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Balance is the Key to Optimizing Athletic Performance, Even When It Comes to Hydration

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In this themed issue, experts are elucidating on training methods to increase athletic performance. Barbara Hogan addresses the topic of overtraining, Dayton Bailey discusses how to make the cycle to run transitions smoother and faster, Nell Rafalovich explores the controversial issues related to concurrent strength and endurance training practices.

As you read the ensuing articles, you will notice a common theme, balance.

This is true not only from a training standpoint but also from a hydration standpoint. As athletes, we have all been taught to take in plenty of fluids. However, if our internal milieu becomes unbalanced, by overhydrating and not maintaining our electrolyte balance, a condition known as hyponatremia or "water intoxication" may occur. This condition is often associated with long distance runners or cyclists who hydrate aggressively with hyposmolar fluids during exertion. The most likely exercise scenario conducive to the development of hyponatremia involves water overload during continuous high-intensity, ultramarathon-type exercise of 6- to 8-hours duration, particularly in hot weather. However, it can also occur in events lasting less than 4 hours, such as a standard marathon.

As you consume large amounts of water over the course of a day, blood plasma increases, thereby diluting the salt content of the blood. Hyponatremia exists when serum sodium concentration falls below 135 mEq.L-1 A sustained low plasma sodium concentration creates an osmotic imbalance across the blood-brain barrier that causes rapid water influx into the brain. The resulting swelling of brain tissue produces symptoms that generally mirror those of dehydration (apathy, confusion, nausea, and fatigue), however these symptoms may be more severe (seizures, coma, cardiac arrest, even death). The World Health Organization advises that the best combination of electrolytes and energy replacement mixed in 1 liter of water is as follows: 20.0 g Glucose; 3.5g Sodium Chloride; 2.9g Trisodium Citrate; and 1.5g Potassium Chloride. It is also recommended that no more than 1L.h-1 of plain water spread over 15-minute intervals during or after exercise be consumed. Remember balance is the key to enhancing athletic performance.

About the Author

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News you need! Certification Updates

Winter 2006

by: Mike Niederpruem, National Director of Certification and Registry Programs

A New Year With New Opportunities

Welcome to 2006! As most of you know, the Committee on Certification and Registry Boards (CCRB) has been busy converting the ACSM Health/Fitness Instructor® and ACSM Exercise Specialist® exams to computer-based testing. Based on the results of the Beta exams delivered last Fall, the live versions of both exams will be available on February 20, 2006. More importantly, in an effort to optimize access to the exams, both are now available on-demand in English on a world-wide basis. This means that exam candidates can select dates, times, and locations that are most convenient for them from a preparation perspective. Finally, candidates don't have to wait four to six weeks for their results. They now receive their exam results instantly upon completion of the test taking experience. For more information, please visit www.acsm.org/certification/getcertified.htm.

2006 also marks the first year ever that workshops are available for the RCEP credential. The first workshop, successfully held at Henry Ford Hospital (Detroit) in January, had over 25 participants, and the tentative plan is to hold up to three other workshops throughout the rest of the year at different locations across the country. Please stay tuned to future editions of *ACSM's Certified News* or *ACSM's Certified E-News* for additional information on dates and locations.

When was the last time you attended an ACSM workshop? If it was more than a year ago, please note that the new, 7th edition of *ACSM's Guidelines for Exercise Testing and Prescription* came out in 2005. As a result, all ACSM workshops have been updated to reflect new information available in the 7th edition. There is no better time than now to

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Higher, Faster, Stronger… Are Your Clients Overtraining?

Barbara J. Hogan, M.Ed., ACSM Health/Fitness Instructor® certified

In the quest to improve performance, serious athletes, fitness enthusiasts, and recreational athletes frequently push themselves excessively, with the belief that the more they train, the better they will perform. This mentality can eventually lead to overtraining and will likely prevent improvements in performance. Fierce determination for achieving success is certainly an admirable trait. However, success depends not only on a high level of commitment; but it relies on a carefully crafted program organized around the principle of periodization, which includes scheduled loads of training stimuli followed by planned periods of rest to ensure adequate recovery.[3]

This article will address the principles of overload, adaptation, and recovery. Physical performance is enhanced through a repeated process of stimulating the body through exercise, then allowing recovery during which adaptation occurs. During this process, an attempt is made to apply adequate overload to elicit improvement while avoiding overstressing the body. The stimulus-recovery-adaptation principle is firmly grounded in science and can lead to great success when orchestrated properly. Let's take a walk down this well-charted path where success depends on a tenacious approach to details of the principles of training.

Training variables

The following is a collection of variables that are manipulated when setting up a training plan. These include variables such as: number of intervals, choice of activity, intensity level, order of exercise, amount of weight or load, length of activity, frequency of exercise, number of sets performed, number of repetitions, and amount of rest between workouts, etc. Any combination of these variables on any given day can produce uniquely different outcomes. The challenge is in determining the appropriate combination for each participant.

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Principles of training

All well-designed programs incorporate a combination of training variables. For clarity, the following terms are defined as a working glossary.

Progressive overload

A well-designed program is based on the principle of progressive overload. "The principle holds that to maximize the benefits of training, the training stimulus must be progressively increased as the body adapts to the current stimulus. The body responds to training by adapting to the stress of the training stimulus."[12]

By increasing the load (resistance), number of sets to be performed, duration of workouts, running speed, etc., physiologic demands can be intensified. On the other hand, if the amount of stress remains constant, the body will eventually adapt to that level of stimulation and further adaptation will not be necessary. As a result, performance levels will not improve.

ADAPTATION

"The process of adjustment to a specific stimulus."[11]

OVERREACHING

"Refers to a brief period of heavy overload without adequate recovery."[12] Overreaching can actually contribute to short term enhanced performance since it usually lasts no more than two weeks.

OVERTRAINING

"Refers to the point where the athlete starts to experience physiological maladaptations and chronic performance decrements."[12]

OVERTRAINING FROM RESISTANCE TRAINING

Defined "as an increase in training volume and/or intensity of exercise resulting in performance decrements."[2]

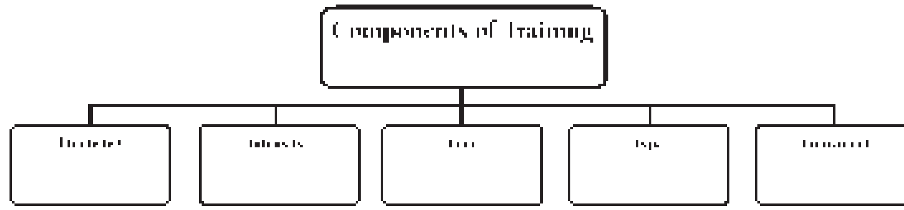
OVERTRAINING SYNDROME (OS)

Persistent underperforming, with or without other accompanying psychological and physical symptoms, despite two weeks of lighter training or complete rest."[2]

Symptoms of overtraining – sympathetic expressions

Sympathetic symptoms of overtraining are "predominant in younger individuals who train for speed and/or power and are believed to develop before the parasympathetic overtraining syndrome."[2] In addition, Lehmann et al[8] reports that sympathetic symptoms include restlessness, excitation, and performance incompetence. According to Fry[2], sympathetic overtraining has been known to cause increased levels of catecholamines, which result in increased heart rate, blood pressure, metabolic rate, and respiration. These cues or symptoms can alert trainers and coaches who work with power and speed athletes or participants; especially if the signs are out of character. For example, a usually calm person may become unusually excited or restless.

Figure 1 - Components of Training



Symptoms of overtraining – parasympathetic expression

Parasympathetic symptoms of overtraining include low resting heart rates, rapid heart rate recovery post exercise, hypoglycemia during exercise, decreased maximal plasma lactate during exercise, and decreased catecholamine levels[2]. Other symptoms may include inhibition, staleness, performance incompetence, and depression.[8] Parasympathetic overtraining is typically found in aerobic activities, such as distance running, swimming, and cycling, according to Lehmann's research on endurance athletes.[8] Two hormones that are often impacted by high volume training are testosterone and cortisol and as the training volume increases, the ratio of these two hormones is altered.[3] Those who train endurance athletes are likely familiar with the symptoms. Historically, these symptoms are well-known and easily overlooked, so it is imperative that fitness professionals keep a sharp eye on the client's behavior and mood. This type of overtraining syndrome is more common than the sympathetic form.

Periodization

"Periodization includes phases of high training stress and planned periods for recovery."[2] Each pre-designed cycle of training has a specific set of goals for a specific time period. The key to preventing overtraining is the proper design and implementation of a periodized training program.

In elite world-class athletes, the devastating results of overtraining can literally erase years of dedication and hard work, so it is understandable that coaches are constantly watching for early warning signs. This topic greatly concerns the U.S. Olympic Committee. Many interesting articles about nutrition, peak performance, and overtraining are posted on their Web site http://coaching.usolympicteam.com/. In Dr. Kirsten Peterson's article is entitled: Athlete Overtraining and Underrecovery: Recognizing the Symptoms and Strategies for Coaches, several helpful suggestions are offered. Since a group of athletes will likely respond differently to the same training stresses, the coach should not focus only on the list of symptoms. What is most important is to note each individual athlete's normal patterns and recognition of deviations from these individual personal norms over time, not the presence or absence of a particular symptom of overtraining. The use of this concept can be a useful tool for early detection of overtraining, whether the coach is training recreational or Olympic athletes.

The full-text version of the article is available at http://coaching.usolympicteam.com/coaching/kpub.nsf/v/5Sept03.

Components to consider in designing a training program

Figure 1 illustrates the various components of training. When designing a program, several components must be considered. These components are known as FITTE Factors:[6]

As fitness professionals, we are aware that a successful program design involves a plan that fits the unique needs of each individual. This is accomplished through recognizing the relationship of the interrelated FITTE factors as illustrated in Figure 1. Remember that the most significant gains in performance come from long-term consistency. With that in mind, the fitness professional should consider the last two components of the FITTE model: type of training and enjoyment, along with appropriate intensities and volumes that the athlete/client can sustain long-term. Remember that intensity and volume are inversely related. While it may be tempting to increase both intensity and volume, intensity and volume should never be increased simul-

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taneously. Finally, keep in mind that in the long run, "more is not always better," especially if fatigue or injury causes the athlete/client to lose motivation or ability to train.

How common is overtraining?

The overtraining syndrome (OS) has been documented in a wide variety of both endurance and strength or power sports. Morgan et al[9] reported that OS developed in more than 60 percent of elite distance runners at least once in their careers. OS has been found in 21 percent of the Australian swimming team after six months of training for a national competition[7] Researchers who studied a soccer team found that more than 50 percent of the players suffered from OS in a five-month competitive season.[8] Olympians are not immune to this problem. Gould et al[4] reported that 28 percent of athletes competing in the 1996 Summer Olympics were overtrained. In addition, 10 percent of 1998 Winter Olympians cited overtraining as a significant reason for diminished performance.[4]

Overtraining in resistance vs. endurance training

As mentioned previously, most of the scientific literature on overtraining is based on aerobic/endurance activities and sports. Does overtraining in endurance activities differ from overtraining in resistance training? Yes. Recent research by Fry and Kraemer[2] found two unique differences. "Excessive resistance training intensity (using too heavy a resistance for extended periods of time) produces a distinctly different neuroendocrine profile. As a result, some of the neuroendocrine characteristics often suggested as markers of overtraining may not be applicable to some overtraining scenarios. The limited data available indicate that the testosterone/cortisol ratio is not altered with this type of training, as seen with high training volumes (increased exercise frequency or performing more sets). However, the exercise-induced concentrations of catecholamines are markedly elevated with high intensity training".[2]

Within the past few years, research has begun to unravel the mystery of how the body responds to the two different types of overtraining. Overtraining can no longer be viewed as a general term that refers to all types of training because it is a complex issue that involves a host of variables.

The prevalence of overtraining is not only significant in elite athletes, but OT is now a common problem in youth sports.

In young athletes, evidence of overtraining surfaces in the form of increased injury rates. Because training has become more sport-specific and nearly continuous, overuse injuries are now common among young athletes. Recent data indicate that 30 to 50 percent of all pediatric sports injuries are due to overuse.[1] In a study of children, ages 5 to 17, who visited a sports injury clinic, 49.5 percent of 394 sports injuries were classified as overuse.[1]. The relative percentage of overuse injuries varies by sport, however. In a two-year study of 453 young elite athletes, 60 percent of swimmers' injuries were due to overuse, compared to 15 percent of soccer players' injuries. Studies on Australian swimmers report that the OS developed in 21 percent of the athletes after just six months of training.[5] In other research, athletes who experienced overuse injuries lost 54 percent more time from training and competition than those who had acute injuries.[1] Within the twelve years spent as an age-group competitive swimmer, I recall frequent physical therapy treatments working on extremely sore shoulders, combined with constant fatigue and diminished race performance. As a young athlete, I thought this was "normal." Unfortunately, my coach did not connect the dots either.

Clearly, health and fitness professionals who work with children or teenagers need to monitor repetitive motion drills or activities since they appear to cause so many injuries. Variation in training is paramount.

The Division of Sports Medicine in Boston, Massachusetts reports that the number one diagnosis in sports clinics who treat young athletes is patellar pain syndrome. This alignment problem in the knee was rarely seen in children until the growth of organized sports.[1]

These findings are alarming and should raise cautionary "red flags," especially since many of these injuries are preventable.

From my twenty plus years as a trainer, I am aware that some clients can become obsessed in their quest to get fit. Special attention should be directed toward teaching the client how to train "smarter," not necessarily "harder." Personal trainers face this challenge daily. It is important to take every opportunity to educate clients who fall into this category about the negative results of overtraining.

The concept of train smarter, not harder, applies to the young and old; elite and recreational; the neophyte exerciser; the experienced competitor and the weekend warrior.

Overtraining vs. Overreaching

In contrast to overtraining, overreaching is a systematic attempt to intentionally overstress the body, coaxing the body to adapt short-term to the increased training stimulus. It refers to a brief period of heavy overload without adequate recovery. Overreaching is simply a shorter, less severe form of overtraining. The athlete or client can easily recover from overreaching by resting just a few days. An example of overreaching is the runner training for a marathon who does his or her longest run and most mileage three to five weeks prior to the marathon, then tapers for three weeks leading up to the event. Recovering from overtraining, however, may take weeks or months. Short-term overtraining (overreaching) lasting up to two weeks, must be differentiated from long-term training (overtraining), since recovery is in direct temporal relationship to overtraining duration. When monitored properly and strategically planned, implementing periods of overreaching cannot only serve as a catalyst for enhanced performance later in the program. It can also provide variety for the participant and as we know, boredom can become a deterrent for performing optimally.

Volume and Intensity

A well-designed program must be based on the principle of progressive overload. This principle relies on three main training variables: volume, intensity, and rest. Increasing either the duration or the frequency of training can increase volume. Examples: volume in endurance activities refers to the amount of yards/meters an individual swims in one day or the total number of miles a runner completed in one day. Volume in resistance training refers to the number of sets and repetitions performed in one day. Intensity in resistance training refers to the weight (load) lifted in relationship to a maximal strength level (e.g., 1 Repetition Maximum) or a multiple Repetition (e.g., 10 Repetition Maximum).

In general terms, we refer to "intensity" in endurance activities in relation to a percentage of an individual's VO_{2max}. For example, it is often written that training intensities between 50 and 90 percent VO_{2max} significantly improve aerobic capacity in most people.

Keep in mind that there is a strong interaction between intensity and volume. As intensity is reduced, volume must increase to achieve adequate stimulus. Inversely, high intensity training requires a decrease in volume.

The role of periodization

The concept of periodization calls for variation in all aspects of training during a specific time period, such as a year. When periodization is used as the foundation of a program, it plays an important role in preventing overtraining. It serves as the fulcrum for balancing adequate stimulus and recovery.

Signs/symptoms of overtraining

In "Current Comment," a publication of ACSM, overtraining expert Andrew Fry, Ph.D., suggests that we watch for decreased performance, decreased training tolerance, decreased motor coordination, and increased technical faults. While reviewing the follow-

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ing list, keep in mind that there are no specific diagnostic tools to show definitive markers for overtraining. In addition, we do not have the luxury of an established "criteria" that can be used to analyze resting, exercising, or recovering heart rate responses. So what is the key? Get to know your athletes or clients and how they respond to easy workouts and to accelerating, more demanding workouts. For example: recording an unusually low or high resting heart rate is not always a reliable indicator of overtraining for every participant. These are simply guidelines. In most cases, you can expect to observe the following:

Markers related to parasympathetic overtraining

- low resting heart rate
- rapid heart rate recovery post exercise
- hypoglycemia during exercise
- decreased maximal plasma lactate during exercise
- decreased catecholamine levels
- staleness
- depression
- unusual digestive disturbance

Markers related to sympathetic overtraining

- restlessness
- excitation
- increased levels of catecholamines
- increased resting heart rate
- increased blood pressure
- increased metabolic rate
- increased respiratory rate
- decreased recovery heart rate post exercise
- loss of appetite
- disturbed sleep

The key to success is prevention

Probably the most insidious thing about overtraining is the fact that we have to overtrain before we see undesirable deviations from the athlete/client's baseline responses. In other words, we don't know we are overtraining until we have done it. With that in mind, increases in training volume or intensity, or decreases in recovery time should be invoked conservatively. The late Arthur Lydiard always said a runner was better off going into a race a bit undertrained than overtrained. This is good advice to heed when designing any training program because the consequences of overtraining will be devastating to performance and will require a long recovery period.

Summary

We all strive to succeed in our efforts, however; only a fraction of the population is willing to pay the price. True champions are a calculating lot. They meticulously calculate their daily routine in various ways, such as:

1. Measure caloric input vs. output
2. Weigh intake of food in grams
3. Measure daily protein and carbohydrate intake
4. Track heart rate responses to a given work load
5. Log mileage or distance
6. Log # of sets, reps, volume, and intensity of resistance training loads
7. Keep a personal mood inventory after each workout
8. Evaluate recovery time

For the highly motivated individual, every workout counts. The goal may be to walk five minutes non-stop, lose thirty pounds, win a Super Bowl ring, or bring home an Olympic gold medal. The secret to success is in knowing when to push and when to relax. The formula is based on a history of well-grounded science as well as a spoonful of common sense. It is clear that overtraining is preventable. As fitness professionals, we are in a unique position to improve athletic performance at all levels of competition; to help obese children and adults reach their long-term health goals; to reduce the rising prevalence of diabetes; and to enrich the lifestyles of millions of people. Finally, keep in mind the fifth component shown in Figure 1: The enjoyment factor. It is important for us to remember that our clients must enjoy the activities that we prescribe in order to keep them active for a lifetime. In fact, enjoyment may be one of the most critical aspects of the training equation, especially if you are working with non-elite athletes (children, seniors, obese and depressed individuals, or rehabilitation patients), etc. The more the client enjoys the activity, the longer they will stay active. The guidance that we as fitness professionals offer literally lasts a lifetime for each client.

The content of this paper is based on fifty years of research. As the research improved, so did the performances of those who underwent the training. Information gleaned from improved research methods and advanced physiologic measurement techniques has produced a well-charted path. However; there is no substitute for close, personal observation and effective communication with our athletes and clients. By following the guidelines presented, our clients will run faster, jump higher, and get stronger.

About the Author

Babs Hogan has a master's degree in kinesiology and twenty-two years' experience as a personal trainer. She is the Executive Director and writer for the Public Health International Association. In addition, she also writes articles for several university Web sites and various magazines. She is a frequent guest lecturer at spas and fitness clubs throughout Texas. She is currently certified through ACSM as a Health & Fitness Instructor and a doctoral student in public health. Contact information: bhogan@hsc.unt.edu

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- **February 24-25, Texas Chapter, Denton, Texas**
  Contact: Joel Mitchell, Ph.D., FACSM, (817) 921-7665, j.mitchell@tcu.edu

Interventions to Minimize the Negative Effects of Prior Cycling On Subsequent Running Performance

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Introduction

In the sports of triathlon and duathlon, participants compete in combinations of exercise modalities successively, transitioning from one sport directly into another. The completion time for these events is inclusive of these transitions from one discipline to the next, and therefore swift and effective transitions are imperative for overall performance in such events. Athletes, especially beginners in the sports of triathlon and duathlon, almost universally experience difficulty running immediately following an intense bout of cycling. The purpose of this review is to examine the current body of knowledge regarding the difficulty associated with the cycle-to-run transition as well as recommendations for increased performance regarding this aspect of this sport. A review of related research should reveal implications for improvement in cycle-to-run transitions by increasing pedaling cadence over freely chosen cadence, increasing the seat-post angle on bicycle frames over the standard for road-cycling, as well as various training and pre-race warm-up activities.

Effects of Prior Cycling on Running

There are several effects of prior maximal cycling on the mechanics and energy costs of subsequent running. Medium-level triathletes have been shown to have a detrimental increase in the mechanical costs of running, as well as heart rate, ventilation, and VO_2 of respiratory muscles during the first minute after an exhaustive bout of cycling.[13,14] These affected energy and mechanical costs of running have been associated with impaired economy and running performance.[1] There are specific alterations in neuromuscular functioning and running mechanics following an exhaustive bout of cycling. Significant differences were observed in the level of activation of the large muscles in the leg/thigh during both the stance and flight running phases following a simulated 40 kilometer (km) cycling time trial when compared to pre-cycling values.[6] Similarly, knee extensor strength is significantly reduced for up to 30 min following a 140 km race effort on a bicycle.[15]

Negative ventilatory responses have also been associated with cycle-to-run transitions. Significant, negative changes have been observed for residual volume, functional residual capacity, the ratio of residual volume to total lung capacity, and the diffusing capacity for carbon monoxide when compared to similar trials using the same protocols in a run-run format.[8] In addition, significant decreases in maximum inspiratory pressure and respiratory endurance time following a bout of cycling and a combination cycle-run effort have been noted when compared to running alone. The decreases brought about by cycling were maintained through the successive run.[2] Collectively, there are many obstacles to overcome, especially for a beginner in triathlon and/or duathlon, in order to make a smooth transition from cycling to running during a race.

Cycling Cadence

The cadence at which an athlete cycles while performing the bike-leg of a triathlon or duathlon has been implicated in increasing performance during the transition from cycling to running. Gottschall and Palmer (2002) observed that a cycling bout performed at a fast cadence [~110 rotations per min (rpm)] before the transition to running significantly increased stride frequency and overall running speed, resulting in faster completion times of a subsequent run when compared to cycling bouts performed at slower cadences at equivalent heart rates.[5] This pedaling rate differs from the freely chosen cadence (~81 rpm) of triathletes found by Vercruyssen et al. (2002).[19] Gonzalez and Hull (1989) have also implicated an unusually high cadence range (98-124 rpm, depending on height) as being a factor in optimizing the biomechanics of cycling itself.[4] Similarly, it has been reported that as cycling power output increases to the levels that would be maintained for the cycling leg of an intermediate distance triathlon or duathlon, the optimal cadence increases to the range indicated by Gottschall and Palmer (2002), or approximately 100 rpm at 400 watts.[5,12] Although only the most elite cyclists can maintain a power output of 400 watts for any amount of time, to the average multisport athlete this implies that the adoption of a higher cycling cadence permits the maintenance of higher power outputs for greater periods of time than that of lower cadences. In other words, the faster a cycling athlete goes, the more power output is required, and the greater the optimal cadence to reach those power demands. Adoption of a high cycling cadence has implications for optimizing running performance following the cycle-to-run transition during a race as well as the cycling performance itself. Since the generation and maintenance of power outputs approaching 400 watts is almost solely in the grasp of only the most seasoned and elite athletes, the adoption of a higher cycling cadence (>100 rpm) is a method which the beginner or intermediate multisport athlete can use to reach and maintain greater wattages, and thus velocity, than available with lower cycling cadences (~80 rpm).

Seat Tube Angle

The ergonomics of the bicycle an athlete rides during a triathlon or duathlon has been shown to affect cycling performance, cycle-to-run transition, and subsequent running performance during race simulations. The prevailing perception is that during a triathlon or duathlon, a steeper (>76°) rather than shallower (<76°) seat tube angle (the angle produced by the seat tube and the down tube at the bottom bracket), helps alleviate much of the difficulty experienced when transitioning from cycling to running. Results of a study conducted by Garside and Doran (2000) suggested that a steep 81° seat tube angle (STA) significantly improved combined cycle-run and subsequent run performances, especially during the first 5 km of the subsequent run, compared to a 73° STA condition. Additionally, beneficial adaptations were also significant for heart rate (HR), stride length, and stride frequency for the 81° STA condition.[3] Gonzalez and Hull (1989) associated a STA of ~76° to 78°+ with optimal cycling bio-

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Prior Cycling... Continued from Page 6

mechanics, depending on height[4]. An increase in STA over 76° also has positive implications for cardiorespiratory responses during cycling.[7] Values for VO_2, HR, and rating of perceived exertion were significantly lower for STA 83° and 90° than at 69°.[7] In fact, only the 69° STA had detrimental cardiorespiratory responses during cycling compared to the 76°, 83°, and 90° STA conditions.[7] Similarly, Price and Donne (1997) found that steeper STAs resulted in significant improvements in HR, VO_2, and power efficiency when comparing the 74° and 80° STA conditions, and the 68° with the 74° STA conditions. The results of these studies indicate that a steeper seat tube angle have positive implications for a faster and smoother transition from cycling to subsequent running. For beginner and intermediate multisport athletes, who generally experience much greater difficulty with the transition from cycling to running, using a steeper STA has implications for alleviating the difficulties experienced, and improving performance during the transition from cycling to running, subsequent running performance, as well as cycling performance.

Training

The inclusion of multi-cycle-run (transition or "brick" workout) sets in training significantly improves performance during cycle-to-run transition.[11] This increase in successive running performance has been shown to be transient, with significant improvements over control conditions lasting only the first few minutes or several hundred meters of post-cycling running.[11] Multi-cycle-run blocks have been implicated in improving running performance subsequent to intense/exhaustive cycling performance.[6,8,10,11,13]

The addition of resistance training to the training regimens of endurance athletes facing the rigors of cycle-to-run transition in a race situation may also prove valuable. Resistance training concurrent with endurance training in cyclists and runners increases time to exhaustion in trained and untrained athletes by increasing lactate threshold at the mitochondrial level.[17] This attenuation of exhaustion during cycling could reduce the alteration of neuromuscular function, and improve subsequent running performance.[15, 17]

Performance Level/Experience

A common finding regarding the improvement of performance during the cycle-to-run transition involves the effect of performance level or length of training history in these sports. Millet et al. found that the performance level of triathletes influenced the alterations of running mechanics immediately following cycle-to-run transition.[13] Specifically, they found that less experienced triathletes were more sensitive to cycling fatigue, resulting in higher mechanical costs of post-cycle running compared elite triathletes.[13] Heart rate, ventilation, and the energy cost of running have been shown to significantly increase for middle-level triathletes after cycling, compared to a lack of significant change in elite athletes.[14]

Results of a study on elite duathletes failed to demonstrate significant differences in the energy cost of running, biomechanical factors, or physiological variables when comparing running performances before and after a simulated cycling leg of a duathlon race.[18] Researchers examining the effect of performance level on cardiopulmonary responses during a simulated cycle-run trial found a significant difference between the ventilatory responses of the lower level triathletes in run-only versus cycle-run trials, whereas there were no observed differences between trials for the elite triathlete group.[9] A more comprehensive training history has even been implicated in improving the biomechanics of running.[1] The implications of these studies are that the difficulties experienced by some triathletes and duathletes during cycle-to-run transition and subsequent running performance seem to dissipate the longer one trains, and among a homogenous group of highly trained tri or duathletes.

Summary

Practical implications for improving performance during the cycle-to-run transition of a race, as well as the running and cycling portions themselves, have been highlighted by various researchers in the reviewed articles. A synopsis of these points follow. The adoption of a high cadence (100 rpm or more), improves running performance subsequent to exhaustive cycling.[5,12] An increase in the seat tube angle during a cycling bout immediately preceding a running bout, from <73° to > 76°, improves/optimizes cycle-to-run transition, subsequent running performance.[3,4,7,16]

The implementation of multi-block sets of cycle-run bouts in training regimens has also been shown to have positive effects on cycle-to-run transition, subsequent running performance, and overall performance in races containing such transitions.[6,8,10,11,13] The addition of resistance training to the training regimens of tri and duathletes may also improve cycle-to-run transitions. Studies show that resistance training has positive effects on the detriments found to occur during the transition from cycling to running in triathlon and duathlon.[17] Lastly, the longer that an athlete trains and participates in triathlons and/or duathlons the less it appears that negative affects are experienced during the transition from cycling to running during a race.[9,13,14,18] In conclusion, the negative performance effects associated with the transition from cycling to running can be minimized by the intervention strategies discussed above, resulting in improved performance during the bike-to-run transition, subsequent running, and overall performance during a triathlon and/or duathlon.

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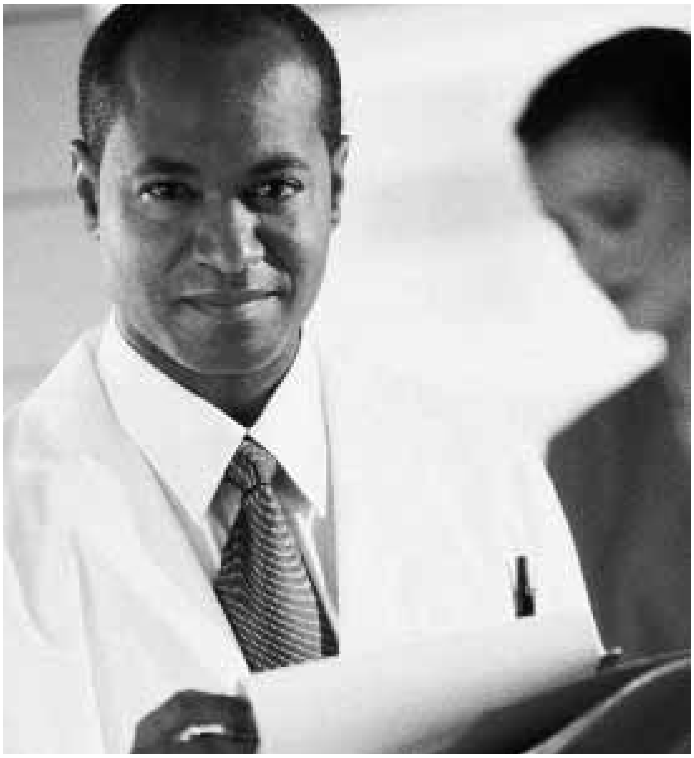
For a complete list of references, please e-mail certification@acsm.org.

Coaching News

Health and Wellness Coaching — A New Model for Cardiac Rehabilitation



This is the tenth edition of the Coaching News column, sponsored by Wellcoaches Corporation in alliance with ACSM, and it appears regularly in *ACSM's Certified News*. This article was written by Blaine Wilson, MS, CHC, and ACSM Exercise Specialist® certified.

A few weeks ago I was cleaning out some old office files and found an interesting study published in the *American Journal of Cardiology* titled "Myocardial Infarction: A New Model for Patient Care." Ever looking for the next new thing to help me professionally, I glanced at the publication date in bold print…. February 1, 1985…21 years ago!

The conclusion of the authors was that medically directed at-home rehabilitation has the potential to increase the availability and decrease the cost of rehabilitation for low risk survivors of AMI. Over the last 21 years subsequent studies have demonstrated the efficacy and safety of at-home and community exercise. In recent years, research publications have reported the efficacy of health promotion counseling by phone. Studies have also shown that various populations have benefited from physical activity counseling over the phone.

Cardiac rehabilitation protocols have evolved from nurse mediated programs to multidisciplinary programs including exercise specialists. They have transformed from continuous ECG monitoring in the clinic to supervising progress via the telephone. In spite of this progress, traditional cardiac rehabilitation programs suffer from low enrollment rates. Third party reimbursement going forward remains unclear. The majority of people that would benefit from cardiac rehab are not participating.

Combining personal coaching, by phone or face-to-face, with rehab programs to help people build self-efficacy is a match for the future. It's now 2006 and the new 1985 model for patient care may have finally arrived. *Smart Money Magazine* in 2001 predicted Health Coaching would be one of the top five new jobs that will be in demand in five years… it has been exactly five years since that prediction. The future is now!

The era of giving advice and hoping for compliance has passed. If we don't change the way we approach our patients, then we are likely to repeat the same mistakes again and again. Our barrier is that we have been trained as experts to give advice and solve problems. After all, we have all those degrees and diplomas hanging on the wall saying we are the expert.

As experts are we really making a difference? Our rehab population is struggling even more than the general population, where 65 percent have a BMI of > 25, 30 percent are obese with a BMI of > 30, 70 percent are not exercising regularly; and almost 80 percent do not consume five or more servings of fruits and vegetables. There's room for improvement.

Coaching patients to build self-awareness, personal responsibility, and self-efficacy, fills a gap in today's rehab programs. Healthcare professionals need the coaching, communication, and facilitation skills to help people build the foundation for lasting health behavior change. Coaches meet their clients where they are, help them create a new future, and find the "the real me."

One program with eyes on the future is the Center for CardioVascular Wellness at the Seattle Heart and Vascular Institute. Pam Burnell, RN, BSN, manages this innovative program and is guiding her traditional cardiac rehab program through the transition to integrate coaching into the menu of services. "We sent 13 staff members to Wellcoaches to become certified wellness coaches and have expanded our program services to include smoking cessation, weight management, and primary cardiovascular risk reduction, all delivered in a 1:1 coaching format. The coach training has delivered the skills we need to truly individualize a client's program based on his/her readiness to change and self-motivation. This is much better than trying to push the patient through changing behaviors" says Burnell.

Burnell now requires all staff to complete the training within a year as a condition of employment. "It's our new standard. The timing was right, and supported by ACSM's reputation and endorsement of Wellcoaches, we are now able to apply coaching skills for every patient encounter" confirms Burnell. Although the application of coaching skills is fairly new in the CV Wellness Center, her initial observations are positive. "We are now better mentors and better coaches, and the coaching skills have increased program effectiveness and client success."

Like Pam Burnell, I envision the certified health or wellness coach being integrated into areas of medicine where health behaviors are important, including pulmonary rehabilitation, CHF clinics, lipid clinics, diabetes clinics, and cancer centers. Coaching change is a key intervention that is poised to become the new model for patient care.

The Coaching News column is sponsored by Wellcoaches Corporation, the leader in health, fitness, and wellness coach training and delivery of wellness coaching services, in partnership with ACSM. To learn more about this topic or other topics on coaching health, fitness, and wellness, visit www.wellcoach.com.

Resistance Training and Endurance Enhancement: Exploring the Pertinent Issues

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The effect of resistance training upon endurance performance is an area of interest for athletes and researchers alike. This article reviews the relevant literature on the "interference effect" for trained athletes and summarizes findings as they bear upon resistance training and endurance performance issues. Studies indicate that the effects of concurrent resistance and endurance training vary according to training status, duration of training, and type of exercise. Researchers agree that mechanisms for the different effects that occur from concurrent training are multifactorial. However, there is an overall consensus that most athletes can benefit from incorporating strength and/or endurance exercises into a sport-specific program.

Maximizing Athletic Performance

The effects of concurrent strength and endurance training have been extensively studied, particularly in relationship to maximizing athletic performance. Strength and endurance training induce different performance and physiological adaptations.[8] Results have ignited ongoing debates about whether or not an "interference effect" occurs among athletes who cross-train. Results seem to largely depend on the intensity of the training and the training status of the athlete.

The typical athlete utilizes both endurance and strength training benefits to take full advantage of their efforts in his/her specific sport. Such cross-training is the result of the known improvements in explosive force from resistance training and longer duration of performance with endurance training.[9] Clearly distinct adaptations occur in response to resistance compared to endurance training. Resistance training is effective in increasing muscle strength and hypertrophy while endurance training optimizes performance characteristics such as lactate threshold, work economy, and maximal oxygen consumption (VO_{2max}).[6,7,8]

Some researchers have found that concurrent training improves performance for endurance athletes. Hickson, Rosenkoetter, and Brown[4] studied the effects of heavy resistance training (high-load, low repetitions) on endurance athletes using the treadmill and bicycle. The results indicated that adding heavy resistance training to previously trained cyclists and runners can significantly improve time to exhaustion. In addition, running economy or the level of oxygen uptake at a given submaximal intensity — has been found to improve with resistance training.[6]

In contrast, heavy resistance training athletes report lower strength gains when endurance activities are incorporated into training regimens compared to strength only programs. The mechanisms responsible for the apparent interference of endurance training on strength gains are not yet well established.[12]

Muscular Strength

The effects of heavy resistance training in combination with endurance training on performance have yielded inconsistent findings. Millet, Jaouen, Borrani, & Candau[10] suggest that strength development may lead to improvements in endurance performance in previously trained individuals. Their results show an increase in muscular power that corresponds with a greater time to fatigue, or work economy. The authors conclude that, "Even over a long period, the oxidative capacity of the lower limb muscles is not affected by the inclusion of strength training into endurance training, supporting the concept of a possible 'additive effect' of strength and endurance training."

Bishop, Jenkins, MacKinnon, McEniery, & Carey,[2] examined the effects of resistance training on endurance performance in competitive female cyclists. After twelve weeks of resistance training in combination with regular cycling training, the participants demonstrated a significant increase in one repetition maximum concentric squat strength (35.9 percent) compared to the control group.[2] Although an increase in leg strength was demonstrated, there was no significant difference in cycling performance. Bell, Petersen, Wessel, Bagnall, & Quinney[1] noted similar strength gains in a study that examined concurrent training and found no difference between low volume resistance and endurance training compared to low resistance training alone. In 1980, Hickson,[3] actually found that concurrent strength and endurance training resulted in a reduced capability to increase strength, but had no effect on the magnitude of the increase in VO_{2max}. Hickson stated that the physiological adaptations that occur in response to exercise are clearly related to the type of training stimulus.

Lactate Threshold

Lactate threshold is the point at which blood lactate initially rises above resting values during progressively increased exercise intensity.[6] Lactate threshold has been used as an indicator of fitness because it is the point in performance where an athlete's efforts begin to diminish due to increased lactate in the blood. Jung[6] suggests that the addition of

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strength training in an endurance athlete's training regimen enhances performance by increasing the power output that an athlete can sustain before lactic acid begins to rise in the bloodstream. He suggests that this allows the endurance athlete to work at a lower percentage of maximum strength, ultimately decreasing blood lactate concentration.

Work or Running Economy

Endurance athletes vary widely in their efficiency of fuel usage during performance. Running economy depends both on the energy needed to move at a particular speed (external energy) and on the energy associated with oxygen delivery, thermoregulation, and substrate metabolism (internal energy). If an athlete's oxygen consumption is less for a given level of external work, they will require less internal energy and thus have an improved work or rather running economy.[11] Some experts view running economy as a more accurate predictor of endurance performance than simply maximal oxygen consumption.[10] Paavolainen, et al.[11] found that simultaneous explosive-strength and endurance training improved the 5K time in well-trained runners without finding significant changes in VO_{2max}. However, the changes that occurred over the nine week period suggested neuromuscular adaptations improved athletes' running economy performance. Similarly, a study by Millet et al.[10] found that work economy improved slightly among endurance athletes who also moderately resistance trained.

Trained distance runners, such as marathoners or ultra-marathoners, have shown up to an 8 percent improvement in running economy following a period of resistance training.[6] Jung believes that the improvement in running economy from strength training is due to improved neuromuscular characteristics and reduced ground contact time.[6] Similar results have been found in highly trained cross-country skiers who maximally strength trained for an eight-week period, in addition to regular sport-specific training. Increased endurance performance, work economy, and longer time to exhaustion, were the significant effects of strength training found among the cross-country athletes.[5] Neural adaptations were credited for improvements in strength, including rate of force development and a more efficient work economy.[5]

Conclusion and Summary

Table 1 summarizes concurrent resistance and endurance training studies. The current literature on the "interference effect," asserts that the effects are variable and mechanisms multifactorial. Moreover, there are many questions left unanswered. Factors that have influenced the conclusions researchers arrived at following an experimental design examining the "interference effect" were training status, type of training, length of study, and measurement techniques. Differences in adaptations to simultaneous strength and endurance training were commonly found to be a result of the training status of the participants at the beginning of each study.

In conclusion, athletes vary in their adaptations to training, so individual responses must be considered when tailoring a training program with the athlete's specific goals in mind. Neuromuscular responses, muscular strength, VO_{2max}, lactate threshold, endocrine changes and work economy all play a role in the adaptations that occur in the body under varying training exercises and programs. Together, these studies suggest that the varied adaptations induced by endurance and strength training are sport specific and that the varied adaptations induced by endurance and strength training can enhance performance for many athletes.

Table 1 - Summary of Selected Studies on Concurrent RT and ET

Study	Subjects	RT Program	Strength Increases	Effects on Endurance
Millet, et al. (2002)	15 triathletes, 2 groups	ES=endurance and heavy resistance 2 x wk for 14 wks E=endurance only	ES=maximal strength were increased, and increased hopping power	ES=led to improved maximal strength and running economy
Bell, et al. (1991)	31 endurance trained males, 2 groups	ES=low velocity RT (3 x wk, 8-12 reps) and endurance S=RT only	ES and S=increased knee extension peak torque and total work	ES=increase in submaximal exercise responses
Bishop, et al. (1999)	21 trained female cyclists, RT and control group	RT=5 sets to failure (2-8 RM) 2 x wk for 12 wks	RT=increased 1RM concentric squat strength	No sig. changes found
Hoff, et al. (2002)	19 male cross-country skiers, RT and control group	RT=3 sets, 6 reps at 85% of 1 RM, 3 x wk for 8 wks	RT=1RM increased, time to peak force was reduced	RT=increase in time to exhaustion and increased work economy
Hickson, et al (1980)	8 strength subjects; 8 endurance training subjects, 7 strength and endurance subjects	Strength training-designed to increase leg strength (5 days/ 10 weeks) Endurance-Interval Training (6 days/ 10 weeks) Strength and Endurance (Combination)	Strength development in Strength Group 44%; Strength Development in Strength and Endurance Group 25%; Endurance Group – no improvement	No significant differences between the Endurance Group and the Strength and Endurance Group in the rate of $V0_{2max}$
Hickson, et al (1988); J Appl Physiol; 1988 Nov; 65(5):2285-90	8 cycling and running trained subjects already at a steady-state level of performance	Strength training-designed to increase leg-muscle strength (3 days/ 10 weeks); Endurance-Training remained Constant)	Strength development in leg increased by 30%; Maximal O_2 uptake was unchanged, however, short-term endurance (4-8 min) was increased by 11 and 13% during cycling and running	Results do not indicate any negative performance effects of adding heavy-resistance training to ongoing endurance-training regimens

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January/February/March Continuing Education Self-Tests

Credits provided by the American College of Sports Medicine • CEC Credit Offering Expires March 31, 2007

SELF-TEST #1 (1 CEC): The following questions were taken from "Higher, Faster, Stronger… Are Your Clients Overtraining?" published in this issue of ACSM's Certified News, pages 2-5.

1. Which of the following training variables are known to be "inversely related?"
   A. Exercise frequency and recovery time
   B. Intensity and volume
   C. Order of exercise and duration
   D. Exercise load and recovery time
2. Which of the following terms is referred to as "a brief period of heavy overload without adequate recovery?"
   A. Tapering
   B. Undertraining
   C. Adaptation malfunction
   D. Overreaching
3. The concept of ____________________allows variation in all aspects of training and is based on cyclical, pre-determined periods of time.
   A. Recovery/Relaxation
   B. Overtraining syndrome
   C. Periodization
   D. Acute progressive theory
4. Recent research shows that there are unique differences between overtraining from endurance activities and chronic resistance training.
   A. True B. False
5. Which of the following symptoms is not commonly associated with overtraining?
   A. Increased concentration
   B. Decreased desire to compete
   C. Increased irritability or anger
   D. Mood swings

SELF-TEST #2 (1 CEC): The following questions were taken from "Interventions to Minimize the Negative Effects of Prior Cycling On Subsequent Running Performance" published in this issue of ACSM's Certified News, pages 6-7.

1. Which is not an identified method to reduce the negative effects of prior cycling on subsequent running performance?
   A. The inclusion of multi-block cycle/run training techniques.
   B. The adoption of a cycling cadence equal to or greater than 100 rpm.
   C. Using a bicycle with a seat tube angle of less than 76°.
   D. The inclusion of strength training in a performance training regimen.
2. Which of the statements is true, as related to the findings in the current body of literature, regarding the effect of a bicycle's seat tube angle on subsequent running performance?
   A. A seat tube angle of 73° is more beneficial than a seat tube angle greater than 76°.
   B. A seat tube angle of 80° is less beneficial in alleviating the difficulties encountered during a transition from cycling to running than a seat tube angle of 76°.
   C. The seat tube angle of a bicycle has no effect on subsequent running performance.
   D. In general, a steeper seat tube angle results is more efficient cycling and subsequent running performance than a shallower angle.
3. Which of the statements is true regarding the effect of performance level or experience on the transition from cycling to running during a triathlon or duathlon?
   A. The negative performance effects encountered during a transition from cycling to running are equal across all levels of involvement in triathlon and duathlon.
   B. More experienced athletes tend not to experience the same severity of negative impact on running proficiency after cycling that novice athletes are prone to encounter.
   C. Prolonged, intense cycling has not been shown to have any effect on subsequent running performance.
   D. Performance level, but not length of experience, has a positive effect on minimizing the negative effects of the cycle-to-run transition in triathlon and duathlon.
4. Which of the following is not a detrimental effect commonly observed during the transition from prolonged, intense cycling on subsequent running performance?
   A. Increased heart rate during the initial phase of post-cycling running.
   B. Reduction of knee extensor strength following an exhaustive bout of cycling.
   C. Negative ventilatory responses.
   D. Decrease in efficiency for both the energy and mechanical costs of running.
5. Which is not true concerning interventions to minimize the negative effects of prior cycling on subsequent running performance?
   A. Manipulation of a bicycle frame's ergonomics can have a positive effect on the transition from cycling to running.
   B. Inclusion of certain training techniques can benefit an athlete by improving performance during the initial stages of post-cycle running.
   C. The adoption of a cycling cadence at or near 100rpm has a performance enhancing effect not only on subsequent running, but also on the cycling leg of a race as well.
   D. There is very little an athlete can do to counter the negative performance implications of prior cycling on running, except improve his/her overall fitness over the course of several years.

SELF-TEST #3 (1 CEC): The following questions were taken from "Resistance Training and Endurance Enhancement: Exploring the Pertinent Issues" published in this issue of ACSM's Certified News, pages 9-10.

1. T/F: The exercise type, intensity, mode and duration of training greatly effects the physiological responses to the athlete's body systems.
   A. True B. False
2. The concept of a possible "additive effect" of strength and endurance training states that:
   A. Strength training has no effect on endurance performance
   B. Endurance training has no effect on power performance
   C. Strength and endurance training complement each other for achieving a higher level of performance
   D. Strength training increases time to fatigue in endurance exercises
3. There is evidence that distinct physiological adaptations occur between strength and endurance training, including the following:
   A. Neuromuscular responses and alterations in motor unit recruitment
   B. Muscular strength and hypertrophy
   C. Exercise duration
   D. Maximal oxygen consumption (VO2 max)
   E. All of the above
4. T/F: Total work economy is now used commonly as the accurate method of measuring how an athlete is conditioned.
   A. True B. False
5. The authors of this article conclude that:
   A. An "interference effect" inhibits endurance athletes that cross-train with resistance exercises
   B. Research is ongoing showing different results for the effects of concurrent strength and endurance training
   C. Power athletes should only weight train
   D. Research shows that cross-training is more beneficial than previously thought

SELF-TEST #4 (1 CEC): The following questions were taken from "Cortisol Connection: Tips on Managing Stress and Weight" published in ACSM Health & Fitness Journal, Volume 9, No. 5, pages 20-23.

ACSM's Certified News

To receive credit, circle the best answer for each question, check your answers against the answer key on page 12, and mail entire page with check or money order payable in US dollars to: American College of Sports Medicine, Dept 6022, Carol Stream, IL 60122-6022

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January/February/March 2006 Issue EXPIRATION DATE: 3/31/07
SELF-TESTS SUBMITTED AFTER THE EXPIRATION DATE WILL NOT BE ACCEPTED.
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Tip: Frequent self-test participants can find their ACSM ID number located on any credit verification letter.

Certification Updates... Continued from Page 1

take an ACSM workshop to learn all the latest, evidence-based information affecting best practices in exercise testing and prescription. Attending an ACSM workshop is a great way to accumulate CECs towards recertification. A full list of available workshops are at www.acsm.org, select Conference and Certification Registration.

The most common question from our certified professionals is to make more CEC workshop opportunities available. As a result, we are introducing a new, one-day continuing education seminar, "Weight Management for the Fitness Professional." This course is one great way to earn CECs towards recertification, and includes information on helping your clients manage their weight through physical activity and collaborating with Registered Dietitians. 1st and 2nd quarter sites are listed below:

- **March 4: East Stroudsburg University, East Stroudsburg, PA**
- **May 7: Swedish Covenant Hospital, Chicago, IL**
- **May 14: Canisius College, Buffalo, NY**
- **May 18: Indiana University of Pennsylvania, Pennsylvania, PA**
- **March 18: University of Miami, Coral Gables, FL**
- **June 8: University of South Carolina, Columbia, SC**
- **June 10: University of Missouri, Columbia, MO**
- **June 16: National Institute for Fitness & Sport, Indianapolis, IN**
- **June 16: Adelphi University, Garden City, NY**

Finally, in December of 2005 we introduced Pearl Izumi as an affinity partner for ACSM Certified Professionals. As a special benefit to our current ACSM Certified Professionals, Pearl Izumi now recognizes your professional status (as an ACSM Certified Professional) as part of their Elite Trainer Network. Specifically, you are eligible for a 40 percent discount off of retail pricing on all Pearl Izumi products. For more information, or to take advantage of this special benefit, please visit the following link: http://www.pearlizumi.com/acsm/details.php.

In the future, you will be receiving periodic follow-up messages directly from Pearl Izumi regarding this special benefit for current ACSM Certified Professionals. Please note that your e-mail address will only be used by Pearl Izumi specifically for this offer, and will not be distributed in any fashion for any other purpose by Pearl Izumi.

Self-tests... Continued from Page 11

1. Cortisol is a hormone that is produced in the _______.
   A. adrenal glands
   B. liver
   C. pancreas
   D. pituitary gland
2. Peak secretion of cortisol occurs _______.
   A. late in the evening
   B. early in the morning
   C. late in the afternoon
   D. immediately after a meal
3. It is believed that cortisol directly influences the consumption of ________.
   A. foods high in protein
   B. foods late in the evening
   C. foods high in sugar and /or fat
   D. foods late in the afternoon
4. The National Cholesterol Education Program identifies women at risk using a waist circumference of more than ________.
   A. 39 inches
   B. 35 inches
   C. 30 inches
   D. 40 inches
5. Which of the following statements is TRUE?
   A. Cortisol is associated with relocating fat to the deep internal abdominal area.
   B. Low levels of cortisol have been linked to hyperglycemia.
   C. Deep abdominal fat has less blood flow and four times less cortisol receptors compared to subcutaneous fat.
   D. The "fight" or "flight" stress response can lead to increased lipogenesis.

Staying up to date with the ACSM Calendar of Events

Whether it's upcoming dates, home study opportunities, or upcoming conferences, you will find the latest continuing education information in the ACSM Calendar of Events at www.acsm.org/meetings/calendar.htm. Calendar entries include conferences endorsed by ACSM that offer continuing education credits, as well as general non-ACSM approved programs that have been submitted to our office.

If you would like to have your meeting reviewed for endorsement, go to www.acsm.org/pdf/endapp.pdf to access the Guidelines for Endorsement and Continuing Education Credit application. For questions on ACSM continuing education opportunities, the ACSM endorsement process, or to receive the monthly calendar of events email, please contact the education department at education@acsm.org. For questions on non-ACSM endorsed continuing education that could be accepted for recertification, please contact Traci Rush at certification@acsm.org.

SELF-TEST ANSWER KEY FOR PAGE 11

	QUESTION 1	2	3	4	5
TEST #1:	B	D	C	A	A
TEST #2:	C	D	B	A	D
TEST #3:	T	C	E	T	B
TEST #4:	A	B	C	B	A

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