2017 Ohio Association of Track and Cross Country Coaches Clinic

The Art and Science of Recovery

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What is Recovery?

Characterized by two major processes:

1) Reestablishment of Homeostasis

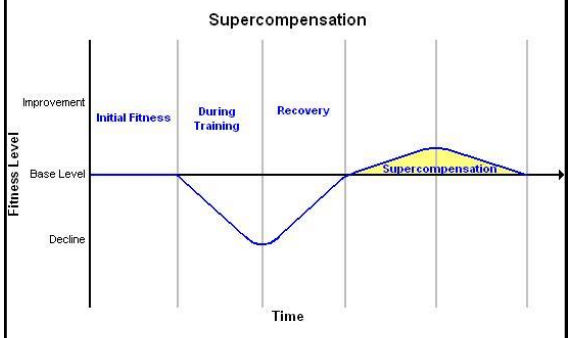
- process during which body recovers from stress imposed by exercise & reestablishes homeostasis in immediate hours after exercise
- characterized by decreased HR & body temp, glucose sparing, elevated fat oxidation, glycogen & CP resynthesis, repair of free radical-mediated damage, lactate removal, & restoration of intracellular electrolyte concentrations & acid-base balance (pH)

2) Adaptation

- process during which body responds to repeated exercise over time
- Workout → signal → activation of transcription factors (proteins that bind to DNA & control transfer of genetic information from DNA to RNA)
- DNA replication → RNA transcription → translation to protein → transportation of protein from cell nucleus to place where it will function
- repeated workouts lead to concerted accumulation of messenger RNAs that are translated into a host of structural & functional proteins
  - With endurance training, accumulation of proteins is manifested as an increase in number of mitochondria.
  - With strength training, accumulation of proteins is manifested as an increase in number of contractile proteins (actin & myosin).

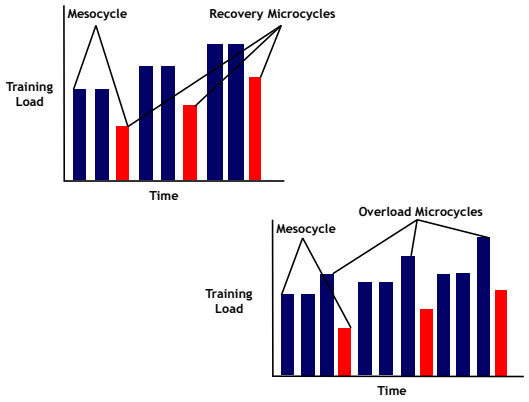
- Improvements in fitness occur during the *recovery* period between workouts, not during the workouts themselves.
- The human body is great at adapting to stress *as long as that stress is applied in small doses*. When the stress is too severe, or not enough recovery has preceded the new stress, injury can result.
- Positive physiological adaptations to training occur when there is a correctly-timed alternation between stress and recovery. When athletes finish a workout, they are weaker, not stronger. How much weaker depends on the severity of the training stress. The faster and more complete athletes' recovery, the more they will get out of their training.

- The most effective adaptations occur when athletes are recovered from previous training & best prepared to tolerate a subsequent overload.
- The greater the training stimulus, the longer the time needed for recovery and adaptation to the stimulus.
- While much of training is a science, with specific biochemical & physiological changes occurring through the use of specific workouts, manipulating stress & recovery in organized & systematic training program to achieve greatest adaptation possible is an art. As such, it needs to be practiced & fine-tuned like other forms of art.



Recovery During Training

- Give athletes chance to adapt & habituate to each level of training before increasing level. Every few weeks, back off volume by about a third for one recovery week before increasing training load. Train athletes in cycles, using final week of cycle as recovery week to absorb the training, make the necessary adaptations, & recover so they can handle upcoming training load.
- Make athletes' training polarized—run easy on easy days so they can truly recover & hard on hard days to provide stress. When designed this way, with both stress & recovery given equal attention & diligence, it is an elegant system that works.



Recovery During Workouts

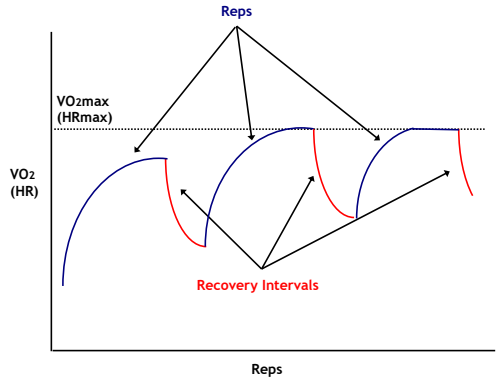
Interval Training

- When interval training was first studied in 1930s, focus was on its cardiovascular aspects with belief that stimulus for cardiovascular improvement occurs during recovery intervals between work periods rather than during periods of activity, as heart rate decreases from elevated value. Emphasis of workout was placed on recovery interval, prompting the name "interval workout" or "interval training."
- During recovery interval, heart rate declines at proportionally greater rate than return of blood to heart, resulting in brief increase in stroke volume. Since stroke volume peaks during recovery interval, & because there are many recovery intervals during interval workout, stroke volume peaks many times, providing stimulus for improving maximum stroke volume & capacity of O_2 transport system, reflected by higher VO_2max.

Recovery During Workouts

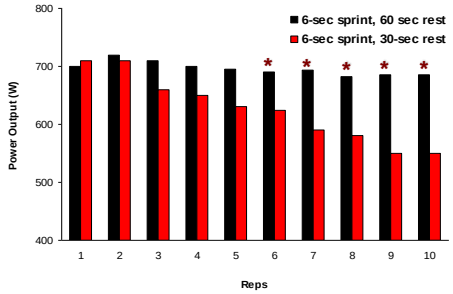
Interval Training

- VO_2max Intervals (3- to 5-min reps)
  - equal to or slightly less than time of rep (1:≤1 work:rest ratio); active
- Anaerobic Capacity Intervals (30-sec to 2-min reps)
  - double time of rep (1:2 work:rest ratio); active
- Anaerobic Power Intervals (5- to 15-sec reps)
  - up to 10 x time of rep(1:5-10 work:rest ratio); passive
  - the longer the rest interval, the more ATP & CP will be restored & the more ATP-CP system can be used as energy source during subsequent reps



Training Anaerobic Power

Influence of Recovery Intervals



Data from Holmyard et al. (1988). *Significantly different from 30-second recovery ($p<0.05$).

Recovery During Workouts

Strength Training

- Muscular Hypertrophy
  - 1 min
  - consecutive sets should be performed prior to full recovery
- Muscular Strength/Power
  - 3-5 min (allows for maintenance of intensity & replenishment of CP stores)
- Muscular Endurance
  - 30 sec

Post-Workout Recovery

- Factors affecting recovery:
  - age (younger people recover faster between workouts)
  - training intensity (higher intensity workouts require more recovery)
  - nutrition
  - environment
  - stress
  - level of cardiovascular fitness (high level of cardiovascular fitness speeds recovery)
- Estrogen protects muscle tissue, inhibits inflammation, & plays significant role in stimulating muscle repair & regeneration following strenuous exercise. Although exact mechanisms by which estrogen influences skeletal muscle damage, inflammation, & repair are not totally clear, estrogen may exert its protective effects by acting as antioxidant, by stabilizing muscles' membranes, & by governing regulation of genes.

Post-Workout Recovery

Refuel

Refueling nutrient-depleted muscles is possibly single most important aspect of optimal recovery.

CHO	PRO
↓	↓
Resynthesis of muscle & liver glycogen	Reparation of damaged tissue
Supports immune function	Synthesis of new protein

Post-Workout Recovery

Refuel

- Endurance running performance is influenced by amount of stored glycogen in skeletal muscles, & intense endurance exercise decreases muscle glycogen stores. The faster you can resynthesize muscle glycogen, the faster the recovery.
- To maximize rate of glycogen synthesis, consume 0.7 gram CHO per pound within 30 minutes after workouts, & 0.7 g/lb every 2 hours for 4-6 hours afterward.

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Chocolate Milk as a Post-Exercise Recovery Aid

Jason R. Karp, Jeanne D. Johnston, Sandra Tecklenburg, Timothy D. Mickleborough, Alyce D. Fly, and Joel M. Stager

Nine male, endurance-trained cyclists performed an interval workout followed by 4 h of recovery, and a subsequent endurance trial to exhaustion at 70% VO_{2peak} on three separate days. Immediately following the first exercise bout and 2 h of recovery, subjects drank isovolumic amounts of chocolate milk, fluid replacement drink (FR), or carbohydrate replacement drink (CR), in a single-blind, randomized design. Carbohydrate content was equivalent for chocolate milk and CR. Time to exhaustion (TTE), average heart rate (HR), rating of perceived exertion (RPE), and total work (W_t) for the endurance exercise were compared between trials. TTE and W_t were significantly greater for chocolate milk and FR trials compared to CR trial. The results of this study suggest that chocolate milk is an effective recovery aid between two exhausting exercise bouts.

Post-Workout Recovery

Refuel

- Protein is another important nutrient to consume after hard & long workouts, especially when trying to build muscle.
- To repair muscle fibers damaged during training, consume 20-30 grams of complete protein (which contain all essential amino acids) after workout.

Post-Workout Recovery

Rehydrate

- Water is vital for many chemical reactions that occur inside cells, including production of energy. When your athletes sweat during exercise, they lose body water that can affect cellular processes.
- Blood volume decreases & becomes thicker if fluid is not replaced, leading to decreased stroke volume, cardiac output, & oxygen delivery. Running performance starts to decline with 2-3% loss of body mass due to fluid loss.
- To rehydrate, drink ½ liter/lb of weight lost during exercise.
- Fluids that contain sodium stimulate kidneys to retain water.
- A good indicator of hydration is urine color, with light color = adequate hydration. If urine looks like apple juice, keep drinking.

Post-Workout Recovery

Other Strategies

- Active recovery
- Adequate sleep
- Reduce other stress in your life
- Limit other activity during day
- Massage?