifiable risk factors are identified and addressed. Such an exam is strongly suggested for all levels of competitive endurance athletes on a yearly basis, even if the athlete is asymptomatic or has high fitness levels. It is strongly recommended that high school and collegiate sports programs work with their physician and their athletes to ensure that an appropriate history and exam is being conducted and any risk factors addressed.

Unfortunately, generally the earliest symptom of a cardiac problem among endurance athletes is sudden death. The identification of the underlying pathology suggests participation in the sport itself is often not the cause of death, rather a trigger of pre-existing abnormalities (2). Efforts are needed to identify those abnormalities prior to tragic expression during sport or training. As work continues to more accurately predict or identify the likelihood of sudden cardiac death, we should consider some of the potentially detectable risk factors for cardiac injury. They include (2):

- Any cardiovascular condition
- Inherited cardiomyopathy
- Abnormal heart rhythm
- Connective tissue disorder
- Aortic dysfunction
- Hypertension
- Abnormal heart rate for age
- Abnormal ECG
- Family history of sudden cardiac death, especially <50 years of age
- Lipid abnormalities
- Drug use or abuse

about the AUTHOR

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Craig Phelps, DO, FAOASM is currently the Provost of A.T. Still University's Mesa, Arizona health sciences campus. He is a member of several key professional societies and associations, including the American Osteopathic Association and the Society of NBA Team Physicians.

- Sickle cell disease or trait
- History or symptoms of fatigue, chest pain, shortness of breath
- Recent or current infection

As part of the RACE for LIFE Initiative, a research and educational program sponsored by the RACE Rx Academy of Exercise Sciences, a brief questionnaire has been created in an attempt to identify some of the risk factors related to adverse cardiac events among endurance athletes. This questionnaire was developed by a group of health care professionals, exercise scientists, coaches, and endurance athletes. While it was not designed to be the sole source of risk evaluation, the questionnaire can be used by organizers of endurance events or by individual athletes to begin examining participation risk. It is our hope this list of questions may prompt athletes to seek medical evaluations if they have an elevated risk or health history that may suggest the need for further preventative measures.

There are also several preventable issues that may trigger a serious cardiac event during endurance exercise or competition. Overexertion and heat-related illnesses are two factors that may be controllable and heavily influenced by preventative measures. The available evidence indicates there is an increased risk of acute coronary event mainly in individuals who do not exercise regularly prior to the endurance event (3). It is recommended that individuals participate in consistent, periodized exercise training for at least 6 months prior to participating in an endurance event. Many participants, mainly recreational athletes, may not train sufficiently leading up to an endurance event. For these individuals, the stress of the event is heightened as their relative work intensity may be much higher, and their physiological systems less tolerant, during the event. Others, usually highly driven competitive athletes, may train excessively prior to an event resulting in over-reaching or overtraining, a state that results in less than optimal performance and potentially elevated risk for an adverse cardiac event. Both groups would benefit from a progressive, periodized training regimen leading up to the competition.

Dehydration begins to place the heart in a compromised position as it attempts to handle the physiological demands of endurance exercise. One of the physiological changes that occur as an athlete becomes dehydrated is a reduction in blood volume. With less blood volume, specifically plasma volume which is primarily water, blood viscosity increases (gets thicker). Thicker blood is more difficult to circulate requiring the heart to contract with much greater force with each beat; and more often each minute. These demands can result in overexertion on the cardiac muscle, even at workloads that would not commonly be considered risky. Electrolyte imbalances may also put endurance athletes at risk of sudden cardiac death.

Athletes can reduce their risk for adverse cardiac complications by consuming adequate, appropriate liquids before, during, and after endurance events. Proper hydration is influenced by body size, exercise intensity and duration, heat, elevation, and humidity. Basic recommendations for fluid intake include 500ml consumed 2 hours prior to exertion, followed by another 500ml about 15 minutes prior to prolonged exertion. Consumption of 120 – 180ml every 15 – 20 minutes is then suggested during exertion, especially in hot and humid conditions (4). Water absorption in the gut is aided by the coupled transport of water and glucose. Therefore, the composition of fluids is important for in-competition fluid intake. It is recommended (4) that fluid solutions should contain some carbohydrate (20 – 60 g/L) and some sodium (20 – 60 mmol/L). Most commercial sports drinks contain between 60 – 80 g/L.

In conclusion, it is our hope that the deaths of some our friends, running mates, and associates will spawn a moment of reflection among the endurance community, both to remember those who have suffered tragic and untimely deaths and to consider our own risk potential for cardiac damage during exercise or competition. If we consider our personal risk factors and remind our training mates to do the same, seek regular evaluations from a health care professional, train properly, and ensure that we properly hydrate ourselves, we will be taking significant steps to avoid and identify possible problems before they result in tragic outcomes. ■

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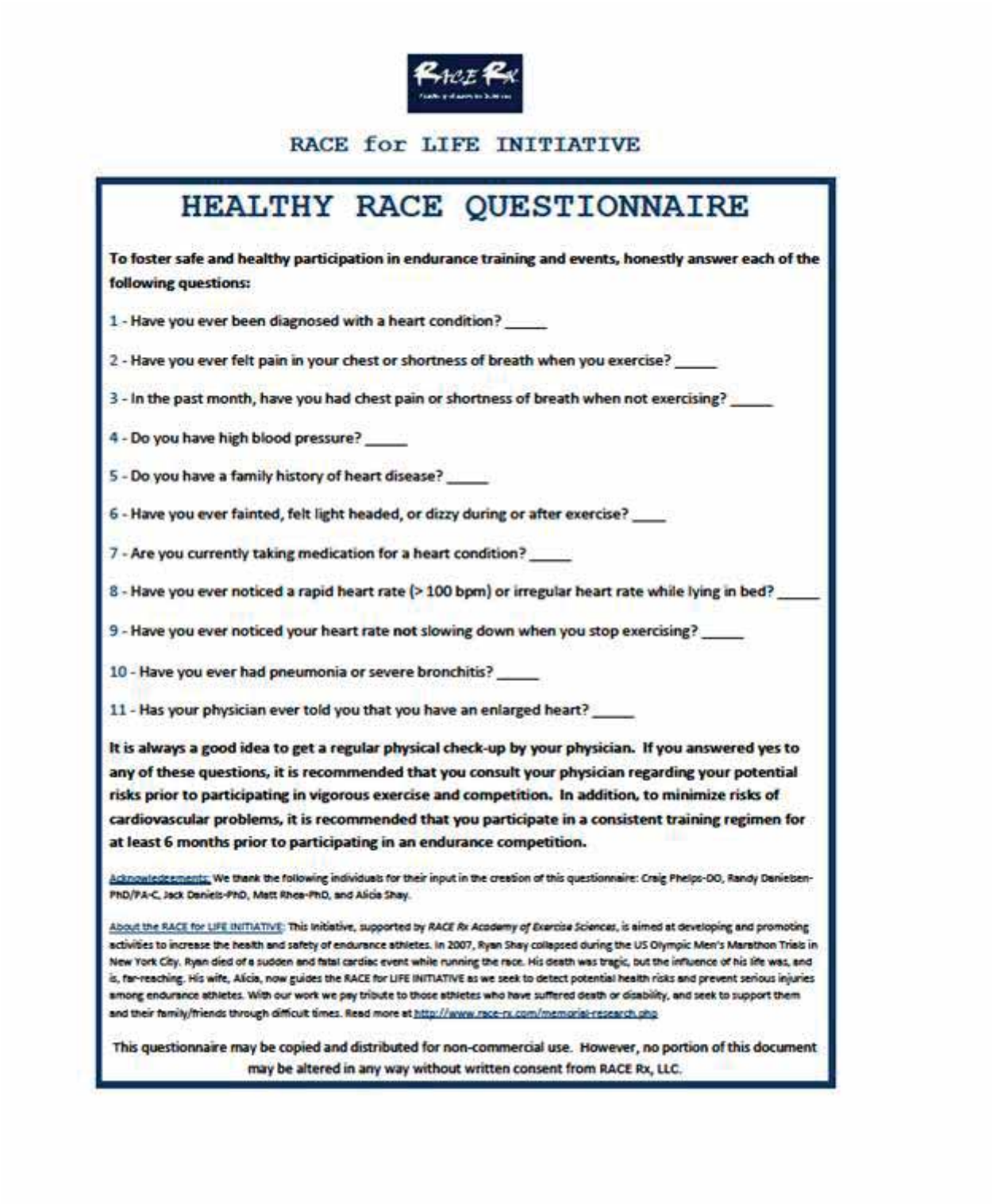
3. Corrado D, Basso C, Schiavon M, and Thiene G.(2006). Does sports activity enhance the risk of sudden cardiac death? *Journal of Cardiovascular Medicine*. 7: 228 – 233.

4. Jeukendrup A and Gleeson M. (2004). In, Sports Nutrition. Human Kinetics: Champaign, IL. P. 189

5. Wilkins K. (2009).Three runners die in Detroit Marathon. Detroit Free Press, October 18.

Figure 1.



RACE for LIFE INITIATIVE

HEALTHY RACE QUESTIONNAIRE

To foster safe and healthy participation in endurance training and events, honestly answer each of the following questions:

1 - Have you ever been diagnosed with a heart condition? _____

2 - Have you ever felt pain in your chest or shortness of breath when you exercise? _____

3 - In the past month, have you had chest pain or shortness of breath when not exercising? _____

4 - Do you have high blood pressure? _____

5 - Do you have a family history of heart disease? _____

6 - Have you ever fainted, felt light headed, or dizzy during or after exercise? ____

7 - Are you currently taking medication for a heart condition? _____

8 - Have you ever noticed a rapid heart rate (> 100 bpm) or irregular heart rate while lying in bed? _____

9 - Have you ever noticed your heart rate not slowing down when you stop exercising? _____

10 - Have you ever had pneumonia or severe bronchitis? _____

11 - Has your physician ever told you that you have an enlarged heart? _____

It is always a good idea to get a regular physical check-up by your physician. If you answered yes to any of these questions, it is recommended that you consult your physician regarding your potential risks prior to participating in vigorous exercise and competition. In addition, to minimize risks of cardiovascular problems, it is recommended that you participate in a consistent training regimen for at least 6 months prior to participating in an endurance competition.

Acknowledgements: We thank the following individuals for their input in the creation of this questionnaire: Craig Phelps-DO, Randy Denieben-PhD/PA-C, Jack Daniels-PhD, Matt Rhea-PhD, and Alicia Shay.

About the RACE for LIFE INITIATIVE: This initiative, supported by *RACE Rx Academy of Exercise Sciences*, is aimed at developing and promoting activities to increase the health and safety of endurance athletes. In 2007, Ryan Shay collapsed during the US Olympic Men's Marathon Trials in New York City. Ryan died of a sudden and fatal cardiac event while running the race. His death was tragic, but the influence of his life was, and is, far-reaching. His wife, Alicia, now guides the RACE for LIFE INITIATIVE as we seek to detect potential health risks and prevent serious injuries among endurance athletes. With our work we pay tribute to those athletes who have suffered death or disability, and seek to support them and their family/friends through difficult times. Read more at http://www.race-rx.com/memorial-research.php

Figure 2.

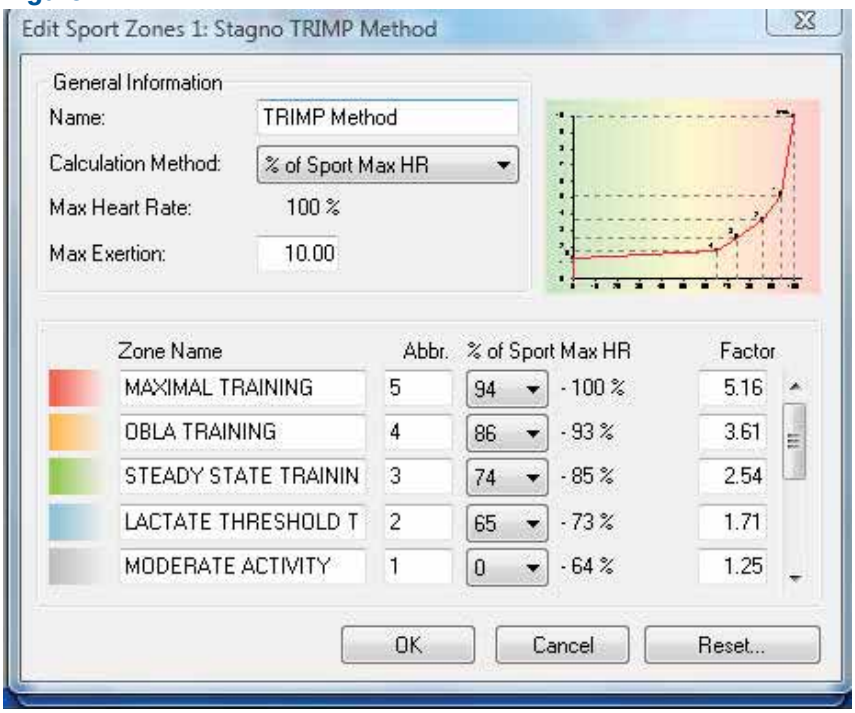


Figure 3.

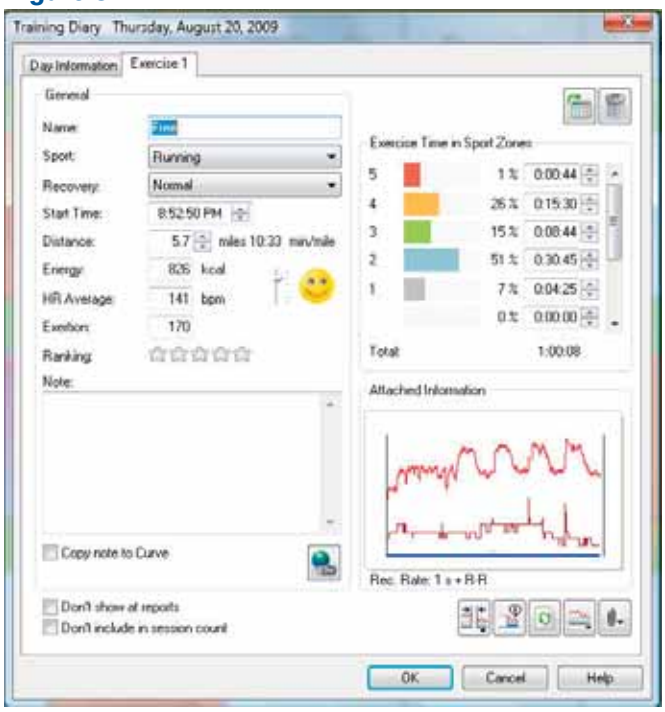


Figure 4.

Heart Rate Monitoring as a Supplemental Tool for Soccer Player Training Programs

Katie Sell, PhD, CSCS and Marcelo Aller, NSCA-CPT, CSCS

about the AUTHOR

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In high level soccer (i.e., NCAA, professional level), players may cover 8 – 12 kilometers in a given match, typically through a combination of walking, running, or sprinting (while often in possession of the ball) (1,6). Intensity levels frequently approach and sporadically exceed anaerobic threshold which places a high degree of stress on the cardiovascular system and metabolic (energy producing) pathways in the body. Therefore, in order to excel as a soccer player and withstand these demands on the cardiovascular system during a match (or training session), soccer players need not only sufficient anaerobic capacity, speed, power and strength, but also adequate (certainly higher than average) aerobic fitness and neurological facilitation (3). A fitter player will not only be able to cover more ground and thus respond to changes in ball possession and opposition plays, but they will also be able to recover more quickly from successive sprints and consecutive games often played within days of each other (2). Consequently, greater emphasis is now being placed on designing training programs for specific sports, in this case soccer, to reflect the metabolic and physiologic demands of the sport in a game or competitive setting (4,5,8).

However, the conundrum that often faces soccer players and their conditioning staff is not what intensity to work out at, but how to monitor the intensity so that optimal benefits can be achieved during the competitive season. In the college setting, coaches are faced with additional challenges:

1. Collegiate soccer has a short (often no more than 3 weeks) preseason
2. An early onset of in-season conference games
3. A complete team typically consists of approximately 25 players (a large group to monitor individually).

The purpose of this article is not to present a comprehensive training program. Excellent examples of soccer-specific training programs for the collegiate player have been presented elsewhere (8). The primary emphasis of this article is to describe how we used measures of heart rate to provide feedback during a soccer-specific summer conditioning program for players off-campus.

Different approaches have been used by coaches during training in an effort to stimulate variations in playing intensity experienced by players in typical match play, small group play, and dribbling drills. These have included heart rate and oxygen consumption monitoring, and self-perceived exertion. Heart rate is one of the most common ways in which intensity is prescribed and monitored (4,8). The inclusion of heart rate measures during metabolic conditioning sessions, skills training, drills and scrimmages, can help reproduce training intensity levels reflective of those experienced by the players on the soccer field. Training that includes heart rate monitoring, as opposed to several of the alternative approaches mentioned earlier, also allows for compensation or consideration for the individual needs of each player in his or her efforts to improve overall aerobic capacity and increase anaerobic threshold.

Heart Rate Data as a Training Tool

The potential for using heart rate monitors as a training tool is well established and implemented within soccer conditioning programs throughout the academic year (1,2,8). Heart rate monitoring has been used by numerous college level soccer players to assist with their conditioning to facilitate purposeful training goals, as well in team training sessions to evaluate effort put forth during fitness testing and game play. Traditionally, heart rate monitors

are worn and data is collected during training sessions, but the ability to download and analyze heart rate data after training or when the athlete is exercising independently, is an underreported, yet highly beneficial application of this training tool.

Players from a Division I northeastern soccer program were provided heart rate monitors during their voluntary summer conditioning program to explore the utility and effectiveness of a heart rate driven training program designed to increase aerobic capacity prior to the fall in-season and the utility of heart rate as a feedback tool for a conditioning program in soccer players. In accordance with NCAA and IRB rules and regulations, this data was collected and heart rate and adherence data was fed back to an independent exercise physiologist, not the coaching staff, during the course of the summer. Players were instructed on correct use of both the heart rate apparatus and the accompanying software at this time, and assisted with downloading the necessary software onto their personal laptops. Following a workout wearing the heart rate watch and transmitter, each player was asked to download the heart rate onto their own computer. Players were then able to see if the downloaded exercise bouts adhered to the prescribed intensities within the summer training program, and were also able to email the downloaded files as an attachment for feedback.

A 2-week sample workout program (weeks 6 – 7 of a conditioning program beginning late May and ending with the start of pre-season at the beginning of August) is presented in table 1 for a player with a heart rate maximum (HRmax) of 195 bpm. As with many non-mandatory summer conditioning programs at the collegiate level, an emphasis was placed upon improving aerobic capacity in preparation for the fall "in-season" and anaerobic threshold through soccer-specific training. Each workout began with a dynamic warm-up and ended with an appropriate cool down. Training bouts were accompanied by agility and plyometric drills, but we found that using heart rate to monitor intensity with these drills was not useful, as the drills did not allow for a sustained heart rate, given an all-out or close to maximal effort was prescribed. Therefore, these drills have not been included in table 1. Players were not asked to conduct interval training more than three times per week in order to optimize effort and allow for adequate recovery, and even less in the initial stages of the summer program in order to establish an aerobic (and anaerobic) base on which to build. The summer conditioning program was also designed under the assumption that each player would be playing games or scrimmaging at least twice a week. The sport zones (maximal training, onset of blood lactate/OBLA, steady state training, lactate threshold training, and moderate activity) are weighted for relative contribution to the overall exercise or training bout – this is reflected in the exertion score (see Figure 1). A higher exertion score typically reflects a longer time spent in a sport zone with a higher relative weighting—for soccer players these were zones of a higher intensity, specifically the "maximal intensity," and "OBLA" zones. This presentation of the data was used to provide feedback to the players. Figure 2 illustrates another manner in which the data can be displayed, and it has been this presentation of the information recorded, which was used by the players during the summer conditioning program to compare their actual training data to the prescribed intensity presented in table 1. The heart rate curve displayed in Figure 2 was subsequently used as a visual feedback tool to players and coaches the following in-season to compare responses during progressive training bouts and illustrate improvements in aerobic fitness.

An analysis of fitness scores of players on this team collected in April (end of Spring post-season) and the following August (beginning of Fall pre-season) suggested that those who consistently emailed in for feedback had notable increases in aerobic fitness (as measured by the Yo-Yo Intermittent Endurance Test (7)) relative to those that were not in regular communication and did not use the heart rate apparatus on a regular basis throughout the summer. Irregular or minimal use of the heart rate apparatus did not necessarily imply that no conditioning took place, just that either heart rate monitors were not used, data not obtained, or feedback not sought.

Program Application

The use of a heart rate training apparatus has allowed for the manipulation of training intensities to target a given training emphasis (i.e., improve aerobic capacity) or mimic soccer-specific game intensities. Once the heart rate training data has been downloaded, coaches and players can evaluate the workout via several perspectives and see a breakdown of the workout according to intensity levels, energy expenditure and distance. This allowed for feedback to be given to players in several ways using the visual presentations of the data to help guide player program manipulation and improvement. This proved to be an especially important component of the heart rate training apparatus given that the players were not on campus and the data was sent for feedback via email. Feedback to the player is not only instantaneous when heart rate watches are worn, but heart rate throughout the entire workout session can be recorded automatically and then downloaded for further analysis post-training bout at one's own convenience.

This article outlines the application of an underused training tool for soccer conditioning programs when coach-athlete interaction is restricted. However, throughout the season, coaches can still use these tools to manipulate time spent in heart rate training zones to suit training climate and goals that might vary throughout a given periodization cycle. The heart rate intensity that defines each sport zone can also be changed for the same reason. Figure 1 shows how this data was converted to help visualize time spent in the respective sport zones, total energy expenditure, average heart rate during the training bouts, and overall exertion score for players throughout the summer. This heart rate curve can show maximal and average heart rate, but also identify abnormal patterns not consistent with other players of the same posi-

tion during similar activities. We have since used heart rate measures in this manner with lacrosse teams. This type of analysis may help identify players experiencing unsafe stress responses to a given exercise or conditioning activity, as well as highlight players in need of more physical conditioning due to inadequate physical fitness or lack of sport-specific conditioning.

Feedback from the players suggested these visual tools provided motivation and encouraged adherence to a summer training program. This suggests they can be empowering for the player or athlete in that they can take ownership and responsibility for monitoring his or her own training program, especially in instances where NCAA rules and regulations prohibit coach (be it strength and conditioning or sport-specific) contact. Overall, including some form of heart rate based training program has advantages for coaching staff or conditioning professionals working with soccer players, or other athletes engaged in sports that necessitate sport-specific conditioning to meet both the aerobic and anaerobic demands of their given sport

The research shown in this study using technology to test and train in a program (table 1) was done as a trial and can be modified or substituted with a program that better addresses the conditioning goals of a given program. This was only intended for informational and educational purposes, to further educate teams, athletes and coaches on benefit of sports technology monitoring. In accordance with NSCA recommendations, always consult with your certified strength and conditioning specialist for specific testing and properly applied conditioning programs. ■

Figure 1. Training diary displaying distance, energy expenditure, and heart rate data from exercise bout.

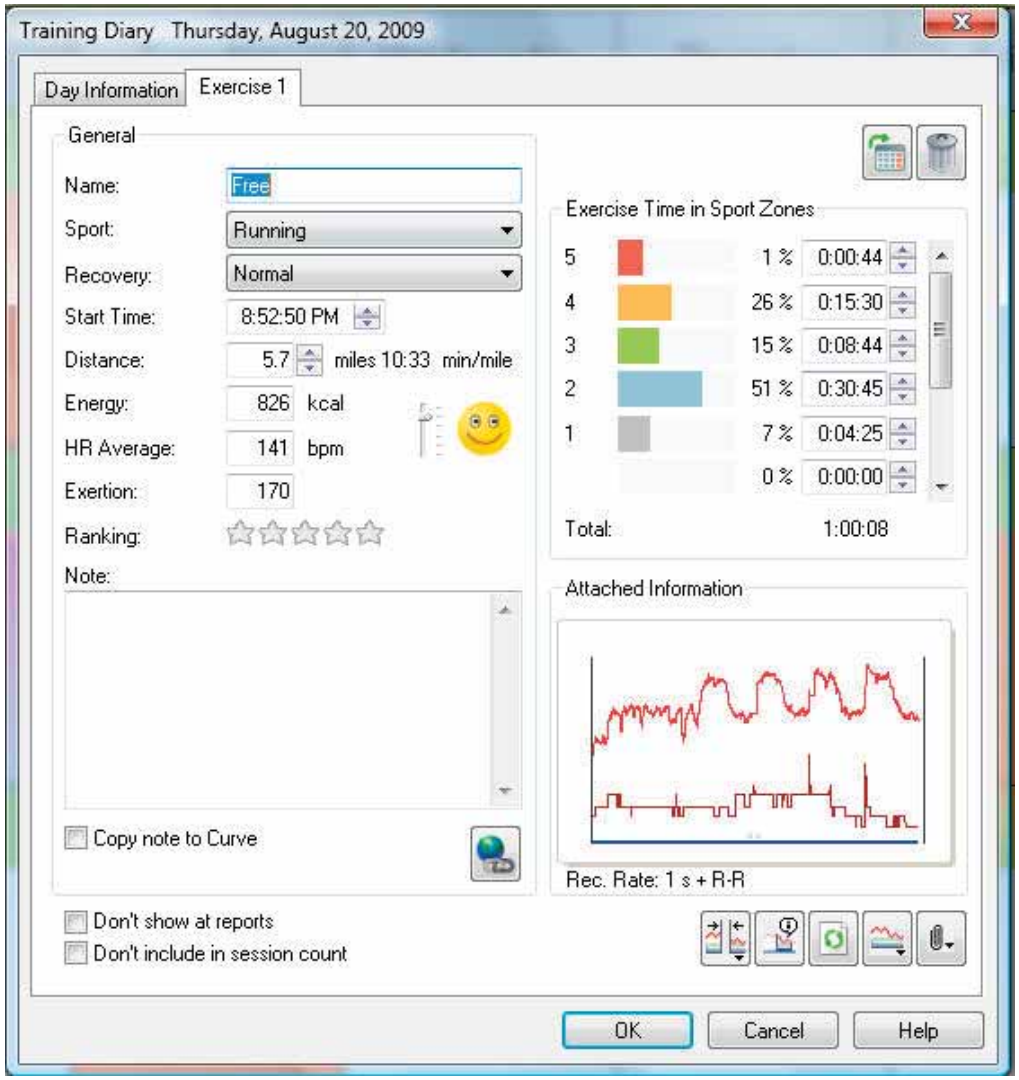

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Figure 2. Athlete's heart rate curve response to workout.

Table 1. Sample Summer Conditioning Program

Week (Day)	Workout	Intensity
6 (1)	4 x 800 m run; 3 min active rest between sets#	156-176 bpm (80-90 %HR_{max})
6 (2)	4 x 200 m; 1 min 30 s active rest between sets#	156-176 bpm (80-90 %HR_{max})
	6 x 100 m; 1 min active rest between sets#	165-185 bpm (85-95 %HR_{max})
6 (3)	4 x 4 min runs; 3 min active rest between sets#	165-185 bpm (85-95 %HR_{max})
7 (1)	3 x 1600 m runs; 3 min 30 s rest between sets	146-165 bpm (75-85 %HR_{max})
7 (2)	4 x 4 min runs; 3 min active rest between sets#	165-185 bpm (85-95 %HR_{max})
7 (3)	4 x 300 m shuttles§; 3 min active rest between sets#	146-165 bpm (75-85 %HR_{max})
	3 x 100 m: 1 min 20 s active rest between sets#	156-176 bpm (80-90 %HR_{max})
	2 x 80 m; 1 min active rest between sets#	All-out effort
7 (4)	6400 m (4 mile) run	136-156 bpm (70-80 %HR_{max})

#Rest period – light jogging no lower than 108 bpm (55% HRmax).

§Shuttle: end-line to midfield and return twice and finish with end-line to midfield run.

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Creatine Credibility

about the AUTHOR

Debra Wein, MS, RD, LDN, CSSD, NSCA-CPT is a recognized expert on health and wellness and has designed award winning programs for both individuals and corporations around the US. She is president and founder of Wellness Workdays, Inc., (www.wellnessworkdays.com) a leading provider of worksite wellness programs. In addition, Debra is the president and founder of partner company, Sensible Nutrition, Inc. (www.sensiblenutrition.com), a consulting firm of RD's and personal trainers, established in 1994, that provides nutrition and wellness services to individuals. Her sport nutrition handouts and free weekly email newsletter are available online at www.sensiblenutrition.com.

One of the most popular nutrition supplements in use today is creatine. Whether in the gym or on the football field, creatine use has become increasingly popular among athletes and the general public. But what are the benefits and possible risks associated with this supplement? Here are a few facts athletes should know about creatine.

What is Creatine and How Does it Work?

Creatine is a naturally occurring amino acid produced by the kidneys and liver. It is transported in the blood to muscles to be used for energy. Typically, the body manufactures about 1 to 2 grams of creatine each day. Creatine can also be obtained from food and individuals who eat meat can consume about 1 to 2 grams of creatine through diet (1). So why take a creatine supplement if it is produced endogenously and can be obtained through food?

Research indicates that additional creatine may be instrumental in allowing muscles to make more adenosine triphosphate (ATP), which stores and transfers energy in muscle cells. This additional ATP is thought to be particularly useful during activities that require explosive bursts of energy, like weight lifting and sprinting (1). In short, creatine may help muscles and nervous tissue recover energy more quickly allowing athletes to increase the duration and intensity of their training.

Creatine is most commonly taken in a powder form known as creatine monohydrate. Many creatine users follow a loading phase in which 20 to 25 grams of creatine are consumed once a day for 5 to 10 days. This phase is followed by a maintenance phase wherein the athlete consumes 2 to 5 grams daily. Alternatively, the same levels of creatine can be achieved by supplementing 3 grams daily for 28 days (2).

Does Research Support Creatine Use?

A large number of scientific studies suggest that creatine does have a positive effect on performance during exercises that require high intensity, short bursts of energy and may also increase lean body mass size in young men. However, these studies saw no evidence that creatine supplementation improved performance in women and older adults. In addition, creatine has not been shown to be effective in improving activities that require consistent aerobic output, like running and swimming (3,4).

It is also important to note that studies have not examined the effects of creatine on subjects ages 18 to 19, an age group that now makes increasing use of this supplement. The American Academy of Pediatrics (AAP) reports that there is virtually no data supporting the safety of performance-enhancing substances in the youth population and for this reason, condemns the use of all of these substances, including creatine, among children and adolescents (5).

Potential Risks

Creatine has been found safe for long term use in healthy adults at doses of 5 grams/day (6). However, higher doses of creatine are associated with several side effects including stomach cramps, muscle cramps, nausea and diarrhea (7). Additionally there have been case reports of kidney and liver damage associated with the use of creatine. For this reason, it is recommended that individuals with existing kidney or liver problems not take creatine (8,9).

Users of creatine should also be aware of product safety issues. Since creatine is classified as a dietary supplement, it is not regulated by the FDA. This means supplement manufacturers do not have to conform to the same safety standards that drug manufactures must adhere to. Of particular concern is the cross-contamination that may occur in facilities that also manufacture performance-enhancing drugs, or anabolic steroids (1). Consumer Labs, an independent testing facility of nutrition products, has approved several powdered creatine products including, EAS, Everlast, GNC Pro Performance, Muscletech and Precision Engineered. Liquid creatine products by Muscle Marketing USA and Vitol Creatine were not approved as impurities or no creatine was found in these products (10).

Bottom Line

Research indicates that creatine can be an effective supplement for improving performance involving short burst of high-intensity activities and in building lean muscle mass. For this reason, creatine may be a useful part of some athletes' training regimen. Dietary supplements, like creatine, will never substitute for well-designed and consistent nutrition and exercise programming. ■

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Basic Core Exercises for Endurance Athletes

about the **AUTHOR**

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Participating in an endurance sport suggests that one must be able to compete for prolonged periods of time. Obvious endurance sports include long distance running and cycling. In addition to the aforementioned, many other sports require athletes to possess some degree of aerobic fitness and muscular endurance. Athletes who participate in sports such as tennis, basketball, golf, and soccer find themselves competing for long periods at a time. An athlete who possesses superior aerobic fitness and muscular endurance is bound to have an advantage over his or her competitor near the end of a game or match.

Possessing adequate muscular endurance, especially of the "core," may also help to reduce injury risk. An athlete who lacks the necessary muscular endurance capacity to perform at a high level late into a game or match may be increasing his or her risk of injury. For example, a golfer may compensate for a lack of core strength by increasing the degree of activity of his or her shoulder muscles. Over time, these increased forces at the shoulder may overstress the tissues causing an injury. The purpose of this article is to introduce the reader to a few basic core exercises that will help to improve one's muscular endurance of the core.

Side Plank (aka Side Bridge) Exercise

One should assume the pose demonstrated in figure 1. The head, torso, and pelvic region should be in alignment and the legs may be held as shown or with one foot placed on top of the other. Once in the pose, perform an abdominal brace (an isometric contraction of the abdominal muscles) and hold the position for the desired period of time (table 1).

When the side plank exercise is no longer challenging, progress to the side plank with hip abduction exercise (figure 2). Again, assume the same position as previously mentioned. Next, raise the top leg (hip abduction) off of the bottom leg while maintaining the correct plank position. Perform sets and repetitions on each side of the body.

Front Plank (figure 3)

One should assume a prone position with the body supported by the feet and the forearms. Alignment of the head, torso, hips, and legs should be maintained. It is not uncommon for one to raise the buttock region higher than the torso and the legs. Correct this technique error by lowering the hips. One will notice that it will feel more difficult to maintain the proper plank posture as the hips are brought into alignment. Next, perform an abdominal brace holding the position for the desired number of repetitions.

To increase the challenge of this exercise, lift one leg at a time while maintaining the front plank pose (figure 4). The extension of the leg should be generated by the gluteus maximus muscle (buttocks), not from the low back.

Take Home Message

These are only a few core exercises that may be performed to improve one's muscular endurance. I recommend that all athletes incorporate core exercises that both maximize endurance capacity and mimic sport-specific positions. A certified strength and conditioning specialist will be able to advance your core exercise routine. ■

Table 1. Sets and Repetitions for Basic Core Exercise Routine

Exercise	Sets	Repetitions	Hold Time	Rest Time
Side Plank	1 – 2 sets, each side	2 – 3 reps, each side	10 –30 seconds	30 seconds
Side Plank with Hip Abduction	1 – 2 sets, each side	20 – 30 leg lifts, each side	1 – 2 seconds at the top of the lift	60 seconds
Front Plank	1 – 2 sets, each side	2 – 3 reps	10 – 30 seconds	30 seconds
Front Plank with Hip Extension	1 – 2 sets, each side	20 – 30 leg lifts, each side	1 – 2 seconds at the top of the lift	60 seconds

Figure 1. Side Plank

Figure 2. Side Plank with Hip Abduction

Figure 3. Front Plank

Figure 4. Front Plank with Hip Extension

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Suzie Tuffey-Riewald received her degrees in Sport Psychology/ Exercise Science from the University of North Carolina —Greensboro. She has worked for USA Swimming as the Sport Psychology and Sport Science Director, and most recently as the Associate Director of Coaching with the USOC where she worked with various sport national governing bodies (NGBs) to develop and enhance coaching education and training. Suzie currently works as a sport psychology consultant to several NGBs.

Endurance Sports FAQs

As a former distance runner, I was excited about writing a column for this Endurance Sports issue. Over several weeks, I generated a long list of potential topics but struggled in choosing one topic as they all seemed relevant. So, instead of choosing only one topic, I have opted to address several. The topics discussed below represent the more common questions asked by endurance sport athletes and coaches (Be sure to email mindgamescolumn@nsca-lift.org if you have a question of your own that wasn't addressed).

"I know imagery can be valuable in preparing for a competition. But, how can I use it for a triathlon where the competition lasts over 2 hours?"

Yes, it would be tough to effectively visualize (see, feel, experience) the entire 2-hour race. It would be quite a time commitment and quite a test of your mental fortitude. Most athletes would lose their focus within a few minutes and give up—which would be unfortunate as imagery can be a very effective tool (as you recognize). Think about using imagery in a different way than say a gymnast, diver or athlete who is executing a specific skill in a short period of time may use it. For an endurance athlete, visualizing the entire competition is probably not necessary. Instead, identify the critical moments, phases or sections of the race. Then, visualize these "snapshots of the competition" to facilitate your preparation and performance. The transition from swimming to cycling, the hill at the end of the run or managing the mass start in the swim are examples of critical parts of a race to focus on and prepare for—use imagery to help you do so.

"The cyclists I work with love competing but their motivation in daily training is up and down. What can I do to help? If they gave a more consistent effort in practice I know it would help performance."

It is nice that you are thinking about what you can do (as opposed to leaving it all up to the athlete) as motivation is a function of the person and the environment. There are, in fact, some things you might be able to do to enhance their motivation. A couple suggestions:

Give purpose to each practice session by clearly communicating how the work you are asking them to do will translate to enhanced performance. You know the "why's" behind the training session but it may not be evident to the cyclist so help them see the rationale to enhance their effort and motivation.

Have each athlete set daily training goals related to what she needs to work on to improve riding performance. Depending on the athlete, these goals may be set by the individual or it may be more effective for you to identify the goals.

Be creative—the same workload can be accomplished in a variety of ways; work to "spice up" training rides to keep things fresh.

Talk to the athletes about the intensity they bring to training on a daily basis. Communicate to them the importance of a strong effort and brainstorm as a group ways to facilitate their daily motivation and intensity.

"Is it best to distract myself so I don't think about the pain?"

First, let's refer to what you are feeling as discomfort which has a more positive connotation than pain. Second, to answer your question, it depends. Let me explain. Both dissociative attentional strategies (purposefully distracting oneself as you are talking about) and associative attentional strategies (attending to bodily functions and feelings) have been found to be effective. Furthermore, athletes have reported using both strategies in practice and in competition. In part, the strategy you opt for will be influenced by your objective. It is recommended that athletes looking to stick to an exercise program should use dissociative strategies (listen to music, talk with a friend while running, put together a mental to-do list) to make the exercise more enjoyable. If, for example, you are exercising to manage your weight, distracting yourself from the discomfort is an effective strategy. Alternately, use of associative strategies (attending to breathing rate, awareness of muscle tension or fatigue) tends to be correlated with faster running performance. Given that both strategies are effective, strive to develop both strategies and determine the situations where each is most effective so you can implement them purposefully. ■

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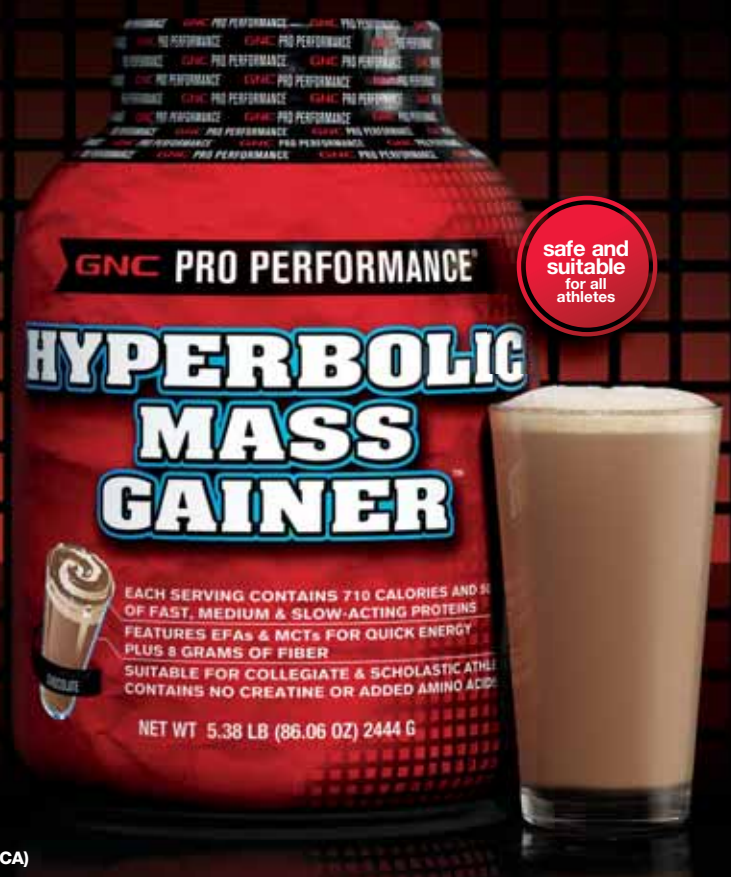

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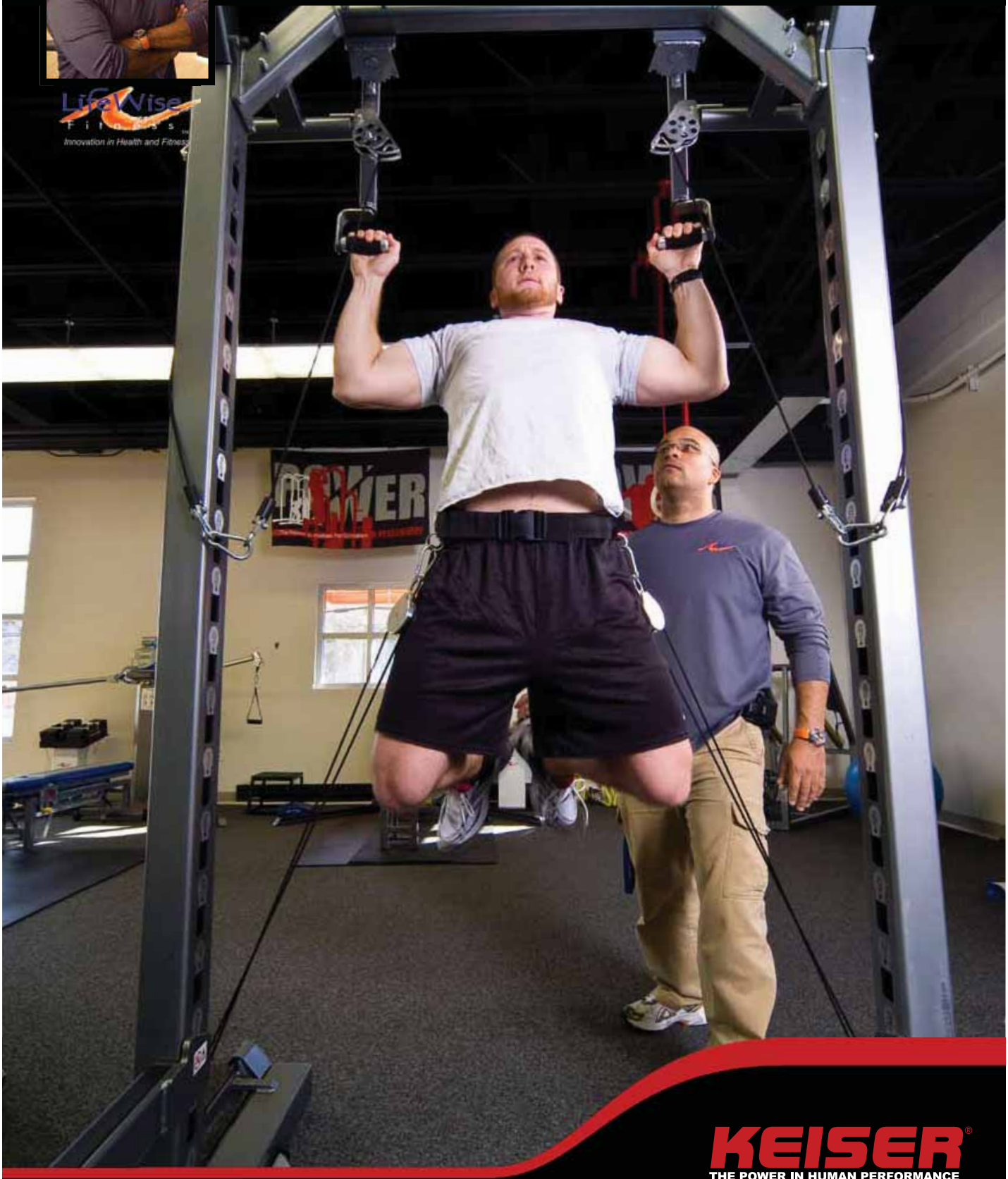

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