Concurrent Training for the Bodybuilder Part II

Jacob Wilson, Ph.D., CSCS, and Gabriel Wilson, M.S., Ph.D. Candidate, CSCS

In part 1 of this series we introduced the topic of concurrent training, which is the simultaneous inclusion of endurance and resistance training. Overall we noted that while the addition of endurance training lowers bodyfat, it also hinders muscle growth, strength and power. We also highlighted a number of reasons why this might be the case. In essence we suggested that the greater the differences are in aerobic training relative to strength training, the greater the interference effects will be in concurrent training. The following article will apply this model and allow you to prevent decrements in concurrent training.

Manipulating Concurrent Training (Optimizing Independent Variable Selection)

Independent variables in science are what we manipulate at the beginning of a study. For example I can vary the intensity of endurance training and see how this affects strength and muscle growth. The primary independent variables which have been researched include the training experience of the individual, the type or modality of endurance training (cycling vs. running), the intensity of cardiovascular training and finally the sequence of cardiovascular training (e.g. cardio performed on the same or separate days from weight training). From extensive analysis of the literature and our extensive background in program variables we put forth that the greater the differences are in aerobic training relative to strength training in most of the variables studied, the greater the interference effects will be in concurrent training. It is important to understand that differences are dependent on the intensity, and biomechanics of the activities performed. This is our current model and will be used throughout the remainder of the paper to explain differing outcomes experienced across concurrent training studies.

Modality of Training

The main two apparatuses utilized for studying endurance performance are the treadmill and the cycle ergometer. These are the classic and main tools of the exercise physiologist, as such most studies in concurrent training are performed either with the athlete running or cycling.

According to our model the more dissimilar biomechanically the mode of training is, the greater the decrements will be in resistance training adaptations. The overwhelming majority of running studies we have analyzed (with the exception of one unique case) has resulted in decrements in strength and hypertrophy. In contrast of the 8 studies pertinent to this paper which used cycling only 2 showed decrements in strength and hypertrophy. Of the remaining studies 5 showed no differences in strength, while one cycling study actually showed that interval cycling bouts could increase strength endurance which is a major property for bodybuilders. Even when comparing similar protocols it appears that individuals are more susceptible to decrements in running than cycling. For example two studies had individuals jog at intensities ranging from 60-80 HRM intensity for durations lasting 20-40 minutes and found declines in both lower and upper body strength as well as power[1, 2]. In contrast by McCarthy and colleagues[3] found strength in compound lifts, neural adaptations as indicated by EMG activity and muscle mass were not inhibited by 50 minutes of cycling 3 days a wk at 70 % heart rate reserve (about 80 % HR max) intensity. Moreover while running has been demonstrated to inhibit upper body strength[4] and power[5], no cycling studies that we are aware of have resulted in any decrements in upper body strength or muscle mass [3, 6-8]. There are at least three reasons why those who use running are more susceptible to decrements than those who cycle.

1. Long duration running uses very little hip flexion and extension. Thus biomechanically you are training the hip flexors to move in a limited range of motion. In contrast cycling has a large range of motion for both hip flexion and extension. If you look at exercises like squats, and leg presses, these are very reliant on large hip mobility and range of motion, which as the figure below shows cycling encourages. We suggest that running actually trains the nervous system to limit hip mobility and therefore hinders performance in core lower body strength and power movements.



2. Muscle damage is elicited to a greater extent during the eccentric or lowering phase of a movement when the muscle is contracting while lengthening while the least amount of damage is caused in the concentric phase in which the muscle shortens. Running has a high eccentric component. For example long distance running causes extreme muscle damage while ultra distance cycling (230 km) does not[9]
3. Finally the fact that running has resulted in decrements in upper body strength and power is most likely a factor of the arm movement, particularly at the shoulder joint while running, which is in contrast to cyclists who have no arm movement during their rides.

Overall we suggest that the more similar the endurance activity chosen to the strength training the lower the decrements will be. This should be taken into consideration when selecting cardio equipment. For example many ellipticals allow the user to select the level of hip flexion.

Training experience

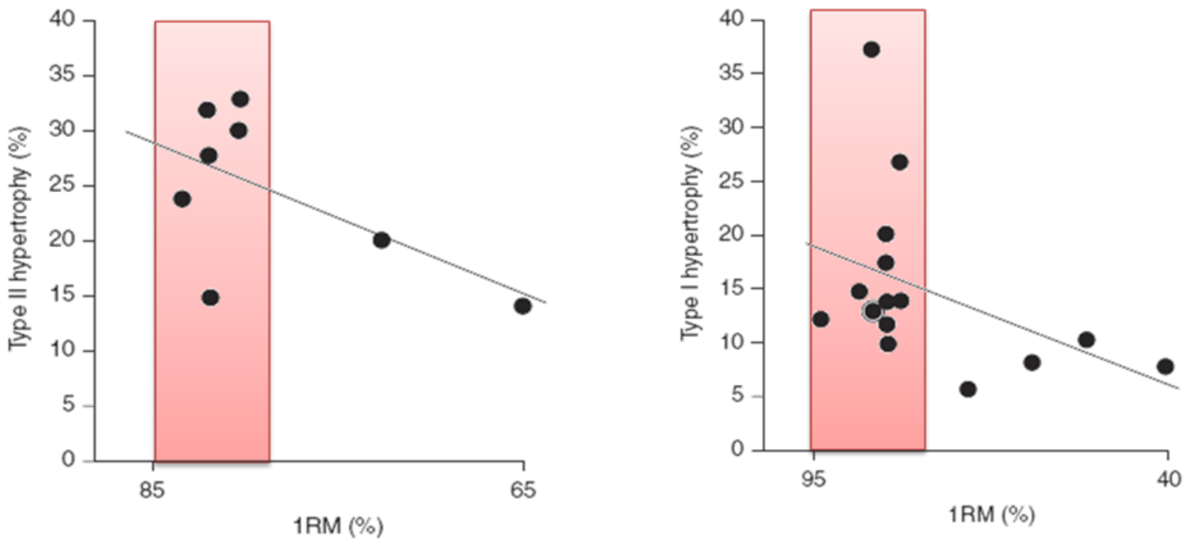
Thus far only one study has compared trained to untrained individuals under a concurrent training protocol. Hunter and colleagues [10] took trained endurance athletes and untrained individuals and had them perform strength training and endurance exercise simultaneously. Predictably it was found that the endurance trained athletes gained more strength then the untrained individuals. Now this suggests that with training experience you are less prone to the negative effects of concurrent training. However the flaw in this study is that they did not examine these endurance athletes while under resistance training alone conditions. Regardless studies have found that adding endurance training to strength training regimens can result in negative effects in both trained [5, 11]and untrained [6, 12] individuals. There are a number of hypotheses however that can be applied toward the experience of an individual.

With training experience you are likely to become less prone to decrements from cardiovascular training. There are a number of reasons why:

A. Following any muscle damaging stimulus your body adapts so that you are protected after the next bout of exercise. For example untrained individuals who ran downhill for 30 minutes raised serum indices of muscle damage by 432 % bout one, yet only raised them 63 % when repeated on a second bout [13] With less muscle damage from running you would expect a lower demand from your body's adaptive resources and less interference with resistance training adaptations.
B. A major goal for bodybuilders during cardiovascular exercise is to increase caloric expenditure. In essence the more work you do (e.g. cycling 10 miles vs. 5) the more calories you expend. If trained you can perform more work at lower intensities where you are less prone to drain resources. Thus, if you are trained you may be able to use this experience wisely to avoid any interference effects. Moreover at any given intensity your body adapts to spare its carbohydrate (glycogen) stores by causing the body to use more fat, thereby placing less drain on your limited supply of muscle glycogen. This is discussed further under the intensity section.
C. With training experience the adaptive process changes. For example the protein synthetic response following training is more rapid and spikes to a greater extent in trained vs. untrained individuals. Thus, the window of adaptation is shorter and more abrupt with training experience. This will be discussed under sequencing of endurance training but has serious implications for how long after resistance exercise that you can perform intense cardiovascular exercise.

Training Intensity

The intensity of a given training session ultimately dictates the outcome or adaptation of a given training program. As can be seen in figure 3, for the bodybuilder, weight training intensity thresholds for slow twitch fiber growth appear to occur around 40 % 1-RM and increase growth in a dose manner peaking at around 80-85 % maximal intensity, while the threshold is approximately 60 % for fast twitch fibers again peaking at around 80-85 %. These peaks are approximately 6-12 repetitions for the upper body and anywhere from 12-20 repetitions for the lower body (individuals can perform more reps at a given intensity with the lower body). Training generally lasts 30-90 seconds in this range of all out effort. At the lower end of the range (30 seconds) approximately 80 % of the fuel used is from anaerobic metabolism.



Dose dependent response between intensity and type I and II fiber growth. Modified with red highlight from Fry [14]

Earlier we predicted that the more similar the training protocols are the lower the decrements would be when concurrent training. However this statement should be qualified. If adaptations are indeed conflicting between opposite spectra of training forms (strength vs. endurance), we need to also specify that the training load must also be sufficient to trigger those adaptations. For example, intensities below 50 % heart rate max, such as occurs during walking are far too low to trigger endurance adaptations in trained individuals. From this we postulate that little to no negative chronic effects will occur if cardio is performed at very low intensities. Further because the majority of fuel at low intensities comes from fat stores we further suggest that acute decrements in performance caused by a depletion of glycogen stores will be minimal.

Adaptations in endurance training depend on the training state of the individual. In untrained individuals adaptations can occur when training for a long duration at 50 % and above VO2max, which is relatively low intensity[15]. However in recreationally endurance trained individuals which is what bodybuilders generally fall under adaptations generally do not occur until training at 65 % VO2max and increase in a dose dependent manner thereafter[15]. For elite endurance athletes however whose training volumes are already high it appears that higher intensities are necessary (>85 % VO2max). When training at 65-80 % VO2max individuals can generally go long durations (30-60 minutes). However at higher intensities (>85 % VO2max) individuals can only train so long and must use intervals. Studies indicate that interval training is optimized at approximately 85-90 % VO2max intensity for 4-5 minutes of work for anywhere from 5-8 intervals[15]. It is important to note that short intervals of 5 minutes of all out work uses the mirror opposite in metabolism(80 % of the fuel is from aerobic metabolism) compared to 30 seconds of all out work (80 % anaerobic metabolism). Therefore the majority of studies have investigated moderate intensity (60-80 % intensity) continuous (30-60 minutes) endurance training, interval training (20 seconds to 5:00 minutes all out for repeated bouts), or a combination of the two.

We postulate that susceptibility to decrements in muscle size, strength, and power will be a factor of both acute fatigue produced by cardiovascular exercise (e.g. glycogen depletion), and chronic conflicting adaptations.

Acute Fatigue

For acute fatigue it is important to note that the use of carbohydrate stores dominates at intensities greater than 65 % VO2max and increases in a dose dependent manner thereafter. For an intensity of 70 % VO2max carbohydrates comprise approximately 60 % of the fuel, while at intensities of 85 % VO2max they comprise approximately 85 % of the fuel, with nearly 100 % at intensities greater than 90 % . Thus a continuous session at moderate intensity (30 minutes) would be predicted to cause less fatigue then 5 all out intervals at close to 90 % VO2max. Thus from an acute perspective optimal interval training (4-5 minute bouts for 6-8 intervals) will leave a bodybuilder more prone to fatigue then moderate intensity continuous training.

Conflicting Chronic Adaptations

Adaptations to endurance training can occur centrally and peripherally. Central adaptations include an increase in cardiac output (blood flow circulated by the heart per minute) as well as neural adaptations which favor prolonged activity(asynchronous firing) [16]. Peripheral adaptations occur at the level of muscle tissue and include adapting the muscle to use a greater percentage of fat for fuel as well as enhance overall aerobic capacity[16]. Generally moderate intensity exercise causes mostly central adaptations, while interval training may have both central and peripheral adaptations [17]. This led Dochery[17] to suggest that the greatest interference effects would occur following interval training. Generally studies which include interval training for a duration of at least 5 minutes, whether cycling or running demonstrate decreases in strength and often times hypertrophy[4, 5]. When analyzing long duration vs. interval training it is best to compare cycling studies as this appears to be the optimal modality of endurance training. Continuous cycling for 30-60 minutes at moderate intensities (60-80 % HRM) appears to not impair free weight strength, motor unit recruitment with slow velocities, or muscle hypertrophy[3, 8, 18, 19]. However it does appear to impair rate of force development, power, and motor unit recruitment at fast velocities [19] This makes sense according to our model which suggests that moderate intensity cardio may be enough to stimulate central (e.g. neural) but not peripheral adaptations [17].

Optimizing Concurrent Training with the Use of Short Duration Intervals

One possible form of endurance training that may not result in decrements is short duration sprints. For example Balbanos[20] and colleagues had basketball players strength train 4 days and 7 hours after each session perform high intensity sprint training. These investigators had athletes perform high intensity sprinting in which the first 4 of 6 weeks only consisted of 100 and 200 meter sprints, while weeks 5-7 incorporated several short 30 meter sprints, with a few longer 400-500 meter sprints. One sample workout included in order of operation: 2*100 meter sprints, 2*80 meter sprints, 10*50 meter sprints, 2*100 meter sprints, 2*80 meter sprints, and finally 10 * 30 meter sprints. Clearly the duration and intensity of these training sessions are very similar to a typical resistance training workout. If these types of training sessions are treated as normal weight training sessions (e.g. the athlete takes into consideration the need for recovery between sessions) then there would be no conflicting adaptations, and perhaps even an augmentation of gains. This is precisely what was found in the study. In general there were no differences between groups for strength or power. In fact some lifts were greater in the concurrent group including 1RM squat (4.5%), lateral pulldown (front) (5.6%), vertical jump (1.5%), Wingate (1.5%), and VO2max (16.1%). And only the concurrent group decreased body fat more than the endurance only group. It should also be noted that sprinting has a high amount of hip flexion, unlike long duration running and is highly correlated to the vertical jump.

Summary of Intensity data

Decrements during concurrent training appear to occur maximally when training at or near maximal aerobic capacity (>85 % VO2max) in intervals of 4-5 minutes and this occurs in all areas including strength, power, and in cases hypertrophy. Longer duration moderate intensity cardio may not impede free weight strength, or muscle growth but generally decreases power. In contrast sprinting for short intervals (<30 seconds) does not appear to impede strength or power, or body composition. Because extremely low intensity cardio such as walking (<50 % HRmax) is not strong enough to significantly cause fatigue in trained athletes, nor enough to stimulate conflicting adaptations it may be that a combination of short duration sprints and low intensity cardio is optimal. For those who are worried about not obtaining a cardiovascular benefit for health purposes, you needn't be. In moderately trained individuals HIT training (8 X 20 second all outsprints) 5 days per week produced greater increases in their VO_{2max} (+15%) and anaerobic capacity (+28%) than a group continuous training for 60 minutes at 70 % VO2 max who increased VO2max by 9.4 % with no increases in anaerobic adaptations.

Sequence and separation between cardio and weights

Sequencing / scheduling takes into account when you should perform cardiovascular exercise relative to your last weight training session. In essence scheduling should take into account how long the fatiguing effects of endurance last, and how long it takes the anabolic window of regeneration is following training so as not to impede the adaptive process.

Several studies have analyzed how long the fatiguing effects of cardiovascular exercise lasts. In general with both continuous long duration and interval training there are decrements in maximal strength and the ability to perform repetitions at a submaximal load immediately, 4 hours, and 8 hours post exercise[21, 22], but these decrements appear to subside by 24 hours[22]. However a previous cardiovascular session, though it does not impede performance, still appeared to change the fiber recruitment response for up to 32 hours[23]. In particular it appears that at least in trained individuals there is greater plasma concentrations of ammonia which is generally thought to increase in formation as a result of a greater reliance on fast twitch fibers, though it may also indicate greater protein degradation[23]. A second variable to consider is glycogen depletion following cardiovascular exercise. Not only will lower glycogen impair performance, but a recent study showed that low glycogen stores impair the anabolic response to resistance training. Studies indicate that when carbohydrates are adequate that glycogen replenishment occurs by 24 hours[24]. Therefore we suggest that prior to 24 hours there is a suboptimal window to generate an anabolic response to resistance training (Figure 3.0)

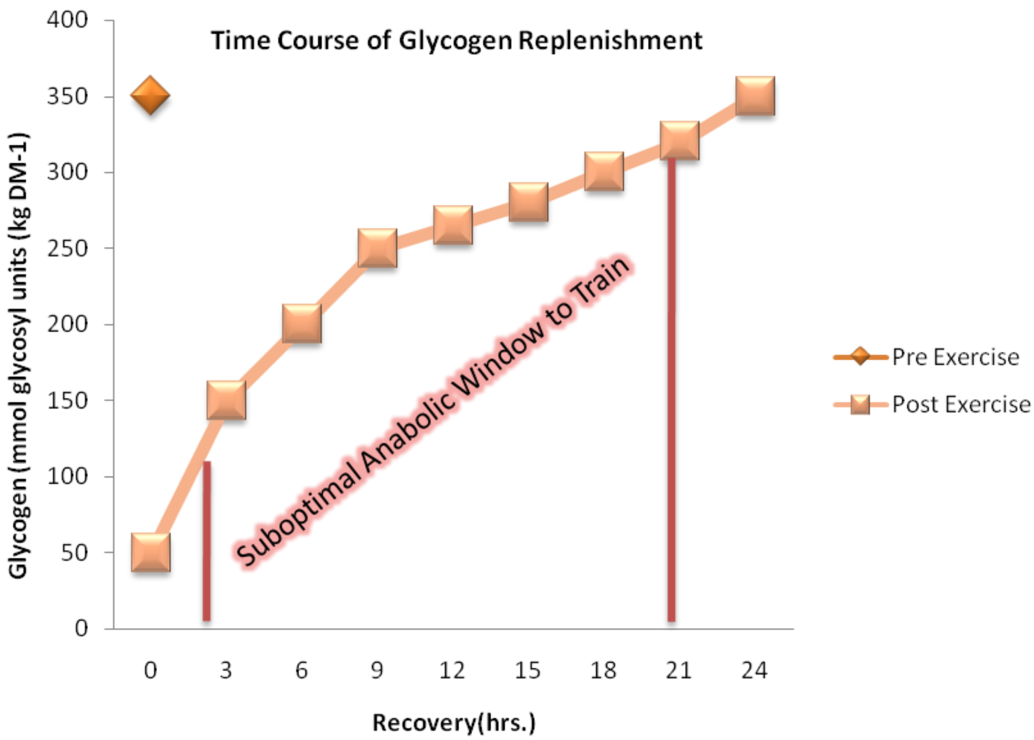
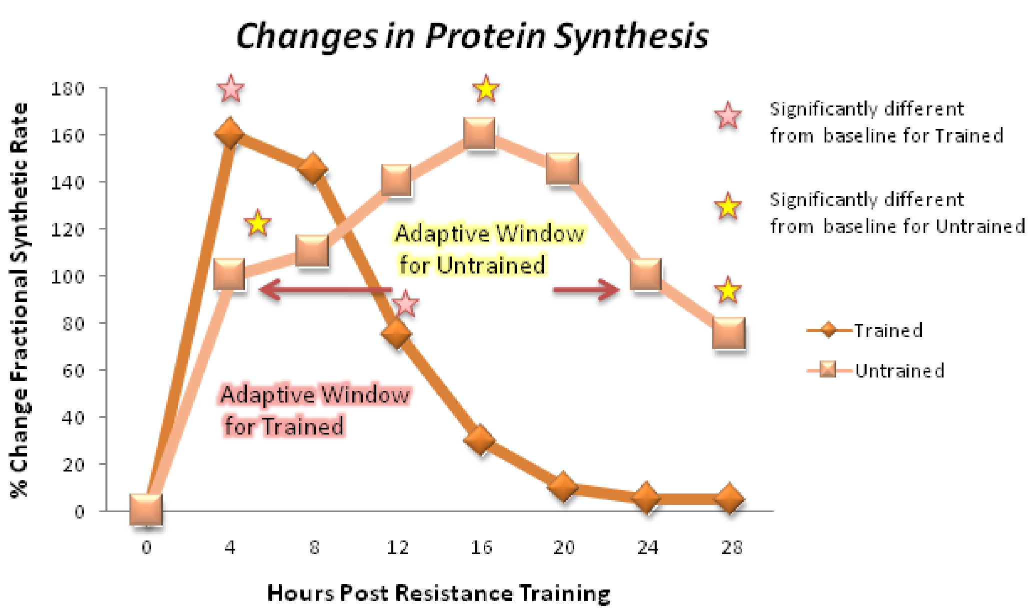


Figure 3.0 Suboptimal window to resistance train. Data to construct figure from Widrick et al. [24]

The second window bodybuilders should be weary of is after exercise. Following training protein synthesis rises within the first hour. In untrained individuals it peaks at 16 hours but can be maintained for up to 72 hours. However, in untrained individuals it peaks at approximately 4 hours but is back to baseline within 16-20 hours. This indicates that in trained individuals endurance training may impair signaling if done before a day has passed, while in untrained individuals it can be up to 3 days!



Summary of Concurrent Training Principles

Modality – Cycling is preffered over running

Intensity – Bodybuilders should perform either very low intensity endurance training (>50 % VO2max) or very high intensity sprints (20X20 second sprints). If performing more traditional cardio, there will be less decraments with moderate intensity (65 % heart rate max) moderate duration (30-60 minutes) as compared to high intensity (>90 % Heart rate max) intervals lasting 4-6 minutes in duration.

Sequencing – In general for trained individuals cardio should be separated from leg days by at least 24 hours prior to and after the training session. For untrained individuals who have difficulty putting on size 24 hours before, and up to 72 hours after should be the optimal prescription. However, if body fat loss is a priority, then they should still wait 24 hours following training.

Keep it Hard-core

Jacob Wilson – jwilson@abcbodybuilding.com

Gabriel Wilson – venom@abcbodybuilding.com

1. Glowacki SP, Martin SE, Maurer A, Baek W, Green JS, Crouse SF. Effects of resistance, endurance, and concurrent exercise on training outcomes in men. *Med Sci Sports Exerc.* Dec 2004;36(12):2119-2127.
2. Dolezal BA, Potteiger JA. Concurrent resistance and endurance training influence basal metabolic rate in nondieting individuals. *J Appl Physiol.* Aug 1998;85(2):695-700.
3. McCarthy JP, Agre JC, Graf BK, Pozniak MA, Vailas AC. Compatibility of adaptive responses with combining strength and endurance training. *Med Sci Sports Exerc.* Mar 1995;27(3):429-436.
4. Bell GJ, Syrotuik D, Martin TP, Burnham R, Quinney HA. Effect of concurrent strength and endurance training on skeletal muscle properties and hormone concentrations in humans. *Eur J Appl Physiol.* Mar 2000;81(5):418-427.
5. Kraemer WJ, Patton JF, Gordon SE, et al. Compatibility of high-intensity strength and endurance training on hormonal and skeletal muscle adaptations. *J Appl Physiol.* Mar 1995;78(3):976-989.
6. Craig B, Lucas J, Pohlman R. Effects of running, weightlifting and a combination of both on growth hormone release. . *J Appl Sport Sci Res.* 1991;5:198-203.
7. Sale DG, MacDougall JD, Jacobs I, Garner S. Interaction between concurrent strength and endurance training. *J Appl Physiol.* Jan 1990;68(1):260-270.
8. Nelson AG, Arnall DA, Loy SF, Silvester LJ, Conlee RK. Consequences of combining strength and endurance training regimens. *Phys Ther.* May 1990;70(5):287-294.
9. Koller A, Mair J, Schobersberger W, et al. Effects of prolonged strenuous endurance exercise on plasma myosin heavy chain fragments and other muscular proteins. Cycling vs running. *J Sports Med Phys Fitness.* Mar 1998;38(1):10-17.
10. Hunter G, Demment R, Miller D. Development of strength and maximum oxygen uptake during simultaneous training for strength and endurance. *J Sports Med Phys Fitness.* Sep 1987;27(3):269-275.
11. Hennessy L, Watson A. The interference effects of training for strength and endurance simultaneously. . *J Strength Cond Res.* 1994;12(8):9-12.
12. Dudley GA, Djamil R. Incompatibility of endurance- and strength-training modes of exercise. *J Appl Physiol.* Nov 1985;59(5):1446-1451.

13. Byrnes WC, Clarkson PM, White JS, Hsieh SS, Frykman PN, Maughan RJ. Delayed onset muscle soreness following repeated bouts of downhill running. *J Appl Physiol.* Sep 1985;59(3):710-715.
14. Fry AC. The role of resistance exercise intensity on muscle fibre adaptations. *Sports Med.* 2004;34(10):663-679.
15. Kubukeli ZN, Noakes TD, Dennis SC. Training techniques to improve endurance exercise performances. *Sports Med.* 2002;32(8):489-509.
16. Laursen PB, Jenkins DG. The scientific basis for high-intensity interval training: optimising training programmes and maximising performance in highly trained endurance athletes. *Sports Med.* 2002;32(1):53-73.
17. Docherty D, Sporer B. A proposed model for examining the interference phenomenon between concurrent aerobic and strength training. *Sports Med.* Dec 2000;30(6):385-394.
18. Hakkinen A, Hannonen P, Nyman K, Lyyski T, Hakkinen K. Effects of concurrent strength and endurance training in women with early or longstanding rheumatoid arthritis: comparison with healthy subjects. *Arthritis Rheum.* Dec 15 2003;49(6):789-797.
19. Hakkinen K, Alen M, Kraemer WJ, et al. Neuromuscular adaptations during concurrent strength and endurance training versus strength training. *Eur J Appl Physiol.* Mar 2003;89(1):42-52.
20. Balabinis CP, Psarakis CH, Moukas M, Vassiliou MP, Behrakis PK. Early phase changes by concurrent endurance and strength training. *J Strength Cond Res.* May 2003;17(2):393-401.
21. Leveritt M, Abernethy P. Acute effects of high-intensity endurance exercise on subsequent resistance activity. . 1999;13:47-51.
22. Sporer BC, Wenger HA. Effects of aerobic exercise on strength performance following various periods of recovery. *J Strength Cond Res.* Nov 2003;17(4):638-644.
23. Leverrett M, Mackaughlin H, Abernethy PJ. Changes in leg strength 8 and 32 hours after endurance exercise. J. . *Sport Sci. .* 2000;18:865-871.
24. Widrick JJ, Costill DL, Fink WJ, Hickey MS, McConell GK, Tanaka H. Carbohydrate feedings and exercise performance: effect of initial muscle glycogen concentration. *J Appl Physiol.* Jun 1993;74(6):2998-3005.
25. Burd NA, Tang JE, Moore DR, Phillips SM. Exercise Training and Protein Metabolism: Influences of Contraction, Protein Intake, and Sex-based differences. *J Appl Physiol.* Nov 26 2008.